



DEPARTMENT OF THE AIR FORCE  
HEADQUARTERS UNITED STATES AIR FORCE  
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AFI91-203\_AFGM3

19 August 2014

MEMORANDUM FOR DISTRIBUTION \_\_\_  
MAJCOMs/FOAs/DRUs

FROM: AF/SE

SUBJECT: Air Force Guidance Memorandum to AFI 91-203, *Air Force Consolidated Occupational Safety Instruction*

By Order of the Secretary of the Air Force, this AF Guidance Memorandum is reissued to immediately change AFI 91-203. This AFGM supersedes AFI 91-203\_AFGM2 that was issued on 25 July 2013. Compliance with this Memorandum is mandatory. To the extent its directions are inconsistent with other Air Force publications, the information herein prevails, in accordance with AFI 33-360, *Publications and Forms Management*.

In advance of a rewrite of AFI 91-203, the Attachment to this Memorandum is updated to provide guidance changes that are effective immediately. An asterisk (\*) indicates newly revised material.

The Memorandum becomes void after one-year has elapsed from the date of this Memorandum, or upon incorporation of an Interim Change or rewrite of AFI 91-203, whichever is earlier.

KURT F. NEUBAUER, Maj Gen, USAF  
Chief of Safety

Attachment:  
Guidance Changes

## **Attachment**

### ***Guidance Changes***

**The below changes to AFI 91-203, dated 15 June 2012, are effective immediately.**

**1.3.1.** The Air Force publishes industrial and general ground safety guidance as Air Force instructions, which implement OSHA standards. The use of this instruction covers hazards which exist in a wide variety of situations and is therefore considered to be applied as a horizontal standard, the same as OSHA does with 29 CFR 1910. Area-specific instructions and technical data include other safety criteria. When AFOSH guidance or safety criteria does not cover a situation, use non-Air Force standards, including national consensus standards, professional safety and health standards, and other Federal agency standards. Air Force activities must comply with OSHA requirements at all times unless the military-unique exemption applies according to DoDI 6055.1, *DoD Safety and Occupational Health Program*. **Note:** AFOSH guidance must be followed at all times. They implement parts of 29 CFR, and include additional requirements not addressed by the OSHA standards. In addition, safety, fire prevention and occupational health requirements in equipment technical orders (TO) must be followed at all times.

**4.14.8.** Is PPE provided and used when needed to protect the hands and feet of workers involved in manual materials handling activities? Reference **4.7.1**

**4.14.9.** Are wheeled hand trucks and dollies loaded so the cargo is stable and the loads won't slip, shift or fall? Reference **4.9.1.5**

**4.14.10.** Is the rated capacity on all lever operated hoists permanently and conspicuously marked and easily visible? Reference **4.9.3.1.1**

**4.14.11.** Are hoists equipped with a device (ratchet and pawl or load brake) that prevents a suspended load from self-lowering and ensures loads are only lowered by operation of the hoist lever? Reference **4.9.3.1.2**

**4.14.12.** Are hoists inspected daily or prior to each use for items such as loose or worn parts, cracked or broken welds, deformed hooks or chain, and bent or deformed pawls? Reference **4.9.3.2**

**4.14.13.** Is an annual inspection accomplished on all MHE? Reference **4.9.3.3**

**4.14.14.** Are identification tags attached to hoists indicating date of inspection, date of proof test, capacity of hoist and identification number of hoist? Reference **4.9.3.4**

**4.14.15.** Do hoist users maintain records of all tests? Reference **4.9.3.5.1**

**4.14.16.** Are only approved lifting devices like slings used to lift loads? Reference **4.9.3.6.2**

**4.14.17.** Do material handlers remove finger rings and jewelry prior to working with materials or moving machinery? Reference **4.11.6**

**4.14.18.** Are materials neatly stacked and the height limited to minimize the possibility for the materials to fall or collapse? Reference **4.13.1**

**4.14.19.** Delete.

**5.2. Scraps and Combustible Waste.** Provide sufficient metal or noncombustible containers with self-closing lids for disposal or recycling of combustible wastes, rags or other items contaminated with combustible or flammable materials. These containers shall be marked IAW AFI 32-7042, *Waste Management*, and AFI 90-821, *Hazardous Communications*. Dispose of contents IAW approved hazardous waste disposal procedures. Contact the installation environmental management office for guidance. Ground areas around facilities where liquids are stored, handled or used shall be kept free of weeds, trash or other unnecessary combustible materials.

**5.3. Combustible Materials.** In industrial operating areas where flammable or combustible liquids and other combustible materials, to include non-soiled excelsior (fine wood shavings), straw, recyclable cardboard or paper, are used or stored, combustible materials shall be kept to a minimum, stored in covered metal containers and disposed of daily. This requirement is applicable when storage of flammable and combustible liquids exceeds:

**5.3.1.** 60 gallon capacity in fixed tanks.

**5.3.2.** 660 gallon capacity in portable tanks.

**5.3.3.** 793 gallon capacity in intermediate bulk containers.

**5.9.7.** Noncombustible materials shall be neatly kept in designated cabinets with their contents plainly marked).

**5.9.8.** Clothing lockers shall be maintained in a clean, orderly condition. Apparel not needed to perform official duties shall be stored in lockers. Objects shall not be stored on top of or under clothing lockers and no flammable liquids shall be stored in lockers.

**5.9.9.** Machinery and equipment shall be kept clean of excess grease and oil and free of excessive dust. Pressure gauges and visual displays shall be kept clean, visible and serviceable at all times. Drip pans and wheeled or stationary containers shall be cleaned and emptied at the end of each shift.

**5.9.10.** Certain cleaning compounds used in housekeeping activities may pose a hazard to workers. To protect eyes, skin and clothing from these compounds, workers shall wear (as required) safety glasses, face shields, aprons and gloves. Installation Ground Safety office and

BE shall be consulted with questions pertaining to PPE. Refer to **Chapter 14** for additional guidance.

**5.9.11.** All surfaces shall be maintained as free as practicable of accumulations of dust, lead, chromium, cadmium or any other foreign particles. Floors shall be kept clean. Spills shall be cleaned up as soon as possible.

**5.9.12. Delete.**

**5.9.13. Delete.**

**6.2.3.** Health Care Facilities. Facility managers and/or safety officers of health care occupancies shall have in effect a written fire plan that addresses appropriate staff response to a fire emergency and appropriate education and training for all elements of the fire plan. The plan will address facility-wide needs in response to fire, area-specific needs for all areas, training for all staff, employees and volunteers, and appropriate training for other non-staff personnel required to participate in the fire plan. This fire plan shall be approved by the Installation Fire Chief. Facility managers shall ensure fire exit drills are conducted IAW NFPA 101.

**6.2.4.7.** Visual Inspection. Managers and supervisors at all levels shall ensure a visual inspection is performed and documented monthly for all fire extinguishers under their control. Extinguishers with discrepancies shall be removed from service until repaired. This inspection includes:

**7.2.1.7.6.** Newly constructed guard railings shall consist of securely mounted top rails, intermediate rails and posts. The top rail vertical height shall be 42 inches, nominal, from the upper surface of the top rail to the floor, platform, runway or ramp level. The intermediate rail shall be approximately halfway (minimum of 21 inches high) between the top rail and the floor, platform, runway or ramp.

**7.5.2.7.** Personnel Training. Personnel who use ladders at any working height shall be adequately trained in the care and use of different types of ladders. The supervisor or a designated trainer shall conduct this training when a worker is first assigned. Refer to paragraph **7.4.6** for additional information on ladder training. Information presented during safety briefings shall satisfy the periodic training requirement. All training shall include hands-on instruction to include inspection of ladders for defects, possible electrocution hazards, proper positioning and placement of ladders for various job sites. Training shall be documented IAW instructions in AFI 91-202, *The US Air Force Mishap Prevention Program* (paper or electronic system may be used).

**7.7.59.** Are personnel who use ladders adequately trained by the supervisor in the care and use of different type ladders when a worker is first assigned? Reference **7.5.2.7**

**7.7.60.** Are ladders stored in a way that provides easy access for inspection and permits their safe withdrawal for use? Reference **7.5.2.5.3**

**7.7.61.** Are wood ladders stored in a location free from exposure to the elements and excessive heat or dampness? Reference **7.5.2.5.3**

**8.9.7.** Ground Fault Circuit Interrupters (GFCI) shall be used on all 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets at job sites where the receptacles are not part of the building/structure permanent wiring. Receptacles on a two-wire, single-phase portable or vehicle-mounted electrical generator rated not more than 5 kilowatts (kW), where electrical generator conductors are insulated from the generator frame and other grounded surfaces, shall be permitted without GFCI protection. Receptacles shall be located outside wet process areas or protected by a GFCI. To protect large areas, GFCI breakers shall be located in the circuit panel. 125-volt, single-phase, 15- and 20-ampere receptacles installed in locations below shall include GFCI protection. See NFPA 70, *National Electrical Code*, Article 210.8, for exceptions, i.e., for locations where GFCIs are not required.

**8.9.7.2.6.** Sinks – where receptacles are installed within six (6) feet of the outside edge of the sink.

**8.9.7.2.7.** Indoor wet locations.

**8.9.7.2.8.** Locker rooms with associated showering facilities.

**8.9.7.2.9.** Garages, service bays and similar areas where electrical diagnostic equipment, electrical hand tools or portable lighting equipment are to be used.

**8.9.9. Delete.**

**8.11.5.2.** Supervisors shall consult with installation Ground Safety office to determine if insulating matting is required in their areas of responsibility. This includes areas where potential shock hazards exist and additional protection is needed, floor resistance is lowered due to dampness and where high voltage (greater than 600 volts, nominal) may be encountered, such as high voltage consoles. Areas with electrical repair or test benches (shops), motors or equipment and control panels require insulating matting.

**8.12. Emergency Equipment (Electrical Safety).** In addition to electrical PPE provided to workers, functional managers shall ensure emergency equipment is available at each operating location where maintenance is performed on energized circuits. High voltage is defined as over 600 volts, nominal. Equipment variations depend on local conditions and the squadron commander or functional manager may add additional items. The equipment may be displayed on a board, stored in an unlocked cabinet or made available in a portable kit, and shall be situated in a conspicuous and prominent location at each site, well marked and readily accessible. Equipment shall be protected against chemical, mechanical or environmental deterioration and shall be inspected or tested for serviceability. Emergency equipment shall consist of:

**8.12.8.** High voltage insulated lineman's rubber electrical gloves (both inner and outer gloves) – if rescuer(s) is(are) likely to contact live wires, conductors or current carrying parts while performing rescue. Voltage rating shall be suitable for voltages encountered in the work area.

**Note 1:** Electrical gloves shall be checked before use IAW UFC 3-560-01, *Electrical Safety O & M*, and American Society for Testing Materials (ASTM) F496-85, *Specification for In-service Care of Insulating Gloves and Sleeves*, and shall be tested and marked with the next test due date.

**Note 2:** High voltage is defined as greater than 600 volts, nominal.

**8.18.2.3.** Arc flash protection shall be provided for all Air Force operations exposing personnel to energized parts greater than 50 volts. Protective clothing required, if any, shall be based on the procedures outlined in UFC 3-560-01 and AFI 32-1064.

**8.19.12.** Are only qualified operators who are designated in writing by the supervisor allowed to work on electrical installations and equipment? Reference **8.9.1**

**8.19.13. Delete.**

**10.4. Lifting Requirements.** Procedures in **Chapter 4**, *Manual Material Handling and Lifting Techniques*, shall be used when personnel lift heavy objects, such as files, books, paper, etc. Team lifting shall be evaluated when the person doing the lifting (or their supervisor) considers the item to be too heavy or awkward to lift safely, or the item or lifter is in an awkward position or location. Use a dolly or other material handling equipment, if available, to move heavy or awkward objects. Refer to **Chapter 4** prior to using material handling equipment, as required.

**11.3.8.** Do all outside activities cease and do personnel seek adequate shelter during a lightning warning? Reference **11.2.3.2**

**13.8. Additional Rescue Guidance.** Where non-Air Force professional rescue agencies cannot promptly rescue a fallen AF worker, the installation Ground Safety office and Fire Emergency Services (FES) Flight may establish training for fire protection workers and adequate installation personnel as authorized or competent rescuers. Training shall be documented IAW AFI 91-202. Coordination with the installation Fire Chief is required to determine if the FES Flight is able to support a fall rescue operation.

**14.4.8.3.** Arc-Flash Resistant Clothing. A flash hazard analysis (FHA) shall be performed for all Air Force operations exposing personnel to exposed energized parts at 50 or more volts IAW NFPA 70E, *Electrical Safety in Workplace*, Section 130.3, and UFC 3-560-02, *Electrical Safety*. Protective clothing required, if any, shall be based on the FHA performed.

**14.5.2.** Upon request, the supervisor, with the assistance of the installation Ground Safety office, shall inspect areas with electrical facilities and determine if insulating matting is required for worker protection. Typical examples of areas where insulating matting is required include locations where potential shock hazards exist and additional resistance is required, floor resistance is lowered due to dampness, high voltages (greater than 600 volts, nominal) may be encountered, such as high voltage consoles, and areas with electrical repair or test benches (shops), motors or equipment and control panels.

**14.6.2.** Do supervisors ensure required PPE job safety training is documented as required by AFI 91-202? Reference **14.3.2.1**

**16.4.3.1.2.** For lines rated over 50 kV, the minimum clearance between lines and any part of the aerial lift shall be at least 10 feet (305 cm) plus 4 inches (10 cm) for each 10 kilovolt over 50 kV, or twice the length of the line insulator, but never less than 10 feet (305 cm).

**16.4.4.** Proximity Warning Devices. Proximity warning devices may be installed on aerial platforms but will not release the operator from assuring safe clearance IAW paragraph **16.4.3.**

**16.5.1.** Work platforms with work levels four (4) feet or higher and accessed by a ladder or stairway at an angle over 60 degrees, shall have guardrails, midrails and toeboards IAW paragraph **16.4.6.10** on all three (3) sides of the work platform, not including work platform access opening. Refer to ANSI 92.3, paragraph 4.12.3.

**16.5.3.8.** Self-propelled elevating work platforms shall be in the lowered position prior to being moved. Manually-propelled mobile work platforms shall not be moved with personnel on the working platform unless allowed by manufacturer's instructions. Locking pins or other devices, as required, shall be in place before anyone is allowed to ascend the stairs or ladder. Tools and equipment left on the work platform while the unit is moved shall rest securely on the floor of the platform and be protected by a rail and toeboard IAW paragraph **16.4.6.10.**

**16.5.11.6.** Mobile work platforms shall be operationally inspected IAW TO 00-20-1 by the user daily, before use, for serviceability and leaks. Items to be inspected will include brakes, jacks, wheel locks, cables, locking pins, hydraulic systems, anchor connections, railings and removable attachments, including bolts, pins or other locking devices and overall equipment condition. Maintenance work stands shall have at least two operational brakes, locks or permanently installed jacks. At least two brakes shall be set and all wheel casters locked before any action, i.e., maintenance, inspections, etc., is performed. Wheel chocks may be used in conjunction with these requirements. Vehicle chocks may be constructed or locally manufactured IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, Section 4.1.2. Platforms shall be locked when not in use to avoid rolling down slanted surfaces or being moved by wind. Stands with defects shall be tagged as unserviceable. Inspection should be documented on AFTO Form 244, *Industrial/Support Equipment Record*. **Note:** A daily inspection is not required for days the stand is not used.

**16.6.1.** Do operators of aerial lifts near electric power lines maintain proper clearances? Reference **16.4.3**

**16.6.25.** Are work platforms secured against movement when not being transported? Reference **16.5.11.5**

**18.5.2.1.1.** Supervisors will ensure either a fixed barrier guard, safeguard device or combination of both is installed and used on every operation when the opening between the die (tool) and base (anvil) is more than ¼ inch. The functional manager and installation Ground Safety office must approve guarding by location. The use of hand-feeding tools, regardless of size, does not

replace a guard or device. Refer to 29 CFR 1910.212 and 1910.217 for additional safe distance and maximum opening requirements.

**18.5.2.21.4.** Belt dressing should not be applied when the belt or rope is in motion. However, if necessary, it shall be applied where belts leave the pulleys, not where they approach them.

**21.3.3.1. AF Form 983, Danger – Equipment Lockout Tag.** The **AF Form 983** and equivalent DoD and commercial tags are authorized for lockout purposes and shall be used for lockout situations. This tag shall be placed on equipment that has been removed from service for maintenance purposes. All employees shall be instructed that these tags indicate that equipment is locked out for maintenance.

**21.4. LOTO Procedures.** Only authorized workers shall perform LOTO procedures. Personnel directly affected by the operation or shutdown of the equipment or machine shall be notified of LOTO devices. Notification shall be given before controls are applied and after they are removed. Refer to paragraph **21.7** for sample procedures. Procedures for applying locks or tags shall include and be performed in the following order. **Note:** If not specifically called for by governing directives for the task being performed, it is recommended that workers be assigned in teams (minimum of two [2] people), one serving as a safety observer.

**21.4.2.7.2.** When the equipment to be worked on does not have normal controls, e.g., on/off switch, etc., use the following procedure for isolation confirmation. Test potential energy sources using appropriately rated and calibrated instruments or testers. Instruments used to test voltage, pressure or temperature shall be checked for proper operation both before and after use. If the authorized worker is not qualified to test the energy being isolated, he or she shall ensure the energy is tested by a qualified person.

**21.4.2.9.** Step Nine – Before restoring machines and equipment to service, the supervisor or authorized employee will:

**21.4.2.9.1.** Ensure all personnel, tools and maintenance or servicing equipment have removed and guards have been reinstalled.

**21.4.2.9.2.** Notify personnel the locks or tags have been removed and equipment is in service.

**21.4.2.9.3.** Remove all locks or tags and restore the energy isolating device to the ‘ON’ position.

**21.6.1. Self-Assessments.** Shop LOTO self-assessments shall be conducted by an authorized worker or supervisor annually, to ensure compliance with all program elements. Self-assessments shall be designed to correct any deviations or inadequacies observed. Refer to **Figure 21.10** for a sample assessment sheet. The assessment shall be documented, provide for a demonstration of the procedures and include, as a minimum:



## EQUIPMENT SPECIFIC LOTO CHECKLIST

**Figure 21.9. Equipment Specific LOTO Checklist.** *This is a tool and shall not replace a written LOTO program.*

A. Equipment Identification: _____		Location: _____
B. This procedure covers servicing and maintenance of machines and equipment in which “unexpected” energization or start up of the machines or equipment, or release of stored energy could injure employees. Authority: 29 CFR 1910.147(c)(4)		
SCOPE OF THIS PROCEDURE: _____		
C. HAZARDOUS ENERGY TYPE ( <i>Hazard</i> ): (Check All That Apply)		
<p>1. Electrical: (<i>shock, electrocution, arc flash</i>)</p> <p><input type="checkbox"/> a. Voltage: AC &lt; 30 or DC &lt; 50 volts</p> <p><input type="checkbox"/> b. Voltage: AC or DC but ≤ 600 volts</p> <p><input type="checkbox"/> c. Voltage: &gt; 600 volts*</p> <p><input type="checkbox"/> d. High current: &gt; 25 amperes at any voltage</p> <p>Include: Capacitors and Batteries</p> <p>IAW AFI32-1064, <i>Electrical Safe Practices</i></p> <p>2a. <input type="checkbox"/> Pneumatic / Hydraulic: &gt; 1 Atmosphere which results in hazardous energy (<i>crush, whipping, noise, shrapnel</i>)</p> <p>Include: Reservoirs, Receivers, Tanks</p>	<p>2b. <input type="checkbox"/> Mechanical: (<i>crush, drop, punch, pinch, grab, cut, rotate</i>)</p> <p>Include: Springs, Platforms (raised), Pendula, Bungees, Flywheels</p> <p>2c. <input type="checkbox"/> Vacuum: &lt; 1 Atmosphere (<i>crush, whipping, noise, shrapnel</i>)</p> <p>Include: Reservoirs, Receivers, Tanks</p> <p>2d. <input type="checkbox"/> Thermal, High temperature: &gt; 120° F surface temperature (<i>burns</i>)</p> <p>2e. <input type="checkbox"/> Thermal, Cryogenic: Unguarded delivery line or conduction to a part where exposure potential exists, potential contact with a cryogenic liquid. (<i>extreme freezing, asphyxiation</i>)</p>	<p>3. <input type="checkbox"/> Chemical: Explosion, Fire, Corrosion, Oxidization, Toxin, Asphyxiation, Mutation, Instability</p> <p>4. <input type="checkbox"/> Radiation: Electro-magnetic, Microwave, Infrared, LASER, Ultraviolet, Ionizing.</p> <p>5. <input type="checkbox"/> Other: Specify:</p> <p style="text-align: center;">_____</p>

D. JOB SPECIFIC LOCKOUT INFORMATION

D.1 <u>Specific Lockout Locations</u> Identification	<u>Lockout Procedure Order</u> Location/Isolation Device	D.2 <u>Dissipate stored energy at these points:</u>  _____
_____	_____	D.2 <u>Block these parts/remove linkages:</u>  _____
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	

E. NAMES OF AUTHORIZED WORKERS PERFORMING THIS LOCKOUT:  
  
\_\_\_\_\_

F. NAMES OF PERSONNEL AFFECTED BY THIS LOCKOUT:  
  
\_\_\_\_\_

G. VERIFICATION REQUIREMENTS:  
  
\_\_\_\_\_

H. SAFETY MEASURES/SPECIAL INSTRUCTIONS: (i.e. PPE)  
  
\_\_\_\_\_

I. LIST ADDITIONAL INFORMATION AS REQUIRED:  
  
\_\_\_\_\_

J. BASIC LOCKOUT PROCEDURES

- 1.  Preparation.
- 2.  Notification.
- 3.  Shutdown.
- 4.  Isolation/Verification.
- 5.  LOTO Device Application.
- 6.  Additional Measures.
- 7.  Isolation Confirmation.
- 8.  Keep LOTO Devices in Place.

K. RELEASE FROM LOCKOUT/TAGOUT

- 1.  Preparation and Notification.
- 2.  Removal of Additional Devices.
- 3.  Remove ALL Locks and Tags.

Notes/Comments:

L. SIGNATURE

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Checklist Instructions:

A.	EQUIPMENT IDENTIFICATION: Identify equipment to be serviced or maintained and list location (i.e., Site, Bldg, Rm.).
B.	SCOPE: Write brief description of work activity.
C.	IDENTIFICATION OF HAZARDOUS ENERGY: Identify all hazardous energy sources associated with the equipment to be serviced or maintained including those that may not require LOTO for activity being performed.
D1.	JOB SPECIFIC LOCKOUT OR TAGOUT INFORMATION. Identify and state location of specific hazardous energy sources associated with equipment that requires lockout or tagout to ensure personnel performing maintenance or service and personnel working near the equipment are protected from unexpected release of hazardous energy.
D2.	List locations where stored energy requires de-energization.
D3.	List parts/equipment/components that require blocking.
D4.	List any other related system that may require shutdown during maintenance or servicing activity.
E.	NAMES OF AUTHORIZED WORKERS PERFORMING THIS LOCKOUT: List names of all authorized workers performing LOTO (attach continuation sheet, if needed).
F.	

	NAMES OF PERSONNEL AFFECTED BY THIS LOCKOUT: List names of personnel affected when performing this LOTO.
G.	VERIFICATION REQUIREMENTS: Specific requirements for testing a machine or piece of equipment to determine and verify effectiveness of LOTO devices and other energy control measures.
H.	SAFETY MEASURES/SPECIAL INSTRUCTIONS: List any special safety concerns associated with this work activity (i.e., electrically rated gloves, hearing protection, safety glasses, face shields, etc.).
I.	ADDITIONAL INFORMATION: (Optional) List any additional information not identified elsewhere on this form (i.e. special sequencing, reference manuals, reference other TOs, etc.)
J.	BASIC LOCKOUT PROCEDURES. Complete steps 1-8, as applicable.
K.	RELEASE FROM LOCKOUT/TAGOUT: Complete steps 1-3, as applicable.
L.	SIGNATURE: Signature of Authorized Worker completing form.

RESTRICTIONS

All workers shall comply with restrictions/limitations imposed on them while using LOTO.

Authorized Workers shall perform the LOTO activities as prescribed in this procedure

Only Authorized Workers are permitted to perform lockout activities prescribed by this procedure.

This procedure shall be used during all activities involving maintenance (repair) or servicing (adjustments, modifications, cleaning, or inspections) of equipment. No worker shall attempt to start/energize or use/operate locked out equipment.

If the designated Authorized Worker is replaced, relieved, or augmented, the new Authorized Worker(s) shall place his/her own lock & tag on the lockout devices **before** the relieved worker removes his/hers.

No worker shall provide locks/tags nor vouchsafe for another worker for any or all isolation points at any time.

If the Authorized Worker leaves sight of the job, even momentarily, that worker shall re-verify the lockout and zero energy state of the equipment before resuming work.

In an emergency, the supervisor shall apply his lock over that of the Authorized Worker until the Authorized Worker can verify a safe state for the operation

In the event of undetermined (long-term) absence of an Authorized Worker who has not released the equipment from LOTO, the supervisor may remove the lock.

Removal shall be performed under the provisions of, paragraph **21.4.5.**, Release from Lockout/Tagout.

If this procedure is part of a larger, more general procedure, energy sources that are part of the larger procedure, but not applicable to this procedure, shall be identified and listed, with an explanation of why they are not a hazard and not applicable or relevant to this procedure.

#### \* **Lockout of High Energy Electrical Sources**

High energy electrical sources (over 600 volts) require special caution and attention to detail. The following steps are in addition to those required for a normal lockout whenever equipment connected to high energy electrical sources is to be worked on.

1. **Workers should be assigned in teams (minimum of two [2] people)** whenever high energy electrical sources are to be locked out.
2. The high energy source shall be isolated from the equipment by at least two (2) energy isolating devices placed electrically in series unless otherwise authorized by URC 3-560-01. Both devices shall be locked open and tagged out before work begins. Each member of the team may elect to place one lock or two.
3. Standard voltmeters shall not be used to determine that the high energy source has been disconnected. Appropriately rated high energy non-contact voltage detectors or phasing voltmeters, i.e., tools suitable for use with "hot sticks," with both audible and visual indications are the preferred instruments.
4. After both locks are placed (following lockout procedure outlined above), the LINE side of the second energy isolating device shall be grounded. The grounds shall remain in place for the entire duration of the work.
5. Workers shall ensure all stored energy, particularly from stray capacitance (in cables, lightning arrestors, power factor correction capacitors, etc.), is safely discharged from all parts of the circuit to be locked out. Grounds shall be in place on all conductors in the work area whenever work is in progress. If grounds are removed for any reason, they shall be replaced before continuing work.
6. When removing locks from a high energy source, at least two (2) people shall independently perform complete inspections of the work area, the equipment worked on, and the entire circuit from the first lock to the equipment. All grounds shall be removed, all tools and parts stored, all areas clean, and all covers and other safety devices installed and secured.

**22.5.2. Containers.** Containers and portable tanks shall meet handling, storage and dispensing requirements specified in this instruction for the product concerned. Refer to NFPA 30 for additional guidance. Tanks and vats shall be installed so rupture or overflow is contained or controlled through dikes, sumps, etc., per 29 CFR 1910.106, *Flammable and Combustible Liquids*.

**23.2.4.6.** Evaluate potential worker exposure related to confined spaces IAW AFI 48-145, *Occupational and Environmental Health Program*.

**23.5.6.2.** Non-permit confined spaces will be reviewed prior to each entry, but no less than annually, to determine if changed conditions in or around the space could have introduced a hazard that is immediately dangerous to life or health, thus changing the classification of the space to permit-required. Well-ventilated, frequently-entered non-permit confined spaces such as aircraft engine inlets/intakes/exhausts and avionics bays can normally rely on a visual review prior to each entry, unless a changed condition in or around those spaces could have introduced an atmospheric or other non-visual hazard, in which case, instrumented testing is warranted.

**23.9. MAJCOM Mandatory Aircraft Confined Spaces** (Reference Table 23.2 below). The following figure identifies confined spaces contained within each aircraft weapons system as defined by the MAJCOM Ground Safety office. This is not an all-inclusive list and is subject to change based on modifications in procedures and weapons system design. The all-inclusive list shall be maintained by each MAJCOM Ground office for each installation under its purview and by the installation CSPT. **Warning:** Proper classification of a confined space depends heavily on the activity that occurs within the space. Therefore, while confined spaces with no hazards inherent within or introduced into the space are categorized as Non-Permit Required (NPR) in the table below, all have the potential to contain a hazard that could change the classification to Permit-Required.

**23.9.1.** If activity in the space introduces or generates any hazards, the installation CSPT must be notified to assess the classification. The installation CSPT may upgrade the classification to PR for that activity if there is potential to create a hazard.

**23.9.2.** Some confined spaces contain fuel lines that are normally intact and not designed to release fuel into the space. In general, most of these spaces are classified as NPR in the table below on the basis that leaks of fuel are a rare event and the entrant would be able to detect the presence of fuel prior to entry. If there is any indication of fuel leakage (odor, visual evidence), the space must be upgraded to PR. Entrants are strongly encouraged to sample air for fuel vapor before entry into NPR confined spaces containing fuel lines as an additional means to verify no leakage has occurred. Check with BE for assistance in selecting fuel vapor detection equipment.

**23.9.3.** In some confined spaces, lines containing nitrogen in liquid or gaseous form pass through the space. These lines are normally intact and not designed to intentionally release nitrogen into the space. In general, most of these spaces are classified as NPR in the table below on the basis that nitrogen leaks are a rare event and the entrant can verify the integrity of the nitrogen distribution system prior to entry. Any evidence of potential nitrogen leakage, e.g., pressure drops or maintenance history, drives an immediate upgrade of the space to PR.

Additionally, due to the odorless and colorless properties of nitrogen, entrants into NPR confined spaces where nitrogen lines or bottles are present must continuously monitor for oxygen levels while in the space to verify no leakage has occurred. Refer to TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks, and Fuel Cells*, for additional guidance.

**23.11.2.** Does the commander and/or functional manager ensure personnel who support the permit-required confined space program are properly trained, equipped and qualified? Reference **23.2.7.2**

**23.11.13.** Do functional managers or commanders, in coordination with the CSPT, ensure the organization's confined spaces are evaluated and tested prior to being classified? Reference **23.3.2**

**23.11.22.** Does the entry supervisor ensure a qualified on-site rescue team is present during all known IDLH space entries? Reference **23.5.3.9**

**23.11.27.** Is an **AF Form 592, USAF Hot Work Permit**, obtained by workers prior to performing hot riveting, welding, cutting, burning or heating operations within a confined space? Reference **23.5.5**

**24.2.5.1.** Compressed air shall not be used for cleaning purposes except when regulated to 30 psi or less, and then only when effective chip guarding, air diffuser, and face shield and safety goggles are used.

**24.5.1.** Strict adherence to standards ensures the safety of parked aircraft. Specific parking locations shall be designated for each aircraft IAW AFMAN 32-1084, *Facility Requirements*. Generally, distances between parked aircraft, wingtip to wingtip, shall allow immediate access of emergency vehicles and permit free movement of equipment and materials. Refer to AFMAN 32-1084 for specific aircraft wingtip distances. Also see UFC 3-260-01, *Airfield and Heliport Planning and Design*. Refer to AFMAN 91-201, *Explosive Safety Standards*, and TO 11A-1-33, *Handling and Maintenance of Explosives Loaded Aircraft*, for parking explosives loaded aircraft.

**24.14.9.** Roll-up Hangar Doors. Roll-up hangar doors shall be maintained in good operating condition with door tracks free of debris and obstructions to allow smooth operation. Operators shall conduct a visual inspection of door path and track-way and correct any discrepancies before operating door. Individuals shall remain clear of door path while door is in motion. Hangar auxiliary service roll-up doors, to include tow vehicle exit doors, shall meet the following requirements:

**24.14.9.2.** Powered roll-up hangar doors equipped with one touch open or close buttons shall have a crush sensor on the bottom of the door installed and operational. **Note:** Manual roll-up hangar doors or powered roll-up doors equipped with dead man switches do not require crush sensors.

**24.15.1.3.** Face shield and safety goggles are required when using compressed air for cleaning. All shop and aircraft maintenance personnel authorized to use air compressors shall be trained in operation and maintenance of air compressors. Compressed air for general cleaning purposes shall be



limited to less than 30 psi. Effective chip guarding shall be provided and have a finger-actuated press (on)/release (off) control. Compressed air shall not be used for cleaning benches, floors, work areas, aircraft interior, clothing or exposed body surfaces. Aircraft pitot-static systems shall not be cleaned with compressed air to prevent instrument diaphragm damage. Refer to paragraph **24.2.5** for additional information on cleaning with compressed air.

**24.16.7.3.** No stand will be used unless all brakes are set and all wheel casters locked. Wheel will be locked either 90 or 180 degrees from the caster lock pin if it interferes with the wheel brake handle. Wheel chocks may be used to supplement these requirements. Stands will be locked when not in use to avoid rolling down slanted surfaces or being moved by the wind when outdoors. Chocks will be constructed or locally manufactured IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

**24.16.7.4.** Self-propelled elevating work platforms shall be in the lowered position prior to being moved. Manually-propelled mobile work platforms shall not be moved with personnel on the working platform unless allowed by manufacturer's instructions. Locking pins or other devices, as required, shall be in place before anyone is allowed to ascend the stairs or ladder. Tools and equipment left on the work platform while the unit is moved shall rest securely on the floor of the platform and be protected by a rail and toeboard IAW paragraph **16.4.6.10**.

**24.18.36.** Are passengers prevented from riding on tow tractors unless adequate seats are provided for that purpose? Reference **24.13.21**

**24.18.37.** Are pintle assemblies and towing connections secured with a pintle hook safety locking device or cotter pin that will positively lock towing connections? Reference **24.7.16**

**24.18.55.** Are locking pins installed, hydraulic pressure released, platform eased down onto the locks and the hydraulic valve closed before anyone is allowed on the maintenance stand? Reference **24.16.7.4**

**25.5.2.** Fire extinguishers with a rating of at least 2A:20BC shall be installed in shop areas located so an extinguisher is available within 50 feet. The number of extinguishers depends upon the size and layout of the facility. The installation FES Flight shall be consulted for more detailed information on the type, selection, installation, inspection, maintenance and hydrostatic testing of portable fire extinguishers. Fire extinguishers will:

**25.12.2.3.11.** All controls shall be tested by the operator at the start of a new shift. If any controls do not operate properly, they shall be adjusted or repaired before the operation is continued.

**25.18.1.1.** Explosive Gases. The most common sewer gases are methane, carbon monoxide and hydrogen sulfide. These gases, when mixed with air and a spark, can explode with great force. Such explosions are most common and dangerous in confined spaces such as tanks, underground lift stations or manholes. Hydrogen sulfide (H<sub>2</sub>S) is generally encountered more frequently in wastewater systems than any other hazardous gas. In light concentrations, it has a foul odor similar to rotten eggs. After continued exposure, H<sub>2</sub>S will over-stimulate the olfactory sensors and will no longer register as an odor. It is heavier than air and usually collects in low areas.

Methane is lighter than air and will escape with proper ventilation. Closed tanks and tight rooms are the greatest danger areas. They shall be tested for oxygen and methane or H<sub>2</sub>S with approved meters.

**25.18.1.5.** Federal and some state agencies set exposure limits to protect workers against exposure to hazardous substances. The Air Force incorporates the most appropriate limits as the Occupational and Environmental Exposure Limits (OEEL). OEELs are the Air Force limits on the amount or concentration of a substance in air. OEELs may also contain a skin designation. Contact BE for questions related to OEELs.

**26.3.5.** Do supervisory personnel ensure operators have PPE such as head, eye and ear protectors, gloves, respirators, etc.? Reference **26.2.3.1**

**26.3.11.** Are all guards secured in place and kept in place during machine use? Reference **26.2.3.2**

**26.3.12.** Are items not permanently installed, such as tools, radios, water coolers, etc., secured so they do not pose a hazard to operators or equipment should the tractor malfunction or overturn? Reference **26.2.3.3**

**26.3.13.** Does the operator prohibit other riders from riding on the tractor? Reference **26.2.3.4**

**26.3.14.** Does operator clean the windshield and other transparent surfaces of ice, snow, dirt, grass and other obstructions from tractors equipped with cabs to ensure clear vision prior to use? Reference **26.2.3.5**

**26.3.15.** Does the operator ensure cracked or severely scratched windshield or transparent surfaces for vision are reported and repaired or replaced? Reference **26.2.3.5**

**26.3.16.** Does the operator keep personnel clear of operating machinery or attachments? Reference **26.2.3.6**

**26.3.17.** Does the operator stop the engine, disconnect the power sources, and wait for all machine movement to stop before servicing, adjusting, or cleaning the equipment (except where the machine must be running to properly service or maintain the equipment)? Reference **26.2.3.7**

**26.3.18.** Do mowing machine operators refrain from attempting to mow on slopes that exceed 4 inches (20-25°) of drop or rise per foot of travel? Reference **26.2.3.8**

**26.3.19.** When using a sickle bar attachment for mowing, does the operator always position the sickle bar on the up-slope side of the tractor? Reference **26.2.3.8**

**26.3.20.** Does the operator park the tractor on a level surface, lower the attachment so it rests on the surface, place the transmission in low or reverse after the engine has stopped (automatic transmission in “park”) and shut the engine off, before the operator dismounts the vehicle? Reference **26.2.3.9**

**26.3.21.** For flex-winged mowers, does the operator ensure the appendages are folded in the “up” position and the locking pins are securely in place when parking? Reference **26.2.3.9**

**26.3.23.** Are all ROPS-equipped tractors fitted with seatbelts? Reference **26.2.7**

**26.3.24.** Have all tractors and attachments been subjected to a noise hazard survey and those whose noise level exceeds 85 dBA placarded with noise hazard warning? Reference **26.2.8**

**26.3.25.** Are approved “Slow Moving Vehicle” emblems and flashing amber light units installed on agricultural tractors used at night in high traffic areas? Reference **26.2.9**

**26.3.26.** Are all power takeoff shafts shielded? Reference **26.2.10.1**

**26.3.27.** Are guards capable of withstanding 250 pounds of downward or inward force? Reference **26.2.10.2**

**26.3.28.** Are guards free of burrs and sharp edges or projections and securely fastened to the unit? Reference **26.2.10.3**

**26.3.29.** Are all guards that were removed for servicing and maintenance reinstalled prior to placing units in use? Reference **26.2.10.4**

**26.3.30.** Are batteries, fuel tanks, oil reservoirs, and coolant systems constructed and located or sealed to assure that spillage will not occur in the event of an upset? Reference **26.2.11**

**26.3.31.** For flight line operations, does the operator ensure a “Slow Moving Vehicle” placard is affixed to the rear of the tractor, have a radio and keep in contact with the tower at all times? Reference **26.2.12**

**27.3.13.** An AF Form 592, *USAF Hot Work Permit*, (see **Figure 27.1**) is required whenever there is cutting, welding or brazing being accomplished outside of the designated shop area. The directions for filling out and signing the **AF Form 592** are contained in **Table 27.2**. The hot work permit must be obtained from the installation FES Flight prior to starting welding operations. The requirements for usage of the **AF Form 592** are outlined in **Table 27.2**. **Note:** BE assistance and coordination may be required, i.e., BE survey report, PPE listing/recommendation, etc.

**27.5.1.** Inside Areas. A specific area shall be designated and approved by the installation FES Flight, Ground Safety office and BE for welding and cutting operations. It shall be of fire resistant or noncombustible construction appropriate for its hazard classification, free of combustible and flammable materials, and segregated from adjacent areas. This area shall be exempt from requiring an **AF Form 592** on a daily basis.

**27.19.35.** Is only approved respirator equipment used when working in atmospheres of hazardous concentrations of airborne contaminants? Reference **27.7.8**

**27.19.36.** Do all welding helmets meet 29 CFR 1910.252, *Welding, Cutting, and Brazing - General Requirements*, requirements? Reference **27.7.9.1**

**27.19.37.** When two or more welders are exposed to each other's arc, are filter lens goggles worn under the welders' helmets to protect them from the harmful rays? Reference **27.7.9.2**

**27.19.38.** Are goggles or other suitable eye protection used during all gas welding or oxygen cutting operations? Reference **27.7.9.3**

**27.19.39.** Is eye protection in the form of suitable tinted goggles or spectacles provided for brazing operations? Reference **27.7.9.5**

**27.19.40.** Are workers trained to arrange helmets to protect the face, neck and ears from the arc's radiant energy? Reference **27.7.10.2**

**27.19.41.** Are ventilated goggles used to prevent fogging of the lenses? Reference **27.7.10.5**

**27.19.42.** Are hand-held shields, designed to shield the face and eyes, prohibited from use? Reference **27.7.10.10**

**27.19.51.** Is the fire guard informed to stop the welding operation if a hazardous condition develops? Reference **27.10.16.10**

**28.19.65.** Are only non-copper beryllium spark-resistant tools used during cleaning operations? Reference **28.13.3**

**28.19.68.** Are only properly trained, qualified and physically-fit personnel permitted to work around electrostatic apparatus? Reference **28.14.7**

**28.19.69.** Are warning signs posted designating the spray process zone as dangerous ? Reference **28.14.8**

**28.19.70.** Is a red "ON" light installed in the interlocked power transformer circuit? Reference **28.14.8**

**30.4.2.3.** Hazard Communication Training. All workers who may be potentially exposed to chemical hazards during the course of work shall require hazard communication training IAW AFI 90-821 upon initial assignment and thereafter when a new hazard or chemical is introduced into the work area/shop or a worker is assigned new or different tasks with new hazards. Prior to any task requiring the use of or exposure to hazardous materials, safety precautions for materials shall be covered in the pre-task safety briefing.

**30.7. High Voltage.** High voltage is defined as greater than 600 volts (root-mean-square [RMS]), nominal, or greater. However, much lower voltage can be lethal. The design and development of all military electronic equipment shall provide fail-safe features for safety of workers during the installation, operation, maintenance or interchanging of a complete

equipment assembly or component part. Operators and technicians shall not attempt to adjust any electronic equipment when there is a possibility of injury from unprotected high voltage. Adjustments on operating high voltage equipment, other than those specified by TO or manufacturer's manuals, shall only be authorized by the unit commander. The unit commander shall consider all operational requirements, TOs, manufacturer's guidance, safety precautions and emergency procedures before authorizing work to proceed. Workers using high voltage to troubleshoot and/or test cables shall be instructed in the precautions necessary for their safety and the safety of others. Workers shall be warned to stay clear while voltage is applied.

**31.1.2.** The battery shop, room or area shall be designed to eliminate certain hazards associated with battery maintenance and shall conform to the specific requirements in this document and 29 CFR 1910.178, *Powered Industrial Trucks*, 29 CFR 1926.403, *General Requirements (Electrical)*, 29 CFR 1926.441, *Batteries and Battery Charging*, NFPA 70, *National Electrical Code*, including Articles 480, *Storage Batteries*, and Chapter 5, *Special Occupancies*, which includes Article 500, *Hazardous (Classified) Locations*, Article 501, *Class I Locations*, and Article 503.14, *Storage – Battery Charging Equipment*. The installation Ground Safety office, BE, Fire Emergency Services (FES) Flight and Environmental Management office shall evaluate and certify battery rooms, shops or areas to ensure they conform to safe design and operating practices. Refer to the provisions of AFMAN 32-1084, paragraphs 7.6.1. through 7.6.5., for additional guidance.

**31.8.3.** Use straps for lifting and carrying batteries. If straps cannot be used, exercise extreme caution when lifting to prevent worker strain, particularly when removing batteries installed in vehicles. When possible, use two people to handle batteries located in places that put a person in an awkward position.

**31.8.7.** Vent Cap Maintenance. Vent caps are designed to help keep the electrolyte or chemical paste within the battery and to keep dirt and other contaminants out. Vent caps shall be kept clean and firmly in place to avoid electrolyte spray, unless authorized by the applicable TO.

**31.8.8.** Vehicle Battery Jump-Starting. Battery jump-starting procedures shall only be accomplished by trained and qualified personnel. Follow TO guidance for proper jump-start procedures. If not available, follow manufacturer's guidance. If manufacturer's guidance is not available, follow steps in **Figure 31.1**, *Jump-Start Diagram*. Workers shall identify the positive and negative terminals on both batteries. Improper connections may cause a large flaming spark and cause both batteries to explode. **Note:** Workers shall NOT connect positive (+) to negative (-) or negative (-) to positive (+) when jump-starting a vehicle. Jumper cables shall be grasped by the insulated handles and not by the bare metal ends. Additionally, workers shall not place their heads close to the battery when connecting jumper cables.

**31.8.9.** Exercise care when handling and storing batteries to prevent damage to the cases and to avoid electrolyte spills. **Caution:** Use care when handling broken battery cases to avoid acid-alkali burns from spilled electrolyte. When handling damaged batteries, follow specific equipment TO maintenance procedures for damaged batteries.

**31.8.10.** The battery in most industrial trucks also serves as a counterweight for the carried load. A replacement battery shall never be installed when its service weight is not within the range of battery weights marked on the truck nameplate. A lighter weight battery could change the truck's center of gravity and upset a loaded truck.

**31.8.11.** Batteries encased in steel trays have lifting holes for moving the battery. Lifting devices shall be designed so vertical lifting stresses are confined to the battery tray. Lifting batteries with two chains attached to a hoist at a single central point (to form a triangle with the battery) is unsafe. Not only does the safe load capacity of a double sling decrease as the angle increases, but the angular stress on the lifting ears of the battery may cause the chain hook to tear out of the steel battery case. A properly insulated spreader bar, or other device as permitted by the applicable TO or manufacturer's instructions, of ample size shall be used with any overhead hoist.

**31.8.12.** Before a battery is removed from a truck or is recharged in a truck, the electrical circuit of the truck shall be open, the battery unplugged from the truck and the brakes set or the wheels chocked. When moving a battery to a recharging location by overhead crane, the battery shall not be pulled or led by the battery cables. Personnel shall not stand under suspended loads.

**31.8.13.** When an enclosed/covered battery is charged, the cover of the steel tray of the battery shall always be kept open throughout the entire recharging period. If a battery remains in the truck for recharging, all battery compartment covers of the truck shall be kept open to help promote cooling of the battery and release of the gases freed during the recharging process. Excessive charging of batteries shall not be permitted, as hydrogen gas is generated. Batteries shall not be disassembled when taken directly from the charger or worked on immediately after being discharged under a heavy load. In either case, the battery may be off-gassing rapidly and may explode if an ignition source is present.

**31.8.14.** The contact surface of mating plugs or connectors on vehicles/equipment, batteries and chargers shall be maintained free of pitting or oxidation to prevent a high-resistance contact condition. Such a condition can result in a decrease of voltage delivered to the truck, with possible premature or sudden stopping of the vehicle. This could be a hazard if rapid withdrawal from a hazardous situation is required. Any work on battery plug contacts shall include precautions to avoid shorting out the battery.

**31.8.15.** Visual inspections are usually sufficient to determine the condition of contacts, which shall be cleaned or replaced if they show evidence of oxidation or pitting. Excessive heating of current-carrying parts indicates a poor electrical contact which shall be investigated.

**31.10.13.** Is jump-starting of vehicles only accomplished by qualified personnel? Reference **31.8.7**

**31.10.14.** Do workers adhere to the **Note** against connecting positive (+) terminal to negative (-) terminal and vice versa when jump-starting a vehicle? Reference **31.8.8.7**

**31.10.15.** Do workers exercise care when handling broken battery cases to avoid the possibility of acid-alkali burns from spilled electrolyte? Reference **31.8.8**

**31.10.16.** Do workers ensure the electrical circuit of the vehicle/equipment is open, the battery is unplugged from the vehicle/equipment and the brakes set or wheels chocked, before a battery is removed or recharged in the vehicle/equipment? Reference **31.8.11**

**31.10.17.** Do workers ensure the cover of the steel battery tray is kept open throughout the recharging period when an enclosed/covered battery is charged? Reference **31.8.12**

**31.10.18.** Is the contact surface of mating plugs or connectors on vehicles/equipment, batteries and chargers maintained free of pitting or oxidation to prevent high-resistance contact? Reference **31.8.13**

**32.16.3.** Are tools not in use kept in suitable containers? Reference **32.3.4**

**33.8.6.** Is the appropriate PPE available and worn when handling composite materials and chemicals? Reference **33.2.1.6**

**33.8.16.** Do facilities offering unreacted composite materials (i.e., auto body fillers, fiberglass repair kits, etc.) ensure the materials are kept in their original containers and that all manufacturer's precaution and usage information is provided to purchaser at time of sale? Reference **33.4.2**

**34.5.7.4.** When personnel are exposed to and working on energized high voltage circuits, i.e., greater than 600 volts, nominal, safety observers trained in CPR shall be present, unless the area supervisor determines the risk of the operation does not warrant a safety observer. Personnel shall follow guidance in UFC 3-560-01, *Electrical Safety*, when an arc-flash exists.

**Table 34.1. Frequently Performed PMEL Operations Where PPE is Required.**

<b>Frequently Performed PMEL Operations Where PPE is Required</b>	
<b>Operation</b>	<b>Type PPE</b>
Battery Servicing/Handling (Wet Cell)	Eye Protection (safety goggles or safety glasses with side shields) Face Shield Gloves, rubber Apron, rubber
Cathode Ray Tube Installation or Removal	Face shield/Safety glasses Gloves
Heavy Lifting	Safety-toe shoes
Compressed Air Cleaning	Side and frontal eye protection
Laser Operations	Laser Eye Protection (LEP)
Use of Hydrazine Related Equipment	Respirators (when engineering controls and work practices are not sufficient to reduce exposures to below the permissible exposure limit) Impervious gloves
Liquid Nitrogen Handling	Eye Protection (safety goggles or safety glasses with side shields) Face Shield Apron, rubber Gloves, insulated Long sleeve garment
Oil Analysis Instrument Testing	Light Shields and Filters
Mercury Servicing/Clean-up	Rubber gloves Respirator approved for use with mercury Goggles
Working in Hazardous Noise Area (Noise Level 85 Decibels (dB) or Greater)	Approved hearing protection
Soldering	Respirator (when BE's OEH risk assessment requires) Eye protection (side and frontal) Face shield or safety goggles
Liquid Fluorocarbon (Freon)	Impervious gloves Eye Protection (safety goggles or safety glasses with side shields) Face Shield

**Note:** PPE listed above are the minimum requirements. Functional managers, ground safety office, BE and **Chapter 14, Personal Protective Equipment (PPE)**, shall be consulted to determine specific PPE requirements for all PMEL Operations.

**35.1.5.3. Mandatory Monthly Inspections.** Wire ropes, chains and hooks shall be thoroughly inspected monthly. Inspections for each item shall be documented (separate documentation) on



the AFTO Form 95 or MAJCOM or locally devised paper or automated system IAW paragraph **35.1.1** and maintained on file for one year. Documentation will include date and time of the monthly inspection, signature of the inspector, an identifier for the equipment inspected and condition of the equipment. Inspection criteria will be IAW applicable paragraphs from this chapter and applicable manufacturer instructions, as required.

**35.1.5.4.** Frequency. Inspections identified as monthly and annual inspections will be considered as such and not a 30 or 365 day inspection. The next inspection must occur by the last day of the perspective month. For example, a monthly inspection conducted on 4 February, the next inspection must be completed by 31 March. An annual inspection conducted on 4 February 2009, the next inspection must be completed by 28 February 2010.

## **35.12. Portable Automotive Lifting Devices (PALD) and Related Equipment.**

**35.12.1.** Requirements. All personnel shall observe all safety precautions in this chapter and those recommended by the manufacturers of the PALD. Always read the owner's manual before operating the PALD. The owner's manual/instructions spell out the proper operating procedures and basic function of the components, which includes the recommended replacement fluid, maintenance and inspection procedures and intervals as applicable.

### **35.12.2. Maintenance and Inspection.**

**35.12.2.1.** Maintenance. The PALD shall be maintained IAW the product instructions.

#### **35.12.2.2. Inspection.**

**35.12.2.2.1.** Visual inspection shall be made before each use of the PALD by checking for abnormal conditions, such as cracked welds, leaks and damaged, loose or missing parts.

**35.12.2.2.2.** Other inspections shall be made per product operating instructions.

**35.12.2.2.3.** Each PALD shall be inspected immediately if the lift is believed to have been subjected to abnormal load or shock. It is recommended that this inspection be made by a manufacturer's or supplier's authorized repair facility.

**35.12.2.2.4.** Owners and/or operators should be aware that repair of this equipment may require specialized knowledge and facilities. It is recommended that an annual inspection of the PALD be made by a manufacturer's or supplier's repair facility and that any defective parts, decals or safety labels or signs are replace with manufacturer's or supplier's specified parts. A list of repair facilities is available from the manufacturer or supplier.

**Table 35.24. Testing and Inspection Requirements for Materials Handling and Storage Equipment.**

<b>Testing and Inspection Requirements for Materials Handling and Storage Equipment</b>					
<b>Note:</b> This table provides a general overview of requirements outlined in this standard. Refer to specific paragraphs identified in parenthesis for more detailed information. See <b>Table 35.25.</b> for additional testing and inspection requirements for hoisting equipment used for critical and nuclear loads.					
<b>Type of Equipment</b>	<b>Load Tests</b>		<b>Inspections</b>		<b>Specialized Operator Qualifications</b>
	<b>Initial (Generally Manufacturer)</b>	<b>Following Repair, Modifications, etc.</b>	<b>Daily or Prior to Use</b>	<b>Periodic</b>	
<b>Manual Hoisting Devices</b>	Yes 100% – 125% (35.5.2.5.2.1.)	Yes 100% – 125% (35.5.2.5.2.2.)	Yes (35.5.2.3.1.)	Annually (35.5.2.3.2.)	No
<b>Powered Industrial Trucks</b>	No	No	Yes (35.3.6.)	No	Yes (35.3.3.)
<b>Conveyors</b>	No	No	Yes (35.4.2.4.)	No	Yes (35.4.2.2.)
<b>Hoists</b>	Yes 100% – 125% (35.6.3.7.2.)	Yes 100% – 125% (35.6.3.7.2.)	Yes (35.6.3.5.1.)	Yes (35.6.3.5.2.) Other (35.1.3.)	Yes (35.6.3.3.)
<b>Slings</b>	Yes 100% – 200% (35.7.3.1.1., 35.7.3.2.1., 35.7.3.2.6., 35.7.3.3.1., 35.7.3.4.1., 35.7.3.5.1.)	Yes 100% – 200% (35.7.3.1.1., 35.7.3.3.1., 35.7.3.5.1.)	Yes (35.7.2.3.1.)	Yes (35.7.2.3.2.)	No
<b>Overhead and Locomotive Cranes</b>	Yes 100% – 125% (35.8.2.7.2.)	Yes 100% – 125% (35.8.2.7.2.)	Yes (35.8.2.5.1.)	Yes (35.8.2.5.2.) Other (35.1.3.)	Yes (35.8.2.3.)
<b>Mobile Cranes</b>	No	Yes 100% – 110% (35.9.2.6.2.1.)	Yes (35.9.2.4.1., 35.1.5.5.)	Monthly (35.9.2.4.1.) Annually (35.9.2.4.2.) Other (35.1.3.)	Yes (35.9.2.2.)
<b>Related Hoisting Equipment (Chain, Wire, Rope, Hook, Personnel Platforms)</b>	Yes (35.11.3.1.1., 35.11.3.2.1., 35.11.7.6.2.)	Yes 100% – 110% (35.11.5.1.1., 35.11.7.6.2.)	Yes (35.11.2.2.1., 35.11.3.1.4., 35.11.5.1.3.)	Yes (35.11.2.2.2.) Monthly (35.11.2.2.1., 35.11.3.1.4. , 35.11.5.1.3.) Other (35.11.2.2.3., 35.11.2.4.3.)	No
<b>Derricks</b>	Yes (35.10.2.1.)	No	Yes (35.10.1.1.1., 35.1.5.5.)	Yes (35.10.1.2.) Other (35.1.3.)	No

**Table 35.25. Additional Testing and Inspection Requirements for Materials Handling Equipment Used for Critical and Nuclear Loads.**

<b>Additional Testing and Inspection Requirements for Materials Handling Equipment Used for Critical and Nuclear Loads</b>		
<b>Note:</b> This table provides a general overview of requirements outlined in this standard. Refer to specific paragraphs identified in parenthesis for more detailed information. Requirements outlined in this table are additional requirements to those outlined in <b>Table 35.24</b> .		
<b>Type of Equipment</b>	<b>Annual Load Test</b>	<b>Periodic Inspection</b>
<b>Hoists</b>		
<b>Nuclear Load</b>	<b>Yes</b> Not less than 100% or more than 125% of the rated capacity <b>(35.6.3.7.3.)</b>	<b>Semiannually</b> <b>(35.6.3.5.2.)</b>
<b>Critical Load</b>	<b>Yes</b> Not less than 100% or more than 125% of the rated capacity <b>(35.6.3.7.4.)</b>	
<b>Slings</b>		
<b>Nuclear Load</b>	<b>Yes</b> Per 11N Series TOs <b>(35.7.2.4.)</b>	<b>Yes</b> Per 11N Series TOs <b>(35.7.2.3.)</b>
<b>Overhead Cranes</b>		
<b>Nuclear Load</b>	<b>Yes</b> Not less than 100% or more than 110% <b>(35.8.2.7.3.)</b>	<b>Semiannually</b> <b>(35.8.2.5.2.)</b>
<b>Mobile and Locomotive Cranes</b>		
<b>Nuclear Load</b>	<b>Yes</b> Not less than 100% or more than 110% <b>(35.9.2.6.2.2.)</b>	
<b>Related Hoisting</b>		
<b>Equipment</b> <b>Critical and Nuclear Load</b>	<b>NDI Hook Annually</b> <b>(35.11.5.1.4.)</b>	

**35.13. Materials Handling Equipment Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

**35.13.1.** Have qualified personnel been identified as training instructors? Reference **35.3.3.1**

**35.13.2.** Have training outlines been developed for all material handling equipment? Reference **35.3.3.2**

**35.13.3.** Does the instructor provide written certification of training completion to the OR&L? Reference **35.3.3.3**

- 35.13.4.** Do instructors evaluate each operator at least once every three (3) years and provide refresher training in relevant topics when there is reason to believe there is a need? Reference **35.3.3.7**
- 35.13.5.** Are safety pallets used to lift personnel designed correctly? Reference **35.3.4.6**
- 35.13.6.** Do operators follow all applicable requirements for safe operation of powered industrial trucks? Reference **35.3.5**
- 35.13.7.** Do materials handling and lifting equipment operators conduct daily or prior-to-use inspections and document them on AF Form 1800 per requirements of paragraph **35.1.1**? Reference **35.3.6**.
- 35.13.8.** Is materials handling and lifting equipment cleaned in designated locations and only with cleaning agents approved by the FES Flight and BE? Reference **35.3.7.2**
- 35.13.9.** Do conveyors meet all required design and safety features? Reference **35.4.2**
- 35.13.10.** Are all personnel trained on procedures for operating conveyors? Reference **35.4.2.2**
- 35.13.11.** Are inspections of manual hoisting and pulling devices conducted annually? Reference **35.5.2.3.2**
- 35.13.12.** Do identification tags attached to hoists include date of annual inspection, date of load test, capacity of hoist and identification number of hoist? Reference **35.5.2.3.3**
- 35.13.13.** Are hoists operated only by personnel who are trained and qualified to use the equipment? Reference **35.6.3.3**
- 35.13.14.** Are inspections of hoists and related equipment performed periodically and documented per requirements of paragraph **35.1.1**? Reference **35.6.3.5.2**.
- 35.13.15.** Do maintenance activities use lockout/tagout procedures IAW **Chapter 21**? Reference **35.6.3.6.5.1**
- 35.13.16.** Have operational (no load) and load tests been performed on all new hoists and those which have had load-suspension parts altered, replaced or repaired? Reference **35.6.3.7.1**
- 35.13.17.** Are annual load tests performed on nuclear-certified hoists? Reference **35.6.3.7.3**
- 35.13.18.** Are annual load tests performed on hoists required to lift critical loads? Reference **35.6.3.7.4**
- 35.13.19.** Are records of periodic inspections, repairs and tests of hoists maintained indefinitely? Reference **35.6.3.8**

- 35.13.20.** Do all slings comply with the design and manufacturing requirements of 29 CFR 1910.184 and ANSI B30.9? Reference **35.7.2.1**
- 35.13.21.** Are slings marked or identified with all required information on the sling or a durable and legible tag or label? Reference **35.7.2.2**
- 35.13.22.** Are documented sling inspections conducted by a qualified person? Reference **35.7.2.3.2**
- 35.13.23.** Are all repaired or reconditioned slings appropriately load tested? Reference **35.7.2.4.2**
- 35.13.24.** Is a record of each sling's most recent load test maintained on file? Reference **35.7.2.4.2**
- 35.13.25.** Is the rated capacity plainly marked on each side of a crane, and if the crane has more than one hoisting unit, is the rated capacity marked on each unit? Reference **35.8.2.2.2**
- 35.13.26.** Do pendant and cab hoist controls for trolley and bridge movement use compass points as the preferred identification wherever possible? Reference **35.8.2.2.6**
- 35.13.27.** Is access to the cab or bridge walkway gained by a conveniently placed fixed ladder, stairs or platform requiring no step over any gap in excess of 12 inches? Reference **35.8.2.2.8**
- 35.13.28.** Is a fire extinguisher, rated at least 10 BC, located in the cab of the crane? Reference **35.8.2.2.9**
- 35.13.29.** Are only properly trained and qualified personnel permitted to operate cranes? Reference **35.8.2.3**
- 35.13.30.** Do cab-operated and pulpit-operated equipment operators meet the minimum physical qualifications? Reference **35.8.2.3.1.2**
- 35.13.31.** Are the standard hand signals posted on or near all cranes? Reference **35.8.2.4.6**
- 35.13.32.** Do personnel involved in materials handling wear all appropriate personal protective equipment? Reference **35.8.2.4.7**
- 35.13.33.** Is a preventive maintenance program established and records maintained and readily available? Reference **35.8.2.6.1.1**
- 35.13.34.** Are hazardous energy control (lockout/tagout) procedures developed and used during powered crane maintenance activities? Reference **35.8.2.6.2.1.3**
- 35.13.35.** Have all cranes received the required operational (no load) test? Reference **35.8.2.7.1.1**

**35.13.36.** Is a clearly legible rating chart located in view of the operator in the crane cab? Reference **35.9.2.1.2.1**

**35.13.37.** Are those portions of crane cabs that extend beyond the main chassis when rotated color coded on the lower areas to denote a strike hazard to personnel on the ground? Reference **35.9.2.1.2.5**

**35.13.38.** Is an audible warning device provided when hoisting operations or moving equipment might endanger personnel in the work area, and is the device control within easy reach of the operator? Reference **35.9.2.1.2.10**

**35.13.39.** Is a warning permanently posted in the cab of the crane which states: —*DANGER HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines!*? Reference **35.9.2.1.2.11**

**35.13.40.** Have man-rated cranes been approved prior to acquisition or use? Reference **35.9.2.1.2.13**

**35.13.41.** Are all crawler, locomotive, truck and mobile hydraulic crane operators licensed to operate cranes? Reference **35.9.2.2**

**35.13.42.** Is a list of qualified operators maintained by the using organization? Reference **35.9.2.2**

**35.13.43.** Do all operators meet the minimum physical qualifications? Reference **35.9.2.2.1.2**

**35.13.44.** Do operators follow correct procedures prior to leaving a crane unattended? Reference **35.9.2.3.5**

**35.13.45.** During periods of non-use, high winds or weather alerts, do operators lower the boom to ground level or a resting platform or otherwise ensure the boom is secure against movement from wind or other forces? Reference **35.9.2.3.6**

**35.13.46.** Are outriggers used when required and is blocking to support the outriggers of sufficient size and strength to prevent shifting or toppling of the crane under load? Reference **35.9.2.3.24**

**35.13.47.** When rotating the crane, is a tag line used when necessary to control rotation of the load? Reference **35.9.2.3.30**

**35.13.48.** Are procedures in place to ensure safe operations in the vicinity of electrical power lines? Reference **35.9.2.3.39**

**35.13.49.** Is appropriate personal protective equipment worn by crane crew personnel and construction personnel involved in crane operations? Reference **35.9.2.3.41**

**35.13.50.** Are energy control (lockout/tagout) procedures used during crane maintenance activities? Reference **35.9.2.5.1.1.2**

**35.13.51.** Are all required load tests of mobile and locomotive cranes conducted and records maintained? Reference **35.9.2.6**

**35.13.52.** Are frequent and periodic inspections of derricks performed as required and documented? Reference **35.10.1**

**35.13.53.** Have all required load tests of derricks been performed? Reference **35.10.2.1**

**35.13.54.** Is a preventive maintenance program established for derricks, and are these maintenance activities documented? Reference **35.10.3.1.1**

**35.13.55.** Are running ropes visually inspected daily or prior to use and are those inspections documented? Reference **35.11.2.2.1**

**35.13.56.** Is a full, written, dated and signed report of wire rope condition kept on file for a minimum of one year and readily available? Reference **35.11.2.2.1**

**35.13.57.** Are hoist chains inspected before use and monthly, and are these inspections documented? Reference **35.11.3.1.4**

**35.13.58.** Are hooks with more than 5% of normal throat opening or any apparent bend or twist from the plane from the original baseline measurements removed from service and replaced? Reference **35.11.5.1.1**

**35.13.59.** Are all hooks visually inspected daily or prior to use and thoroughly inspected each month? Reference **35.11.5.1.3**

**35.13.60.** If operations require removal or replacement of hooks and/or lifting fixtures, is the lifting capacity of the hooks/lifting fixtures readily identifiable to the hoist/crane operator? Reference **35.11.5.4**

**35.13.61.** If an approved crane is used to lift personnel, is the platform used to suspend personnel designed correctly? Reference **35.11.7**

#### **37.2.4. Delete.**

**37.4.1.** Are hazards engineered out, isolated, guarded against or a safer chemical used whenever possible before considering the use of PPE? Reference **37.1.1**

**37.4.2.** Are electrostatic discharge (ESD) sensitive equipment computers, printers and data processing equipment protected as needed to prevent damage from static electricity? Reference **37.1.4**

**37.4.3.** Do supervisors prohibit eating and drinking in hazardous work areas? Reference **37.2.2**

**37.4.4.** Is sufficient cooling air available for computers, printers and related equipment?  
Reference **37.2.3**

**37.4.5.** Is the area around computers, printers and related equipment kept clean to prevent buildup of paper and other materials which could pose a fire hazard or restrict cooling airflow and cause excessive temperatures which could damage equipment or pose a fire hazard?  
Reference **37.2.3**

**37.4.6. Delete.**

**37.4.7.** Are cords and cables placed such that they do not pose a fire hazard or a tripping hazard to personnel? Reference **37.2.5**

**37.4.8.** Are used laptop batteries disposed of IAW direction from the installation Environmental Management office? Reference **37.2.7**

**37.4.9.** Are power taps and extension cords prohibited from use with high current items, such as coffee makers, microwave ovens, heaters, food preparation equipment, etc.? Reference **37.2.8**

**37.4.10.** Does equipment plugged into power taps exceed the capacity of the power tap or facility wiring? Reference **37.2.8**

**37.4.11.** Are all aisle ways within data processing rooms clearly defined and kept free of obstructions? Reference **37.3.3**

**37.4.12.** Are suitable noncombustible containers used for scraps and wastes as they accumulate?  
Reference **37.3.4**

**37.4.13.** Are building floors, especially raised floors in data processing rooms, kept smooth, clean and free of obstructions and slippery materials? Reference **37.3.6.1**

**37.4.14.** Are floor loading capacities identified and posted? Reference **37.3.6.2**

**37.4.15.** Are rooms with conductive floors cleaned and maintained with products which will not adversely affect the conductivity of the floor? Reference **37.3.6.3**

**37.4.16.** Are sub-floors under raised floors in data processing rooms cleaned periodically, but not less than once every 60 days, unless extended by the FES Flight? Reference **37.3.6.4**

**37.4.17.** Is storage prohibited in sub-floor areas? Reference **37.3.6.4**

**37.4.18.** Is the area beneath raised floors cleaned if any spilled material penetrates the raised floor? Reference **37.3.6.5**



**37.4.19.** Are signs prohibiting food or drinks posted at each entrance to data processing rooms and at each remote terminal location? Reference **37.3.11**

**37.4.20.** If supervisors determine food and drink are authorized in data entry equipment rooms, is such authorization posted in each data entry room or area? Reference **37.3.11**

**37.4.21.** Is storage of materials above suspended ceilings prohibited? Reference **37.3.12**

**37.4.22.** Are plainly marked emergency control switches installed in all data processing rooms and located at designated exit doors? Reference **37.3.13**

**37.4.23.** Does the FES Flight approve the location, method and quantity of tapes, disk packs and other data storage media stored in a facility? Reference **37.3.16**

**37.4.24.** Are battery-operated emergency lighting units immediately repaired or replaced when found to be defective or inoperative? Reference **37.3.21**

**37.4.25.** Are illuminated exit signs provided for each exit and passageway? Reference **37.3.22**

**37.4.26.** Has a survey of each data processing facility been completed by the installation CE to determine if a water hazard exists? Reference **37.3.23.2**

**39.8.1.** Are signs prominently displayed reminding workers to wash their hands after using toilet facilities? Reference **39.1.3**

**39.8.2.** Are plumbing and appliances installed IAW AFI 32-1066, *Backflow Prevention Program*? Reference **39.2.4**

**39.8.3.** Is ingestion and preparation of food items prohibited in working areas? Reference **39.2.6**

**39.8.5.** Is proper ventilation provided to remove hazardous vapors and excess moisture from the facility? Reference **39.2.9**

**40.2.18.6.** Extremely Cold (Cryogenic). A cryogenic liquid has a boiling point below minus 130° F (minus 90°) at 14.7 psia.

**41.2.2.** Lodging facilities shall comply with DoD standards, UFC 3-600-01, *Fire Protection Engineering for Facilities*, Air Force directives and NFPA 101, *The Life Safety Code*. The installation CE shall ensure applicable directives are included when contracting for construction of new lodging facilities or renovation of existing facilities. The building custodian shall ensure correct phone number for the installation Fire Emergency Services (FES) Flight, security forces and medical facility are updated monthly and posted on telephones.

**41.2.2.1. Delete.**

**41.2.2.2. Delete.**

**41.2.2.2.1. Delete.**

**41.2.2.2.2. Delete.**

**41.2.2.2.3. Delete.**

**41.2.2.2.4. Delete.**

**41.2.2.2.5. Delete.**

**41.2.2.2.6. Delete.**

**41.2.2.3. Delete.**

**41.2.2.4. Delete.**

**41.2.2.5. Delete.**

**41.2.6.7.** All electrical receptacles (125 volt, single phase, 15- and 20-ampere) installed in bathrooms, kitchens or where receptacles are installed within six (6) feet of the outside edge of any sink shall have Ground-Fault Circuit-Interrupter (GFCI) protection.

**4.4.1. Delete.**

**4.4.2.** Does the building custodian ensure correct phone numbers for the FES Flight, security forces and medical facility are posted on telephones on a monthly basis? Reference **41.2.2**

**41.4.3.** Are all fire exits clearly marked the path of exit kept clear of equipment and materials? Reference **41.2.4**

**41.4.4.** Are all employees trained in proper evacuation procedures? Reference **41.2.4**

**42.7.7.** Do personnel who may be exposed to ionizing radiation during their duties or occupation wear personal radiation monitoring devices? Reference **42.2.4.3**

**43.5.1.1.** Personnel handling or transferring LN<sub>2</sub> or LOX shall follow PPE requirements in **Figure 43.3**. Non-absorbent long sleeves shall extend to the gloves. Cuff-less trousers shall be worn outside leather boots or over high-top leather shoes to shed spilled liquid. Boots and shoes shall have no mesh sides or air holes and will be tightly laced to prevent spilled cryogen seeping inside. Only tightly woven materials shall be worn during LN<sub>2</sub> or LOX operations. A face shield, eye protection (safety goggles or safety glasses with side shields) and apron (leather or other BE-approved) shall be worn.

**43.12. Personal Protective Equipment (PPE) for LN<sub>2</sub> and LOX Operations.** The following (**Figure 43.3**) is a quick reference guide for minimum PPE requirements for activities and equipment in LN<sub>2</sub> and LOX operations. It is not all inclusive and the omission of an activity or

item of equipment does not mean that PPE is not required. The supervisor is ultimately responsible for providing and enforcing the wear of PPE recommended or required by the installation Ground Safety office or BE. Specific PPE for each work area and worker is determined through coordination with the supervisor, unit commander, Ground Safety office and BE. BE is the Office of Primary Responsibility (OPR) and installation authority for determining respiratory protection requirements IAW AFOSH Standard 48-137, *Respiratory Protection Program*. The worker is responsible for the care and proper use of PPE provided. PPE shall be used wherever inhalation, absorption or physical contact injuries may occur. Refer to **Chapter 14, Personal Protective Equipment (PPE)**, and TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, for more details on PPE, recommended usage, national stock numbers (NSNs) and other relevant information.

**Figure 43.3. Personal Protective Equipment (PPE) For LN<sub>2</sub> and LOX Operations.**

<b>Operation</b>	<b>Minimum Required PPE</b>
Operating LN <sub>2</sub> and LOX Generating Plant	Thermal Gloves Eye Protection (safety goggles or safety glasses with side shields) Face Shield Ear Protection (Consult BE's OEH risk assessment)
Cleaning LN <sub>2</sub> and LOX Generating Plant	Eye Protection (safety goggles or safety glasses with side shields) Face Shield Chemical Gloves (Consult BE's OEH risk assessment) Chemical Apron Respirator (Consult BE's OEH risk assessment)
Mixing Chemicals	Eye Protection (safety goggles or safety glasses with side shields) Face Shield Chemical Gloves (Consult BE's OEH risk assessment) Chemical Apron
Moving Chemicals	Eye Protection (safety goggles or safety glasses with side shields) Face Shield Chemical Gloves (Consult BE's OEH risk assessment) Chemical Apron
Storage and Transfer of LOX	Head cover Eye Protection (safety goggles or safety glasses with side shields) Face Shield Gloves (loose fitting), leather, welder's gauntlet cuff (DLA-A-50022) (NSN 8415-00-268-7860),

	<p>medium with gloves, cloth, work, cotton knit (DLA-A-55213) (NSN 8415-00-964-4760), medium as an insert; or  Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673) or equivalent  Apron (NSN 8415-00-082-6108)  Coveralls, cotton white (mandatory) (NSN 8405-00-037-9274)  Cuff-less trousers  Long sleeve shirt (Optional)  Jacket (Optional)  Shoes, which fit closely around the top, with rubber soles and heels (no mesh sides or air holes)</p>
<p>Storage and Transfer of LN<sub>2</sub></p>	<p>Head cover  Eye Protection (safety goggles or safety glasses with side shields)  Face Shield (NSN 4240-00-542-2048)  Gloves (loose fitting), leather, welder’s gauntlet cuff (Federal Specification KKG486, Type II, NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (MIL G-1057E), medium as an insert; or  Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673)  Apron (NSN 8415-00-082-6108)  Cuff-less trousers  Long sleeve shirt (Optional)  Jacket, or  Coveralls, cotton white (NSN 8405-00-037-9274)  Shoes, which fit closely around the top, with rubber soles and heels (no mesh sides or air holes)</p>
<p>Servicing of Aircraft with LOX  (Consult TO 00-25-172)</p>	<p>Head cover    Eye Protection (safety goggles or safety glasses with side shields)  Face Shield or locally purchased hard hat face shield combination  Gloves (loose fitting), leather, welder’s gauntlet cuff (DLA-A-50022) (NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (DLA-A-55213) (NSN 8415-00-964-4760),</p>

	<p>medium as an insert; or  Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673) or equivalent  Apron (NSN 8415-00-082-6108)</p> <p>Coveralls, cotton white (mandatory) (NSN 8405-00-037-9274)  Cuff-less trousers  Long sleeve shirt (Optional)  Jacket (Optional)  Shoes, which fit closely around the top, with rubber soles and heels (no mesh sides or air holes)</p>
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**44.3.6.5.** Hoods and ducting shall be kept free of grease accumulation. Hood filters over grease vapor producing activities (for example, deep fat fryers and grills) shall be washed at least daily. Hood filters in other areas shall be washed at least weekly. Ducting shall be cleaned as necessary but at least once every six (6) months. Cleaning of filters and ducts shall be documented IAW local procedures. Cooking shall not be permitted under hoods without properly installed filters or when the fire extinguishing system is not operating. Exhaust hoods shall be vented outside the facility. Refer to NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, for additional guidance. **Exception:** Cleaning of hood and exhaust ducts serving food service equipment may be extended to every two years if a dining facility prepares less than 10 meals per month.

**44.5.11.** Ground-Fault Circuit-Interrupters (GFCI). These devices safeguard personnel from current leakage to ground and are mandatory in all new food services facilities, facilities undergoing modification in areas subject to wash down and in all areas where excessive water presents an electrical shock hazard. They shall be used IAW paragraph 8.9.7.2. GFCIs are not required for appliances such as freezers or refrigerators. A GFCI breaker installed in the circuit panel can provide GFCI protection for large areas.

**BY ORDER OF THE  
SECRETARY OF THE AIR FORCE**

**AIR FORCE INSTRUCTION 91-203**

**15 JUNE 2012**



**Safety**

**AIR FORCE CONSOLIDATED  
OCCUPATIONAL SAFETY INSTRUCTION**

**COMPLIANCE WITH THIS PUBLICATION IS MANDATORY**

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This instruction implements Air Force Policy Directive (AFPD) 91-2, *Safety Programs*, and consolidates all Air Force Occupational Safety and Health (AFOSH) 91-series standards. Refer to Air Force Instruction (AFI) 91-202, *The US Air Force Mishap Prevention Program*, for guidance on submitting requests for variance to requirements of this instruction. Report conflicts in guidance between this instruction, federal standards or other Air Force directives through MAJCOM, DRU or FOA ground safety offices to Headquarters Air Force Safety Center, Ground Safety Division, Policy and Procedures Branch (HQ AFSEC/SEGP), 9700 G Avenue SE, Kirtland AFB NM 87117-5670. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847,

*Recommendation for Change of Publication;* route AF Forms 847s from the field through the appropriate functional’s chain of command. This publication may be supplemented at any level, but all direct supplements must be routed to the OPR of this publication for coordination prior to certification and approval. Records Disposition: Ensure all records created as a result of processes prescribed in this publication are maintained IAW AFMAN 33-363, Management of Records, and disposed of IAW Air Force Records Information Management Systems (AFRIMS) Records Disposition Schedule (RDS) located at <https://www.my.af.mil/gcss-af61a/afirms/afirms>. This instruction defines the Air Force’s minimum safety, fire protection and occupational health standards. Requirements in this publication are mandatory, unless indicated otherwise, and apply to all US Air Force organizations and personnel, including US Air Force Reserve Command (AFRC) units, all Air National Guard (ANG) personnel, with the exception of state employees. In addition, it includes ANG Air Technicians during their daily operations as well as when deployed as a federal military force. This standard implements parts of Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR), 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 (TOs). Note: MAJCOMs may have more stringent or restrictive requirements than those contained in this instruction or other Air Force Occupational Safety and Health (AFOSH) instructions/standards. Therefore, all requests for interpretations or clarifications concerning these publications must be forwarded through the servicing MAJCOM/DRU/FOA safety, health and/or civil engineering organization, as applicable.

No TO, Instruction or Operating Instruction can address every hazard or potential hazard that may arise from a specific task or combination of tasks. Where situations exist that are not covered by existing directives, use a Risk Management (RM) process to assess risk associated with those situations and determine adequate safeguards or procedures to manage the risk. Refer to AFPAM 90-902, *Operational Risk Management (ORM) Guidelines and Tools*, for guidance on using the RM process. Note: The RM 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 AFI 91-202).

**SUMMARY OF CHANGES**

This document, AFI 91-203, replaces and substantially changes Air Force Occupational Safety and Health (AFOSH) Standard 91-501 and all other 91-series AFOSH standards. This document updates and merges Air Force safety principles, concepts and program elements into a single consolidated occupational safety and health document. This instruction incorporates the safety principles and concepts of the Occupational Safety and Health Administration (OSHA) and other national consensus safety agencies.

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## Chapter 1

### INTRODUCTION

#### 1.1. Purpose.

1.1.1. Occupational Safety and Health Administration (OSHA) safety guidance published in the Department of Labor 29 series Code of Federal Regulations (CFR) provides workers a safe and healthy workplace. OSHA dictates what must be accomplished in the workplace, but not necessarily how it will be accomplished, or by whom.

1.1.2. Commanders are responsible for the safety of their facilities and personnel, including the correction of all hazards and deficiencies in their workplaces. This instruction assigns responsibilities to individuals or functions to help Commanders manage their safety and health programs, ensuring they comply with OSHA and Air Force guidance. This instruction provides a uniform program, which MAJCOM/Wing/Installation Commanders may supplement, as necessary, to ensure a safe and healthy work place.

#### 1.2. How to Use This Document.

1.2.1. This instruction is a consolidation of all material in the 91-series Air Force Occupational Safety and Health (AFOSH) standards relating to Air Force general operations. References to other Air Force publications, OSHA standards and national safety consensus standards are provided as appropriate.

1.2.2. This instruction is intended for use by installation ground safety officials, commanders, functional managers, supervisors and workers at all levels, including Air Force civilians. The information in this instruction is derived from many sources and includes non-Air Force and Air Force directives in a single document for protection of workers and compliance with Federal law. **Note 1:** This instruction does not include state employees. **Note 2:** This instruction may contain criteria that are not fully compatible with host-nation safety criteria. In cases of conflict, local safety offices shall coordinate with MAJCOM Ground Safety office to resolve these issues.

**1.3. Applying Standards.** All Air Force units must comply with applicable safety guidance during all Air Force operations. MAJCOMs, DRUs and FOAs may supplement AFOSH guidance when additional or more stringent safety, fire prevention and health criteria are required. When there is conflicting guidance, use the guidance that provides the most protection.

1.3.1. The Air Force publishes industrial and general ground safety guidance as Air Force instructions, which implement OSHA standards. Area-specific instructions and technical data include other safety criteria. When AFOSH guidance or safety criteria do not cover a situation, use non-Air Force standards, including national consensus standards, professional safety and health standards, and other Federal agency standards. Air Force activities must comply with OSHA requirements at all times unless the military-unique exemption applies according to DoDI 6055.1, DoD Safety and Occupational Health Program. **Note:** AFOSH guidance must be followed at all times. They implement parts of 29 CFR, and include additional requirements not addressed by the OSHA standards. In addition, safety, fire prevention and occupational health requirements in equipment technical orders (TO) must be followed at all times.

### 1.3.2. Occupational Safety and Health Administration (OSHA) Requirements.

1.3.2.1. Air Force safety officials cannot grant exemptions to OSHA standards, only DoL has the authority to grant exemptions to OSHA standards. Refer to AFI 91-202, Chapter 8, for additional information. Air Force Safety Center and higher headquarters and installations safety offices may establish more stringent requirements than those established by OSHA. **Note:** OSHA references in this standard list the CFR number, part number and part title, as applicable, i.e., 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*.

1.3.2.2. Some non-OSHA requirements in this standard cannot be waived without specific permission of HQ AFSEC/SEG, AF/SG or HQ AFCESA/CEO/CEX, as appropriate. In those instances, a statement indicating who to contact is included.

**1.4. Responsibilities.** This paragraph describes specific responsibilities to ensure the safety of facilities and personnel. In addition, see AFI 91-202, *The US Air Force Mishap Prevention Program*.

1.4.1. Air Staff. All Air Staff elements shall ensure policies and procedures are consistent with the guidance of this instruction.

1.4.2. Air Force Safety Center (HQ AFSEC) shall:

1.4.2.1. Formulate and execute policy. Clarify roles, responsibilities and guidance applicable to all areas of safety.

1.4.2.2. Act as approval authority for safety variances. **Note:** Requests for variances shall be processed through the Major Command (MAJCOM), Direct Reporting Unit (DRU) or Field Operating Agency (FOA) ground safety offices, who, in turn, will forward to AFSEC/SEG.

1.4.3. Major Commands (MAJCOMs), DRUs and FOAs shall provide program oversight and supplement safety and health guidance, as necessary.

1.4.4. Commanders, Functional Managers and Supervisors shall:

1.4.4.1. Ensure applicable Occupational Safety and Health (OSH) guidance for workplace and operations is available to all personnel.

1.4.4.2. Ensure compliance with occupational safety, fire prevention and health program requirements in their areas of responsibility.

1.4.4.3. Ensure AFOSH program requirements are part of subordinate employees' performance measurements in all activities.

1.4.4.4. Ensure pertinent OSHA documents and AFOSH guidance are available at installation ground safety offices. Also, commanders, functional managers and supervisors at OCONUS locations shall ensure applicable host-nation safety guidance is available. **Note:** Electronic or paper products are acceptable.

1.4.4.5. Provide a safe and healthful workplace and conduct monthly self-inspections for hazards or deficiencies.



1.4.4.6. Provide employees training in job safety, fire prevention and health, as required by OSHA and AFOSH directives, Air Force Policy Directives (AFPD), Air Force Instructions (AFI), Air Force Manuals (AFMAN) and any other associated directives.

1.4.4.7. Provide employees necessary personal protective equipment (PPE) and ensure compliance with program requirements. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

1.4.5. Supervisors. Supervisors must recognize potential mishap factors in the workplace. Supervisors shall not require personnel to work in environments and conditions hazardous to their safety or health without first providing adequate engineering, administrative controls and/or PPE. Supervisors shall:

1.4.5.1. Ensure safe working conditions.

1.4.5.2. Provide necessary protective equipment.

1.4.5.3. Ensure required guards and protective equipment are provided, used and properly maintained.

1.4.5.4. Ensure tools and equipment are properly maintained and used.

1.4.5.5. Plan the workload and assign employees only to jobs they are qualified to perform.

1.4.5.6. Ensure employees understand the work to be done, the hazards that may be encountered and the proper procedures for doing the work safely.

1.4.5.7. Take immediate action to correct any violation of safety rules observed or reported to them.

1.4.5.8. Ensure workers exposed or potentially exposed to hazardous chemicals or materials are trained on the hazards of those chemicals and materials per AFI 90-821, Hazard Communication, including information from the Material Safety Data Sheet (MSDS) for each chemical or material used. However, Bioenvironmental Engineering (BE) and installation Ground Safety office shall be consulted for selection of PPE.

1.4.5.9. Conduct Job Safety Analysis (JSA) of job tasks as required to ensure a safe work environment. **Note:** A JSA shall be accomplished when new equipment is installed, equipment is relocated or new procedures are implemented in critical or hazardous operations. Part of the JSA process overlaps BE efforts to link tasks to hazards and identifying Occupational and Environmental Health (OEH) PPE requirements. The JSA shall involve BE to avoid duplication of effort and to ensure proper awareness of process changes. Refer to paragraph **1.5** of this instruction and AFI 91-202, *The US Air Force Mishap Prevention Program*, and installation Ground Safety office for additional guidance.

1.4.6. Air Force Personnel (military and civilian) shall:

1.4.6.1. Comply with OSH guidance.

1.4.6.2. Promptly report unsafe working conditions/activities including any safety, fire and health hazards and deficiencies to the supervisor.

1.4.6.3. Promptly report injuries and illnesses to the supervisor, i.e., occupational illness and on-duty injury to DoD military and civilian personnel, and off-duty injury to DoD military personnel.

1.4.6.4. Comply with PPE requirements, including its use, inspection and care.

1.4.6.5. Give due consideration to personal safety and the safety of fellow workers while performing assigned tasks.

1.4.6.6. Ensure workers comply with required medical surveillance examinations.

**1.5. Job Safety Analysis (JSA).** Supervisors shall ensure JSAs are conducted on all work processes, where appropriate, to identify potential hazards, determine appropriate PPE and include preventative measures in procedures to mitigate the hazards. AFI 91-202 is the prescribing directive for JSAs. General PPE requirements are also located in 29 CFR 1910.132, *Personal Protective Equipment-General Requirements*. See [Figures 1.1](#) and [1.2](#) for a sample JSA and JSA Worksheet. Training or retraining may be required when a JSA is conducted. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process.

1.5.1. Documentation. Each work center shall conduct and document JSAs where appropriate. JSAs shall include the following data:

1.5.1.1. Work procedure evaluation, to include the following elements:

1.5.1.1.1. Basic steps of work task.

1.5.1.1.2. Potential hazards with each step of the work task.

1.5.1.1.3. Appropriate PPE required for work task.

1.5.1.1.4. Preventative measures to mitigate the hazards.

1.5.1.1.5. Recommended safe task procedures.

1.5.1.2. Name and signature of person certifying the JSA has been performed.

1.5.2. Training. Training shall include discussion on work task steps, potential hazards, any PPE requirements identified in BE and safety surveys and preventative measures to mitigate work task hazards. At a minimum, training should emphasize these requirements and shall include:

1.5.2.1. When PPE is necessary.

1.5.2.2. How to put on, take off, adjust and wear PPE.

1.5.2.3. Limitations of PPE.

1.5.2.4. Care, maintenance, useful life and disposal of PPE.

1.5.2.5. An opportunity for each employee to demonstrate knowledge and understanding of training, as well as an ability to properly use PPE (hands-on training prior to work).

1.5.3. Retraining is required when:

1.5.3.1. Employee exhibits a lack of understanding or skill with the required work task, hazards involved with the work task or PPE.

1.5.3.2. Changes in the workplace render previous training inadequate or obsolete.

1.5.3.3. Changes in the types of PPE used render previous training inadequate or obsolete.

1.5.4. Supervisor shall verify affected employees have received and understand required training through written certification that contains:

1.5.4.1. Name of each employee trained.

1.5.4.2. Dates of training.

1.5.4.3. Subject of certification.

**Note:** This should be documented IAW AFI 91-202, i.e., respirator, fire extinguisher, personal protective eye equipment.

**1.6. Military-Unique and Nonmilitary-Unique Policy.** The Air Force policy is to comply with AFOSH, OSHA, DoD and other non-DoD regulatory safety and health standards and guidance as provided under federal law and in accordance with DoD policy with respect to military-unique and nonmilitary-unique workplaces, operations, equipment and systems.

1.6.1. Military-Unique. The term military-unique refers to military and civilian workplaces, operations, equipment and systems unique to the national defense mission. This includes combat and operation, testing and maintenance of military-unique equipment and systems such as military weapons, military-unique aircraft, early warning systems, military space systems, ordnance and tactical vehicles. It also includes operations such as peacekeeping missions; field maneuvers; combat training; aerospace operations; military flight and missile operations; military-unique research, development, test and evaluation activities; and actions required under national defense contingency conditions.

1.6.1.1. The Air Force shall apply AFOSH, OSHA, DoD and other non-DoD regulatory safety and health standards and guidance to military-unique workplaces, operations, equipment and systems in whole or in part, insofar as practicable.

1.6.1.2. When military design, specifications or operational requirements render compliance with applicable standards or guidance unfeasible or inappropriate in whole or in part, procedures will be codified via technical orders, job guides, operations orders, a JSA or some other means to address residual hazards and alternative protective measures.

1.6.1.3. The installation or wing commander, or their subordinate group commanders who oversee the workplace, operation, equipment or system in question, will employ the guidance in this instruction, DoDI 6055.1 and 29 CFR 1960 when making military-unique determinations.

1.6.1.4. IAW DoDI 6055.1, OSHA representatives have no jurisdiction over military-unique operations or equipment. Per DoDI 6055.1, paragraph E3.5.4., OSHA and NIOSH officials, acting as representatives of the Secretary of Labor, are authorized to conduct announced or unannounced inspections of all DoD workplaces, except military-unique workplaces and nonmilitary-unique workplaces staffed exclusively with military personnel. Additionally, OSHA officials are not authorized to inspect workplaces or operations for compliance with any standard implementing 10 U.S.C. 172 (explosive safety) or 42 U.S.C., Sections 2012, 2021 or 2022 (nuclear safety).

1.6.2. Nonmilitary-Unique. The term nonmilitary-unique refers to military and civilian workplaces, operations, equipment and systems that are comparable generally to those of the private sector. Examples include facilities involved and work performed in the repair and overhaul of weapons, aircraft or vehicles (except for equipment trials); construction; supply services; civil engineer or public works; medical services; and office work. USAF shall comply with AFOSH, OSHA, DoD and other non-DoD regulatory safety and health standards and guidance with respect to nonmilitary-unique workplaces, operations, equipment and systems, regardless of whether work is performed by military or civilian personnel.

**1.7. National Consensus Standards.** Select committees of federal, industrial and private sector personnel develop these standards under the sponsorship of one of the national standards-setting organizations. Examples are: American National Standards Institute (ANSI), National Fire Protection Association (NFPA) and the American Society of Mechanical Engineers (ASME). National consensus standards are not directive, unless adopted by a regulatory federal agency or the Air Force. **Note:** National consensus standards referenced in this document have been adopted for Air Force use and list the standard, part/document number and part/document title, as applicable. Examples are: ANSI B71.1, *Outdoor Power Equipment – Walk-Behind Mowers and Ride-on Machines with Mowers – Safety Specifications*, and NFPA 70, *National Electrical Code*.

**1.8. Medical Facilities.** Medical facilities and operations shall follow guidance contained in this instruction (AFI 91-203), and maintain a safety program compatible with The Joint Commission or the Accreditation Association for Ambulatory Health Care (AAAHC) standards, as applicable. Typically, installation hospitals shall follow guidance provided by The Joint Commission and clinics shall follow guidance provided by AAAHC. The safety program within medical facilities and operations shall also meet NFPA Codes and Standards, pertinent federal regulations and national consensus standards.

**1.9. Qualified Person.** A qualified person is one who has been designated by the commander or designated representative and by reason of training, experience or instruction has demonstrated the ability to perform duties at a required level of competence. The qualified person shall be trained to recognize hazards of an operation and evaluate those anticipated hazards. The definition of a qualified person may vary depending on discipline. However, the prerequisites required to become a qualified person rest with the supervisor and shall be documented in appropriate training records.

**1.10. Documentation.** This instruction specifies use of AFTO Form 95, *Significant Historical Data*, AFTO Form 244, *Industrial/Support Equipment Record*, or other appropriate inspection, maintenance and general purpose forms for documenting maintenance and inspection actions. With expanding use of automated systems for tracking these activities, requiring specific paper forms may impede use of more efficient automated processes. Therefore, use of automated systems for documenting inspections, maintenance and other activities is acceptable in place of specified AFTO Forms 95 and 244 or other appropriate inspection, maintenance and general purpose forms. Electronic signatures or other unique personal identifiers (not initials) are acceptable. While this instruction eliminates the requirement for paper forms, MAJCOMs, NAFs, local procedures, Technical Orders and other Air Force guidance may continue to require use of these forms. Please check the prescribing directive(s) before discontinuing use of any forms. Maintenance units shall follow documentation guidance in AFI 21-101, *Aircraft and*

*Equipment Maintenance Management*, and 00-20 series TOs, and lock out/tag out requirements in **Chapter 21**. Intercontinental Ballistic Missile (ICBM) maintenance units shall follow documentation guidance in AFI 21-202V1, *Missile Maintenance Management*.

**1.11. Variances and Exemptions.** The affected work center shall process a request for variance or exemption when it is impossible to meet AFOSH guidance due to operational needs, mission impact or technical reasons. When requesting a variance or exemption, the work center leadership must identify and implement interim control measures to reduce the degree of risk associated with the hazard in order to protect personnel, equipment and/or property. The process for requesting a variance or exemption is provided in AFI 91-202, *The US Air Force Mishap Prevention Program*.

1.11.1. AFSEC may grant a variance or exemption to AFOSH guidance that is more stringent than OSHA standards, whereas only OSHA can grant variances or exemptions to Title 29 (OSHA) requirements. Requests for variances or exemptions shall be forwarded through the MAJCOM safety office to AFSEC. If the request for variance or exemption is to an OSHA standard, the AFSEC will serve as the liaison between OSHA and the Air Force requester.

1.11.2. Variances are temporary and are granted with the understanding that permanent control measures are planned and will be in place within a time period not to exceed five years. Exemptions grant permanent relief from a requirement and can be approved when the applicant can substantiate their proposed methods, equipment or facilities protect the worker as well or better than the AFOSH guidance or OSHA standards. **Note:** A unit's inability to fund corrective action does not constitute sufficient justification to request a variance or exemption. Request extensions for variances through the MAJCOM safety office to HQ AFSEC/SEG.

1.11.3. The installation Ground Safety office, with assistance from the affected work center, will assemble a thorough and detailed staff package with the following attributes.

1.11.3.1. Clearly defines the safety-related variance or exemption being requested, i.e., a description of the situation identifying the AFOSH guidance/publication, paragraph and specific reason(s) compliance is not possible.

1.11.3.2. States the rationale why the AFOSH guidance/publication cannot be followed.

1.11.3.3. A description and risk assessment of permanent control measures planned, date they will be in place, plus identify interim control measures used to protect personnel, equipment or property, or used to mitigate the risk or hazard.

1.11.3.4. Identifies the number of personnel exposed and protected by interim control measures relative to the operation or condition on a regular basis, and any major items of Air Force property involved.

1.11.3.5. A Job Safety Analysis (JSA) will be conducted on all work processes, where appropriate, to identify potential hazards, preventative measures in procedures to mitigate the hazards and proper personal protective equipment (PPE), if required.

1.11.3.6. In the case of a variance request, spells out a way ahead to resolve the problem, or a description of why it is believed the problem cannot be resolved.

1.11.3.7. In the case of an exemption request, spells out how the proposed methods, equipment or facilities protect the worker as well or better than the AFOSH guidance.

1.11.3.8. Proposes a plan to remedy the problem.

1.11.3.9. Includes drawings, photographs, maps, etc. to clearly and thoroughly document all of the above.

1.11.4. Installation safety office will then forward the request to the appropriate MAJCOM safety office through appropriate command channels.

1.11.5. The MAJCOM safety staff reviews and, if recommended for approval, forwards requests to AFSEC/SEG (safety-related issues), AFCESA/CC (fire prevention-related issues) or AFMOA/SGZ (health-related issues), as appropriate, for final approval. **Note:** Requests received without MAJCOM coordination will be returned to requestor without action.

1.11.6. The appropriate agency will review the request for merit and adherence to the requirements stipulated in Step 3. In the case of requests for variance or exemption to Air Force standards the MAJCOM/SEG will be notified of approval or non-approval.

1.11.7. The MAJCOM/installation Ground Safety Manager (GSM) will maintain a master file of approved variances or exemptions that apply to the installation/MAJCOM/AF as long as they are in effect and for one year thereafter. The GSM will distribute copies of variances and exemptions to the appropriate fire, health and functional managers, as needed.

1.11.8. Functional managers must inform and train affected employees personnel and employee representatives on approved variances, exemptions, or any special procedures required. This training will be documented. Copies of the variance or exemption will be posted in affected work areas until integrated in the JST guide.

**1.12. First Aid, Cardiopulmonary Resuscitation (CPR) and Bloodborne Pathogen (BBP) Training.** Workers who perform duties with risk of cuts, burns or electrocution, or perform duties in remote locations away from emergency medical responders (911/fire department/ambulance), will have a plan for immediate medical response pending definitive transfer and care. Workers who may be expected to provide immediate medical response will receive training in first aid to include bleeding control and bloodborne pathogens awareness, shock management and emergency care of persons having open wounds and burns. In particular, workers who install, maintain, relocate or inspect communications systems, work with high-voltage systems, or perform duties as safety observers will receive this training. Initial first aid and CPR training shall be accomplished within 30 days after an individual is assigned. All workers requiring CPR training will receive refresher training before current CPR certification expires. Workers not passing certification tests will repeat training at least annually, and supervisors should mitigate risk by having workers who have passed certification tests be available during higher risk and more remote activities. Whether by the local Medical Group, the American Red Cross or other appropriate organization, CPR training shall be provided for unit instructors, who, in turn, will train unit personnel. If CPR training is not provided by the host medical facility, instructor training shall be obtained from an approved source, i.e., American Red Cross, American Heart Association, military network, etc. **Note:** Universal precautions must be observed. Infection control requires the supervisor and worker to assume that all human blood and specified human body fluids are infectious for HBV, HIV and other bloodborne pathogens.

Where differentiation of types of body fluids is difficult, all body fluids are to be considered as potentially infectious. Any person in the performance of their duties who could reasonably be expected to come in contact with blood or other potentially infectious materials must be trained IAW 29 CFR 1910.1030, *Bloodborne Pathogens*.

**Figure 1.1. Job Safety Analysis Guide.**

**JOB:** **DATE:**  
**WORKCENTER:** **SUPERVISOR:**  
**TITLE OF WORKER WHO PERFORMS TASK:**  
**REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE):**  
**ANALYSIS BY:** **REVIEWED BY:**

**F1.1. Sequence of Basic Steps.** Break the task down into its basic steps. For example, what is done first, what is done next, etc. You can do this by: (1) observing the task, (2) discussing it with workers, (3) using your experience and knowledge of the task or (4) a combination of all three. Record task steps in the task in their normal order of occurrence. Describe what is done; not the details or how it is done. Three or four words are normally enough to describe each task step.

**F1.2. Potential Mishap Causes or Hazards.** For each task step, ask yourself what mishap could happen to workers performing the task and what the probability would be of the mishap occurring. Get the answers by: (1) observing the task, (2) discussing the task with workers and/or (3) using “lessons learned” from other mishaps. Ask the questions:

F1.2.1. Can workers be struck by or contacted by anything?

F1.2.2. Can they strike against or be exposed to any item that can cause injury?

F1.2.3. Can they be caught in or between anything?

F1.2.4. Can they fall?

F1.2.5. Can they overexert themselves?

F1.2.6. Are they required to do repetitive lifting or heavy lifting?

F1.2.7. Are there potential hazards such as chemical substances, physical agents (including noise, ergonomic and thermal stress), ionizing and non-ionizing radiation or biological exposures?

**F1.3. Recommended Safe Task Procedure.** For each potential mishap cause or hazard identified, consider the following questions:

F1.3.1. How should workers perform the task step to avoid a mishap or eliminate the potential hazard?

F1.3.2. What can be done to eliminate or mitigate the hazard by redesigning the work area or equipment?

F1.3.3. How can the procedure be modified to eliminate the hazard? **Note:** Be sure to describe in detail the precautions workers must take and ensure that these steps are placed in the task procedure or checklist. Take special care to ensure important steps or details are not inadvertently omitted from the task and that guidance is clear, specific and easily understood by workers. Also, the JSA shall include the requirements in paragraph **1.5.1**.





## Chapter 2

### HUMAN FACTORS

**2.1. Human Factors.** Human factors are not just about humans. It is about how features of people's tools, tasks and working environment systemically influence human performance. Mishaps are rarely attributed to a single cause, or in most cases, even a single individual. Every organization should work to identify what factors and conditions create potential hazards, and if/when a mishap occurs, determine why and how to prevent it from happening again. For additional information on human factors and human error, refer to AFI 91-204, *Safety Investigations and Reports*, Attachment 5.

2.1.1. Physiological factors such as unhealthy emotions, job or domestic pressures, distractions, job knowledge, shift-work, hurrying or feeling rushed can contribute to an unsafe attitude and negatively impact worker performance. Examples include workers:

2.1.1.1. With insufficient training and lack of awareness, i.e., inattention to tasks and lack of familiarity with the work area.

2.1.1.2. Ignoring directions from supervisors and work leaders.

2.1.1.3. Failing to use personal protective equipment (PPE) or proper tools.

2.1.1.4. Performing a task while distracted by personal problems or interpersonal situations.

2.1.1.5. Using equipment when not properly trained or qualified.

2.1.1.6. Being unaware of the hazardous properties of flammable and combustible liquids or materials and their proper control. Refer to 29 CFR 1910.1200, *Hazard Communication*, for additional information. **CAUTION:** Complying with and reading instructions on Material Safety Data Sheets (MSDSs) or labels of cleaning products can prevent mixing of incompatible products.

2.1.2. Physical factors such as fatigue, strength limits, lack of sleep, ergonomic design constraints, and the influence of alcohol/drugs may contribute to behavior that leads to a mishap. Examples include workers:

2.1.2.1. Not following established procedures or taking unauthorized shortcuts to save time.

2.1.2.2. Performing job tasks while taking prescribed medications that may cause drowsiness.

2.1.2.3. Performing job tasks while under the influence of alcohol or illegal drugs.

2.1.2.4. Exposed to moving parts that can get clothing, hair or body parts caught in the machinery. The potential for a machine-related mishap is greater when a worker is physically fatigued.

2.1.3. Organizational factors such as inadequate staffing, emphasis on production over safety and lack of workplace supervision can also lead to a mishap. Examples include many of the errors listed in paragraphs [2.1.1](#) and [2.1.2](#) above.

**2.2. Responsibilities.** Managers, supervisors and workers must be aware of human factors such as fatigue, worry, anger, inattention, illness or improper attitudes that can lead to worker error and may result in injury. Engineers, functional managers and supervisors can, in some cases, mitigate the effects of human factors in the workplace by considering personnel exposure and work processes when placing machinery and equipment in the workplace. The supervisor shall ensure ear plugs fit the individual prior to employee use. Personnel not actually involved in the work, but within the area affected by the noise, shall also be provided hearing protection. If process not already evaluated, contact BE for an OEH risk assessment.

**2.3. Bioenvironmental Engineering (BE) Responsibilities.**

2.3.1. IAW AFI 48-145, *Occupational and Environmental Health Program*, BE accomplishes occupational and environmental health (OEH) risk assessments. These assessments identify sources of inherent health risk, to include chemical, biological, radiological, noise, ergonomic stress, thermal stress and physical threats/hazards. BE recommends controls to mitigate health risks associated with identified health threats/hazards. Controls options include engineering and administrative controls or the use of PPE. When different guidance (BE survey reports, technical orders, AF instructions, OSHA Standards, etc.) prescribes different levels of PPE, personnel shall contact the installation BE to determine the most appropriate level of protective equipment.

2.3.2. BE shall identify hazardous noise areas and recommend appropriate control or protective measures IAW AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*. Newly acquired equipment which generates potentially hazardous noise shall be evaluated by BE within 30 days of its receipt in the workcenter. When noise level surveys identify a need for hearing protection, ear plugs or ear muffs (or both) shall be provided by their organization to affected personnel and their use strictly enforced by supervision.

## Chapter 3

### PHYSICAL HAZARDS

#### 3.1. Hazards.

3.1.1. Before considering the use of PPE, hazards shall be engineered out, substituting a less hazardous material or less hazardous process, isolating operations, providing work-around procedures, rearranging or moving elevated or tall objects or furniture, or providing administrative controls whenever possible. The use of protective equipment is considered the least preferred method of controlling hazards and shall not be relied on alone to protect against hazards. Protective equipment shall be used in conjunction with guards, engineering controls and sound manufacturing practices. When PPE will be used to protect workers from physical hazards, consider that eye, face and body injuries may be caused by exposure to chemicals, materials thrown from machines and when substances are propelled by air pressure or similar energy sources. Eye and face injuries may occur when liquids are sprayed, squirted, splattered, dropped or applied. When PPE is required, it must be matched to the identified hazards. This is accomplished by reviewing the JSA and material safety data sheets (MSDS) for the task. Refer to [Chapter 14](#), *Personal Protective Equipment (PPE)*, or contact the installation Ground Safety office or BE for assistance. Eyewash units, eye/face units, deluge showers and similar devices are emergency equipment and are not substitutes for protective devices. Refer to [Chapter 19](#), *Emergency Shower and Eyewash Units*, for additional guidance.

3.1.2. Examples of physical hazards include:

3.1.2.1. Soaps and solvents can cause slippery surfaces and lead to slips and falls. Contact can also cause health problems such as dermatitis and eye irritation. Other medical problems can occur if soaps and solvents are inhaled.

3.1.2.2. Some cleaning solvents may ignite if heated or applied to hot surfaces, causing fires and/or injuries to workers.

3.1.2.3. Pressure cleaners and steam cleaners operate at pressures in excess of 100 pounds per square inch (psi) and temperatures near 200 degrees Fahrenheit (F) and can cause severe burns, scalds, and penetrate skin.

3.1.2.4. Flying or falling objects may pose hazards in the work area.

3.1.2.5. Improper Lifting. Refer to [Chapter 4](#), *Manual Material Handling and Lifting Techniques*, for additional guidance and information.

3.1.2.6. Skin contact with natural elements such as poison ivy, poison oak or foreign substances that may cause irritations or adverse reactions to an individual.

3.1.2.7. Inhalation. This is the most common method of worker exposure to potential contaminants. The exposure levels and type of respiratory protection required are based on the recognized safe exposure levels to contaminants known or suspected to be in the workplace. Refer to AFOSH Standard 48-137, *Respiratory Protection Program*, for additional guidance and information.

3.1.2.8. Poor lighting.

3.1.2.9. Radiation. Ionizing and non-ionizing are the two basic types of radiation. Radiation safety shall be a part of the installation safety program. 29 CFR 1910.1096, *Ionizing Radiation*, and AFI 48-148, *Ionizing Radiation Protection*, list requirements for working in an area with ionizing radiation. Non-ionizing radiation includes most RF energy sources, light sources and lasers. Protection levels and requirements are outlined in AFOSH Standard 48-139, *Laser Radiation Protection Program*, and AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*.

3.1.2.10. Thermal Injuries. Temperatures can vary depending on work location and/or environment. Hot and cold temperatures can cause thermal injuries that threaten life and limb, and serious mission degradation or failure. Cold temperatures can cause dehydration, slowing of reflexes, freezing and non-freezing cold injuries such as frost-bite, trench-foot, hypothermia or death. Hot temperatures can cause heat illness, exhaustion, cramps, heat stress and even death. Personnel newly assigned to a work location may be highly susceptible to thermal injuries until they are acclimated to the new work location and environment. Periodic breaks are recommended when working outside in extreme cold or heat. Refer to AFPAM 48-151, *Thermal Injury*, for guidance and additional information on thermal injuries and their prevention/treatment.

3.1.2.11. Noise can cause hearing loss or prevent hearing of warning signals. Noise shall be controlled at the source when feasible. When control methods fail to bring exposure within allowable limits, appropriate hearing protection, such as ear muffs, ear plugs or both, shall be worn when required or working in hazardous noise environments. Identified hazardous noise sources shall be labeled (where possible) with the appropriate Air Force Visual Aid (AFVAs 48-101, 48-103, 48-104 and/or 48-105) to warn operators to wear hearing protection. BE conducts OEH risk assessments, then recommends appropriate engineering controls, administrative actions or PPE. Refer to AFOSH 48-20, *Occupational Noise and Hearing Conservation Program*, for additional guidance.

**3.2. Housekeeping.** Quality housekeeping, personal appearance, work habits, condition of equipment and job organization directly contribute to safe and efficient workplace operations. Refer to [Chapter 5](#), *Housekeeping*, for additional guidance.

## Chapter 4

### MANUAL MATERIAL HANDLING AND LIFTING TECHNIQUES

**4.1. Special Requirements (Hazards and Human Factors).** Strains, sprains, hernias, fractures, bruises and lacerations may result from poor manual material handling and lifting practices. Lifting, carrying, dropping and lowering are the common physical acts responsible for these injuries. Many strains result from improper lifting techniques, lifting with no assistance or failure to use required and available manual material handling equipment.

**4.2. Manual Handling.** Influencing factors when manually lifting materials include the size, shape and weight of the object to be lifted, and distance to be moved. Proper lifting techniques are as important as the weight of the object. Heavy materials or awkward positions may require mechanical assistance or team lifting be used. Refer to paragraph [4.6.3](#) for additional guidance on team lifting.

**4.3. Lifting and Carrying.** Several variables influence a worker's ability to manually handle and lift materials. Physical capabilities of the individual and variables in the work environment need consideration. Proper consideration and knowledge of worker limitations and the use of correct lifting and carrying techniques will reduce the possibility of injury.

4.3.1. Physical characteristics include factors such as strength, mobility, fatigue and motor functions of the individual.

4.3.2. Psychological considerations include the motivation, emotional state, job satisfaction and attitude of the individual toward work.

4.3.3. Pre-existing worker injuries should also be considered, if known.

4.3.4. Task variables include the weight, size, shape, distribution, degree of shift (of the load in the container) and the location of the center of gravity (CG) of the load to be handled.

4.3.5. Workplace layout and the degree of movement required, obstacles, distances moved and direction of movement shall be considered.

4.3.6. Level of demand to include frequency of lift, duration of lifting task, accelerations and velocities of lift, shift duration, degree of precision and relative proportion of muscles involved in the lift shall be considered.

4.3.7. Environmental variables such as heat and cold stress, noise and vibration, lighting, toxic agents, traction, stability of the work platform and atmospheric contaminants shall also be considered.

**4.4. Training.** Supervisors shall ensure their workers receive thorough instruction and training on proper manual lifting techniques both routine or high risk and any PPE required. In addition, workers shall be instructed in the use of available manual lifting devices. To the new worker, hand trucks and wheelbarrows look deceptively easy to use. Supervisors shall instruct workers on their use. Improvements in work methods, eliminating manual material handling hazards and understanding the stresses involved during manual handling are important and need to be addressed during training. This training shall include both verbal and written materials that explain how to do the task correctly with practice and proper motions. Training shall be documented IAW AFI 91-202, *The US Air Force Mishap Prevention Program*. Additional

information on establishing a program may be found in this chapter and in the National Safety Council (NSC) *Accident Prevention Manual for Industrial Operations, Engineering, and Technology*. Supervisors may contact the installation Public Health (PH) office for assistance in developing the program and to review the NSC publication. The supervisor shall consider having personnel evaluated for physical fitness for duty when job tasks require continuous manual lifting. Workers with physical profile changes shall be evaluated for possible reassignment to prevent recurring injuries.

#### **4.5. Minimizing Manual Material Handling Hazards.**

4.5.1. Engineering Controls. The preferred method to minimize risks of manual lifting is the use of engineering controls/mechanical assists to decrease force, repetition, distance of travel and frequency of manual handling activities. Some examples include use of scissor tables, elevators, conveyors and gravity chutes.

4.5.2. Administrative Controls. Job rotation schedules and mandatory work-rest cycles can be used to reduce mishap potential, but do not eliminate the hazard and are not as reliable as engineering controls.

4.5.3. Work Design Principles. Conduct a JSA (refer to [Figure 1.1](#)) to identify potential hazards and, when practical, arrange tasks and select workstations using the following principles: (**Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process.)

4.5.3.1. Place objects to be lifted at the approximate height of the knuckles when the arms dangle at side of the body.

4.5.3.2. Place object as close to the body as possible.

4.5.3.3. Do not twist the back while picking up, putting down, carrying or changing direction with an object. When rotating, rotate with the hip joint. Crouch down while keeping the object close in to lower the object.

4.5.3.4. Limit stack height to shoulder level. If items must be stacked higher, provide step-up access to eliminate lifting above shoulder level.

4.5.3.5. Use grips, handles and other devices to provide better control of items.

4.5.3.6. Slide materials instead of lifting, whenever possible.

4.5.3.7. Use gravity assist in moving materials.

4.5.3.8. Ensure adequate maneuvering space to eliminate the need to twist the body.

4.5.3.9. Team lifting will be used when items are known to weigh more than 25 pounds or when items are lifted from an awkward position or location. Refer to paragraph [4.6.3](#) for additional guidance on team lifting.

**4.6. Proper Lifting Methods.** No single technique exists to prevent injury during lifting and material handling. The best prevention strategy is to utilize effective ergonomic techniques, i.e., ensure workstations are properly designed, loads are manageable in both size and weight distribution, the frequency and duration of lifting are not excessively stressful and workers can demonstrate a knowledge of proper techniques for material handling. There are three basic

methods of lifting: straight back-bent knees, free style and kinetic. Each has advantages and limitations. Refer to [Figure 4.1](#) for an illustration of proper lifting technique.

4.6.1. The kinetic method is the most widely accepted and taught because it provides more stability for the worker while reducing load on the back muscles and intervertebral disks.

4.6.1.1. Inspect the object before lifting to make certain no grease or slippery substance will cause the object to slip. Also inspect the object for slivers, sharp edges and rough or slippery surfaces before attempting to lift.

4.6.1.2. Position feet correctly. Place feet far enough apart for balance with one foot to the rear of the object and the other foot slightly ahead of the other foot and to the side of the object.

4.6.1.3. Crouch close to the load. Stay close to the load to minimize strain on the back muscles.

4.6.1.4. Always keep the back as straight as possible. It may not be possible to keep the back in the vertical plane but avoid arching the back. Bend from the hips and not from the middle of the back.

**Figure 4.1. How to Lift Properly.**



4.6.1.5. Pick up materials with a full palm grip. Do not attempt to pick up items using a fingertip grip. Gloves (leather or leather-palmed) shall be worn when lifting objects which have sharp or burred edges, or splintered surfaces.

4.6.1.6. With the arms, slide the object towards the body putting it in motion (kinetic energy). At the same time, lift the object with the legs and bring the back to a vertical position. Keep the object close to the body; avoid twisting while lifting.

4.6.2. Setting the Object Down. Use the same motion as when lifting, but reverse it to set an object down. Lower the load by bending the legs and crouching with the back straight. Take care when releasing the load to prevent injury to fingers, hands or feet.

4.6.3. Team Lifting. Always seek and obtain assistance, when it is necessary to move heavy or unusually shaped items manually. Assign additional workers to the task when it is not practical to use mechanical equipment. When two or more people are required to move or carry an object, adjust the load so each person carries an equal part. If possible, use workers

similar in size and train them in team-lifting. Workers need to understand that if one worker lifts too soon, shifts the load, or lowers improperly, that person or their partner(s) may be overloaded and strained. Test lifts should be made before proceeding. The key to lifts using two or more people is to make every move in unison. Assign one person to give orders to ensure the necessary coordination for movement. The supervisor and workers are responsible for assessing all available methods to safely handle materials and for using mechanical assistance whenever possible.

**4.7. Carrying Methods.** Acceptable carrying methods differ based upon the type of material, distance and number of workers. Workers should be instructed during initial training in each procedure. For example: neck, shoulder, side, tray, two-person, under-arm carry methods, etc.

4.7.1. Points to remember:

4.7.1.1. Use appropriate PPE for each task, such as gloves and protective footwear, as required by paragraph [14.4.10](#).

4.7.1.2. Keep fingers away from pinch and shear points.

4.7.1.3. Make sure the path of travel is clear.

4.7.1.4. Do not carry a load that obstructs the view of the direction of travel.

4.7.1.5. Do not twist with the back to change direction or put an object down. When rotating, rotate with the hip joint. Crouch down while keeping the object close in to lower the object.

4.7.2. Following are descriptions of various types of carrying methods:

4.7.2.1. Neck Carry Method. In this method, the material is carried on the back of the neck and shoulders with both arms lifted to shoulder height and the hands grasping the sides or top of the load.

4.7.2.2. Should Carry Method. The load rests on one shoulder with the near arm helping to support the weight and the other arm brought across the body to steady the load.

4.7.2.3. Side Hand Carry Method. This is simply the suitcase method and can be used only where the load may be grasped by a handle or equivalent.

4.7.2.4. Tray Carry Method. The material is carried in front of the abdomen with both hands placed under the bottom surface and the body serving as the balancer.

4.7.2.5. Two Person Carry Method. A load is carried by two people who use oral signals to coordinate their movements. They decide on appropriate emergency signals to be given if the grasp of either person should slip. They walk in step to coordinate their movements.

4.7.2.6. Under-arm Carry Method. The material is carried under one arm with the other arm brought across in front of the body to steady and balance the load. Also called Side Under-arm Carry Method.

**4.8. Carrying Items Up or Down Stairways:**

4.8.1. Adhere to the guidance provided by the supervisor.



- 4.8.2. Try to reduce the bulk or size of the object carried to allow for maximum visibility.
- 4.8.3. Use assistance when required and available.
- 4.8.4. Use mechanical material handling equipment whenever loads are too heavy or bulky to be lifted or carried efficiently or safely by hand.

**4.9. Manual Material Handling Equipment (MHE).** This equipment shall be used whenever loads are too heavy or bulky to be lifted or carried efficiently or safely by hand. Hand trucks, dollies, two-wheeled hand trucks and wheelbarrows (when properly used) simplify materials handling and greatly reduce the hazards of handling supplies and equipment.

4.9.1. Hand Trucks, Dollies and Wheelbarrows. Hand trucks, dollies, wheelbarrows or other manual devices shall be used to lift and/or carry bulky or heavy items whenever possible. Apply the following basic principles when using this equipment:

- 4.9.1.1. Tip the load to be lifted forward slightly so the tongue of the handling equipment goes under the load.
- 4.9.1.2. Make sure the tongue of the hand truck is all the way under the load prior to movement.
- 4.9.1.3. Keep the center of gravity of the load as low as possible. Place heavy objects at the bottom of the load. Keep feet clear of the wheels.
- 4.9.1.4. The center of gravity of the load on both the hand truck and wheelbarrow shall be kept as low as possible. The weight should be forward so it will be carried by the axle, not the handles. If loaded correctly, the material handling equipment should carry the load—the operator need only balance and push.
- 4.9.1.5. Place the load so it will not slip, shift or fall. Load only to a height that allows a clear view ahead. For added safety, strap or chain bulky or dangerous cargo, such as cylinders or drums, to the handling equipment's frame.
- 4.9.1.6. Avoid walking backward with handling equipment if possible. This eliminates the need for workers to look over their shoulder to see clearly.
- 4.9.1.7. Never brake handling equipment by putting your foot on a wheel; keep your feet clear of the wheels at all times.
- 4.9.1.8. Move the handling equipment at a safe speed. Do not run. Keep the handling equipment constantly under control.
- 4.9.1.9. When handling equipment is loaded in a horizontal position, proper lifting procedures discussed in paragraph 4.6 shall be used to prevent operator injury.
- 4.9.1.10. Two-wheeled hand trucks and wheelbarrows are designed in a variety of shapes and sizes for both general and special purposes. Preference shall be given to procuring hand trucks and wheelbarrows equipped with knuckle guards.
- 4.9.1.11. Secure and store unused trucks in a designated area where they don't create a hazard or traffic obstruction.

4.9.2. Multi-Wheel Trucks. As with two-wheeled equipment, multi-wheeled trucks and dollies vary greatly in design and use. Most mishaps occur due to improper parking, causing

the worker to fall over the equipment, or improper loading of material, which causes the cart to tip. Extra emphasis shall be placed on worker training in these two areas, along with frequent observation of work practices to immediately correct unsafe acts. In addition:

- 4.9.2.1. When loading, arrange the cargo so items won't fall.
- 4.9.2.2. If the truck has no drawbar, push it. Keep hands behind the cart.
- 4.9.2.3. If the truck has a drawbar, pull it, to allow for a better line of sight. Stand to one side to keep the truck from running into ankles.
- 4.9.2.4. If there are floor markings, stay within their boundaries.
- 4.9.2.5. When storing the truck, lock or block its wheels.
- 4.9.2.6. Don't misuse the truck.
- 4.9.2.7. Don't ride on a truck designed for a walking operator.
- 4.9.2.8. Don't carry other people on the truck.
- 4.9.2.9. Don't exceed the truck's maximum load capacity.
- 4.9.2.10. Ensure the weight of the truck, plus its load, does not exceed posted floor loads.
- 4.9.2.11. Ensure adequate clearance in aisles and other tight areas.
- 4.9.2.12. Remember that the momentum of a truck can make it hard to change speed or direction.
- 4.9.2.13. Watch for pedestrians—always give them the right-of-way.
- 4.9.2.14. Don't block aisles, doorways or material another worker may need.

#### 4.9.3. Lever-Operated Hoists.

4.9.3.1. Acquisition. Lever-operated hoists shall meet industry standard requirements and specifications.

4.9.3.1.1. Capacity of all lever-operated devices shall be permanently and conspicuously marked in an easily visible place on the hoist.

4.9.3.1.2. Only ratchet and pawl, and load brake hoists, with a means to prevent a suspended load from self-lowering, shall be procured. Lowering under load shall be by operation of the hoist lever.

4.9.3.2. Inspections. Daily or prior to each use, lever-operated hoists shall be inspected for:

- 4.9.3.2.1. Loose or worn parts, nuts, bolts, etc.
- 4.9.3.2.2. Cracked or broken welds or parts.
- 4.9.3.2.3. Deformed or damaged hooks or chain.
- 4.9.3.2.4. Bent or deformed pawls.

4.9.3.3. An annual inspection shall be conducted on all MHE. The inspection shall include:

- 4.9.3.3.1. Complete inspection of all wire rope, chain and fittings or attachments.
- 4.9.3.3.2. Inspection of brakes, pawls or other holding features.
- 4.9.3.3.3. Inspection of the chain length. Chains that have elongated more than one fourth of an inch in 12 inches or as required by TO or manufacturer's instruction shall be removed from service.
- 4.9.3.4. Identification Tags. Identification tags shall be attached to all hoists and shall include the following information: date of inspection, date of proof test, capacity of hoist and identification number of hoist.
- 4.9.3.5. Maintenance and Testing.
  - 4.9.3.5.1. All new hoists shall have the manufacturer's certification indicating that all proof-testing has been accomplished. All hoists which have had load-suspension parts altered, replaced or repaired shall be proof-tested before use. These tests shall be performed at no less than 100 percent or more than 125 percent of the rated capacity. Underhung hoists that are not an integral part of a supporting structure for lateral movement, such as an overhead crane, must have manufacturer's certification indicating the proof test was accomplished with a test load of at least 125 percent of rated capacity. A record of all tests shall be maintained by the user. Refer to ANSI B30.16., *Overhead Hoists*, for additional information.
  - 4.9.3.5.2. Maintenance and lubrication shall be performed IAW the manufacturer's instruction or applicable TO.
- 4.9.3.6. Safe Operations.
  - 4.9.3.6.1. Lever-operated hoists shall only be used in a direct pull. A sheave or pulley of adequate size shall be used where indirect pulls are permitted by design of the hoist.
  - 4.9.3.6.2. Hoist cable, rope and chain shall not be wrapped around the load. Use only slings or other approved lifting devices. For example, cargo straps shall not be used for lifting, unless stated in approved Air Force technical data.
  - 4.9.3.6.3. Positive action safety latches shall be installed on all hooks.
  - 4.9.3.6.4. Hooks shall not be point loaded unless designed for this purpose. All loads shall be seated in the saddle of the hook.
  - 4.9.3.6.5. Extensions to levers (cheater bars or pipes) shall not be used to increase leverage. Extendible levers designed and permanently installed by the manufacturer are authorized.
  - 4.9.3.6.6. Manually operated lever hoists shall only be operated by workers familiar with the use of the equipment. Operator qualifications shall be as determined by the facility and/or shop supervisor or designated representative.
  - 4.9.3.6.7. The rated load shall not be exceeded except for authorized proof tests.
  - 4.9.3.6.8. Hoists shall be attached to well defined dead-end points capable of withstanding the intended load. **Note:** Lifeline attach points shall not be used for hoists.

**4.10. Inspection of Materials.** Prior to movement, material shall be examined for sharp edges, protruding points and weak places. When defects cannot be corrected, additional steps shall be taken to protect the worker. For example, using an enclosed cart when moving sheet metal scraps.

**4.11. Personal Protective Equipment (PPE).** Supervisors shall identify the need for PPE for manual material handling tasks. They may use a JSA to accomplish this as necessary (refer to [Figure 1.1](#)). The installation Ground Safety office and BE are available to assist in this evaluation process. [Chapter 14](#), *Personal Protective Equipment (PPE)*, DoD 4145.19-R-1, *Storage and Materials Handling*, and AFJMAN 23-210, *Joint Service Manual (JSM) for Storage and Materials Handling*, should be consulted when selecting PPE. **Note:** BE will certify the applicability of health-related PPE (e.g., chemical protective equipment, respirators, etc.).

4.11.1. Protective footwear shall be provided and worn when there is a reasonable possibility of foot injuries due to heavy or sharp objects and electrical and/or static electricity. (Reference paragraph [14.4.10](#))

4.11.2. Personnel shall wear leather or leather-palmed gloves when manually handling objects that have sharp or burred edges or splintered surfaces.

4.11.3. Personnel shall wear appropriate hearing protection when working in or visiting hazardous noise areas.

4.11.4. Personnel shall carry tools that have sharp edges in protective holders.

4.11.5. Personnel shall wear appropriate protective clothing when transporting, delivering or working with hazardous materials.

4.11.6. Material handlers shall not wear finger rings, jewelry (which includes watches) or loose clothing, and shall keep long hair completely covered when around moving conveyor belts, open rotating shafts or other moving parts of machinery. Refer to [Chapter 9](#), *Jewelry*, for additional guidance on wear of jewelry.

4.11.7. Workers shall wear goggles and/or safety glasses with side shields and gloves when cutting strapping. Workers shall stand clear so cut strapping does not contact the face or body. A board or other hold-down device may be used to prevent the strapping from flying out from the material when cut.

**4.12. Inspection and Maintenance of Manual Material Handling Equipment (MHE).** Manual MHE, such as hand trucks, wheelbarrows, dollies, pallet jacks and similar unpowered equipment, shall be checked visually before use to assure equipment is in operable condition. This equipment shall also be maintained and inspected IAW the manufacturer's instructions. Any required repairs shall be accomplished prior to use of the equipment.

**4.13. Other Safety Requirements.**

4.13.1. Stack all materials neatly and arrange them in an orderly manner. Limit the stack height to minimize the possibility for the materials to fall or collapse.

4.13.2. Remove, repair or replace defective or broken strapping on material.

4.13.3. Do not throw materials from elevated places except when using approved chutes. Carry or lower them.

4.13.4. If MHE is not available and drums must be manually moved, roll drums by pushing with the hands, not the feet. Ensure a minimum of two workers set the drum upright.

4.13.5. Do not run when carrying materials.

4.13.6. Practice good housekeeping when unpacking materials. Discard banding, packing materials, and empty cartons properly and do not allow these materials to accumulate in work areas.

**4.14. Manual Material Handling and Lifting Techniques Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

4.14.1. Are personnel who regularly perform manual lifting duties properly trained? Reference [4.4](#)

4.14.2. Does training instruction include information such as what PPE is required, what manual lifting devices are available and their proper use? Reference [4.4](#)

4.14.3. Is training documented IAW AFI 91-202? Reference [4.4](#)

4.14.4. Are manual materials handling activities kept to a minimum through the application and use of engineering controls when possible? Reference [4.5.1](#)

4.14.5. Are loads to be lifted manageable in both size and weight distribution? Reference [4.6](#)

4.14.6. Are objects to be lifted inspected for grease or other slippery substances that might cause the object to slip? Reference [4.6.1.1](#)

4.14.7. Do individuals seek assistance when it is necessary to move heavy or odd shaped items? Reference [4.6.3](#)

4.14.8. Are workers properly trained in team lifting techniques when they will be lifting heavy or odd shaped items? Reference [4.6.3](#).

4.14.9. Is PPE provided and used when needed to protect the hands and feet of workers involved in manual materials handling activities? Reference [4.7.1](#)

4.14.10. Are wheeled hand trucks and dollies loaded so that the cargo is stable and the loads won't fall? Reference [4.9.1.5](#)

4.14.11. Is the rated capacity on all lever operated hoists permanently and conspicuously marked and easily visible? Reference [4.9.3.1.1](#)

4.14.12. Are hoists equipped with a device (ratchet and pawl or load brake) that prevents a suspended load from self-lowering and ensures loads are only lowered by operation of the hoist lever? Reference [4.9.3.1.2](#)

4.14.13. Are hoists inspected daily or prior to each use for items such as loose or worn parts, cracked or broken welds, deformed hooks or chain, and bent or deformed pawls? Reference [4.9.3.2](#)

4.14.14. Is an annual inspection accomplished on all MHE? Reference [4.9.3.3](#)

- 4.14.15. Are identification tags attached to hoists indicating date of inspection, date of proof test, capacity of hoist and identification number of hoist? Reference [4.9.3.4](#)
- 4.14.16. Do hoist users maintain records of all tests? Reference [4.9.3.5.1](#)
- 4.14.17. Are only approved lifting devices like slings used to lift loads? Reference [4.9.3.6.2](#)
- 4.14.18. Do material handlers remove finger rings and jewelry prior to working with materials or moving machinery? Reference [4.11.6](#)
- 4.14.19. Are materials neatly stacked and the height limited to minimize the possibility for the materials to fall or collapse? Reference [4.13.1](#)

## Chapter 5

### HOUSEKEEPING

**5.1. Floors and Walking Surfaces.** Keep areas where personnel walk and work free of potential tripping and slipping hazards such as tools, electrical cords, air lines and packaging materials. Clean up spills as soon as possible and post warnings until cleanup is complete. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, for additional information.

**5.2. Scraps and Combustible Waste.** Provide sufficient metal or noncombustible containers with vapor tight and spill proof lids for disposal or recycling of combustible wastes, rags or other items contaminated with combustible or flammable materials. These containers shall be marked IAW AFI 32-7042, *Waste Management*, and AFI 90-821, *Hazardous Communications Program*. Dispose of contents IAW approved hazardous waste disposal procedures. Contact the installation environmental management office for guidance. Use properly marked, covered metal or noncombustible containers for storing clean rags.

**5.3. Packing Supplies and Recycled Materials.** Non-soiled excelsior (fine wood shavings), straw, shredded paper, recyclable cardboard, recyclable paper and other packing/recyclable materials shall be stored in isolated fire-resistant facilities. Small supplies of packing materials, which are kept in shops for immediate use, shall be stored in metal or noncombustible covered containers. Remove protruding nails, brads and staples from crates, cases, packing boxes, casks, boards and lumber to prevent injury to personnel.

**5.4. Electric Buffing Machines.** Ensure electric buffing machines are equipped with “deadman” control switches. Unless the machines are double insulated, ensure electrical cords include three-prong plugs to ensure positive ground.

**5.5. Walls and Ceilings.** Keep projections from walls to a minimum. Maintain ceilings in good repair and free of loose plaster. Replace damaged, broken or missing fire rated ceiling tiles. Openings in ceilings can delay activation of smoke detectors and sprinkler heads.

**5.6. Stacking Materials.** Stack materials so they may be easily reached but do not protrude into aisles or passageways. Use crossties, separators or dunnage to prevent objects from falling or toppling over. When materials are stacked to a height less than 15 feet, maintain an 18-inch clearance below ceiling sprinkler deflectors, joists, rafters, beams and roof trusses. If the stack is over 15 feet in height, increase the clearance to 36 inches. Position all stacks of materials to ensure an 18-inch clearance around light or heating fixtures, or follow manufacturer’s instructions, regardless of height. Refer to AFJMAN 23-210, *Joint Service Manual (JSM) For Storage and Materials Handling*, for additional information.

**5.7. Lighting Fixtures.** Fluorescent light fixtures without self-locking tubes shall have shields, clamps or other devices installed to keep the tubes from falling out of the fixture.

**5.8. Trash.**

5.8.1. Garbage cans shall be securely covered when not actually being filled or emptied.

5.8.2. Trash and garbage cans shall be leak-proof and adequate in number and size.

5.8.3. If the garbage disposal area is adjacent to or part of the general receiving area, floors and/or dock areas shall be kept clear of refuse and waste.

5.8.4. Garbage containers shall be positioned in a proper rack. Heavy garbage containers shall be moved on dollies to eliminate as much lifting as possible.

5.8.5. Garbage cans shall be washed and sanitized monthly with hot soapy water.

5.8.6. Place broken glass in a sturdy container or enclose the broken glass in cardboard or protective shield if disposal includes placing glass in a plastic bag. This should eliminate broken glass protruding from bags and prevent injury to personnel who handle the bags.

**5.9. Industrial Areas.** Good housekeeping shall be maintained in all areas, shops, yards, buildings and mobile equipment facilities/areas. Supervisors and workers are responsible for good housekeeping in or around the work area they are supervising or working.

5.9.1. Material shall not be placed where it might create a hazard for workers or visitors, by falling, being a trip hazard or causing the collapse of structures.

5.9.2. Aisles and passageways shall be kept clear of tripping hazards.

5.9.3. Nails shall be removed from loose lumber or the points turned down.

5.9.4. Surplus and waste materials shall not be allowed to accumulate in any mobile equipment. Tools and supplies shall be properly stored.

5.9.5. Disconnect switches, distribution panels and alarm supply boxes shall not be blocked by any obstruction that would prevent ready access.

5.9.6. Wire reels shall be stacked with strips of wood between reels.

5.9.7. Flammable materials shall be stored in approved containers in approved areas. Refer to **Chapter 22, *Flammables and Combustibles***, for additional information.

5.9.8. Combustible materials shall be placed in covered self-closing metal containers.

5.9.9. Noncombustible materials shall be neatly kept in designated cabinets (with their contents plainly marked).

5.9.10. Clothing lockers shall be maintained in a clean, orderly condition. Apparel not needed to perform official duties shall be stored in lockers. Objects shall not be stored on top of or under clothing lockers and no flammable liquids shall be stored in lockers.

5.9.11. Machinery and equipment shall be kept clean of excess grease and oil and free of excessive dust. Pressure gauges and visual displays shall be kept clean, visible and serviceable at all times. Drip pans and wheeled or stationary containers shall be cleaned and emptied at the end of each shift.

5.9.12. Certain cleaning compounds used in housekeeping activities may pose a hazard to workers. To protect eyes, skin and clothing from these compounds, workers shall wear (as required) safety glasses, face shields, aprons and gloves. Installation Ground Safety office and BE shall be consulted with questions pertaining to PPE. Refer to **Chapter 14** for additional guidance.



5.9.13. All surfaces shall be maintained as free as practicable of accumulations of dust, lead, chromium, cadmium or any other foreign particles. Floors shall be kept clean. Spills shall be cleaned up as soon as possible.

**5.10. Snow and Ice.** Snow and ice shall be removed from all walkways, sidewalks and work areas expediently where they may create a hazard or interfere with the work. If ice cannot be readily removed, sand or other approved materials shall be applied. Snow and icicles above walkways shall be removed.

**5.11. Housekeeping Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

5.11.1. Are floors and walking surfaces kept free of potential tripping hazards such as tools, electrical cords, air hoses, materials and liquids? Reference [5.1](#)

5.11.2. Are noncombustible containers with vapor tight and spill proof lids provided for the disposal of combustible wastes, soiled rags and other flammable materials? Reference [5.2](#)

5.11.3. Are packing materials such as excelsior (fine wood shavings), packing straw and shredded paper stored in an isolated fire-resistant building? Reference [5.3](#)

5.11.4. Are protruding nails, brads and staples removed from packing materials to prevent injury to personnel? Reference [5.3](#)

5.11.5. Are aisles and passageways kept clear of stacked materials? Reference [5.6](#)

5.11.6. Is an 18-inch clearance maintained below fire protection sprinkler heads, rafters, joists, beams and roof trusses when materials are stacked less than 15 feet high? Reference [5.6](#)

5.11.7. Are trash and garbage cans leakproof and adequate in number and size? Reference [5.8.2](#)

## Chapter 6

### FIRE PROTECTION AND PREVENTION

#### 6.1. Hazards.

6.1.1. General. The maintenance and operation of portable fire extinguishers and fire suppression systems may involve exposure to toxic fire extinguishing agents and by-products of combustion. Breathing toxic gases, absorption through skin contact or ingestion of toxic liquids is hazardous to your health. The severity of the hazard depends upon the type of chemical, concentration and duration of exposure. Additionally, fires produce toxic by-products of combustion, consume oxygen and produce high temperatures which create areas immediately dangerous to life and health (IDLH). It is important personnel receive training in the proper use of available portable fire extinguishers and fixed fire suppression systems, and fire education safety on preventing fires, protecting themselves and intervening early when fire occurs.

6.1.2. Inspections, Testing and Maintenance. Fire detection, suppression and alarm systems, including fire hydrants, are subject to failure unless inspection, test and maintenance (ITM) programs are conducted IAW UFC 3-601-02, *Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems*. When a fire protection system is out of service for more than 4 hours in a 24-hour period, the installation Fire Emergency Services (FES) Flight or civilian-equivalent fire unit, as appropriate, shall be notified by the facility manager or other responsible user, the building shall be evacuated or the user/occupant shall establish a fire watch (approved by the installation FES Flight) for all areas left unprotected by the out-of-service system, until the system has been returned to service. Facility managers shall use the RM process, with advice from the installation FES Flight and Ground Safety office, to determine to what extent the facility may be used while corrective actions are pending. Installation Civil Engineering (CE) will evaluate and prioritize work orders concerning fire protection systems in need of repair IAW guidance from AFPAM 32-1004, Volume 2, *Working in the Operations Flight Maintenance Engineering*. Refer to NFPA 101, *The Life Safety Code*, for additional guidance.

6.1.3. Extinguishing Agents. A detailed list of clean agents can be found in UFC 3-601-02 or at the U.S. Environmental Protection Agency (EPA) website: <http://www.epa.gov>.

#### 6.2. General Requirements.

6.2.1. Facility Managers/Supervisors shall:

6.2.1.1. Establish and maintain a training and certification system to ensure employees are trained and understand their fire prevention and protection responsibilities in their work areas. This training and certification system shall include documented annual training of employees, including fire extinguisher training and location of fire extinguishers, and immediate indoctrination of newly hired employees. This requirement may be fulfilled through the job safety training and documentation process IAW AFI 91-202, *The US Air Force Mishap Prevention Program*.

6.2.1.2. Coordinate this fire prevention and protection training program with the installation FES Flight. **Note:** Building evacuation procedures in Services facilities may be practiced without actual participation of patrons, with the prior approval of the installation FES Flight Chief.

6.2.1.3. Make sure the facility is in a fire-safe condition at the close of business.

6.2.1.4. Conduct and document daily closing inspections. Maintain documentation on file for 30 days following the last duty day of the month, i.e., May's documentation shall be kept on file until 30 June.

6.2.1.5. Maintain occupant load information. Every room constituting an assembly occupancy and not having fixed seats shall have the occupant load of the room posted in a conspicuous location near the main exit from the room. The maximum occupant load shall be calculated by the installation FES Flight, based on the actual exiting capacity of the corridors, aisles, stairs, doors and other egress components.

6.2.1.6. Notify the installation FES Flight of all major social events when temporary decorations or unusual arrangements exist.

6.2.2. Commercial Food Service Facilities. Commercial food service facilities shall be maintained as required to prevent the loss of US Air Force resources. The installation FES Flight shall inspect grease and heat removal hoods, ducts and exhausts at all food service facilities such as clubs, snack bars, fast-food outlets, bowling alleys, chapels, troop feeding or any other facility where food service cooking occurs. This inspection includes a review of employee training, installation and maintenance of required fire safety equipment, whether or not hood and duct cleaning has occurred and whether the cleaning frequency is adequate. Fire inspectors shall also inspect hood and duct systems to ensure thorough cleaning has been accomplished. The unit commander will appoint in writing a Quality Assurance Evaluator (QAE) for cleaning conducted under a service contract. QAE function is usually accomplished by the facility manager.

6.2.2.1. Commercial food service equipment which may create grease-laden vapor shall be provided with a system for smoke and grease-laden vapor removal. An automatic extinguishing system listed by a nationally recognized test laboratory (NRTL) for the protection of cooking equipment, ducts and grease-removing devices shall be provided. Other commercial food service and holding equipment shall be provided with a system for removal of smoke and heat. These systems shall be operational at all times except for scheduled inspections, testing and routine maintenance. If any of the systems are out of service for any reason, equipment protected by that system shall not be used. Activation of the fire suppression system will automatically shut down cooking equipment, sound the fire alarm and signal the fire department. Consult installation FES Flight for additional guidance.

6.2.2.2. Managers of these facilities shall establish and enforce the following procedures:

6.2.2.2.1. Grease filters shall be installed in all grease hoods and extraction systems designed with filters covering equipment. The filters shall be continually maintained in proper operating condition and shall fit properly. Cooking shall not be permitted without the filters installed. Spare filters shall be available for cooking facilities that operate continuously. Refer to NFPA 96, *Ventilation Control and Fire Protection of*

*Commercial Cooking Operations*, for additional guidance on facility installed systems.

6.2.2.2.2. All installed grease filters and exposed surfaces of hoods shall be thoroughly cleaned daily, or more often if necessary, to prevent grease buildup.

6.2.2.2.3. Hood and exhaust ducts serving food service equipment shall be thoroughly cleaned every 6 months, or more frequently when determined by the installation FES Flight. This cleaning cycle includes grease accumulation on fans, roofs, louvers, exterior walls, cupolas, etc., where the system exhausts to the outside. When cleaning is complete, all electrical controls, detection devices and system components shall be returned to an operable state by qualified personnel. Cover plates shall be replaced and dampers and diffusers shall be positioned for proper air flow. Specific guidance for cleaning is outlined in NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, for facility installed systems. **Exception:** Cleaning of hood and exhaust ducts serving food service equipment may be extended to every two years if a dining facility prepares less than 10 meals per month.

6.2.2.2.4. The exhaust system shall continually operate while the food service equipment is in use. If an exhaust fan is shut down or removed for repair or replacement, equipment served by that exhaust system shall not be used until the fan is returned to full service.

6.2.2.2.5. Portable, mobile or temporary food service equipment that uses grease or oil, such as donut machines and deep-fat fryers, shall be located beneath a system complying with paragraph 6.2.2.2 or have an integral grease removal and fire suppression listed by a NRTL IAW NSF/ANSI Standard 4: *Commercial Cooking, Rethermalization and Powered Hot Food Holding, and Transport*.

6.2.2.2.6. Deep fryers, pressure fryers, tilt skillets and other food service equipment capable of producing grease/fat laden vapors shall be listed by NRTL IAW NSF/ANSI 4.

6.2.3. Health Care Facilities. Facility managers and/or safety officers of health care occupancies shall have in effect a written fire plan that addresses appropriate staff response to a fire emergency and appropriate education and training for all elements of the fire plan. The plan will address facility-wide needs in response to fire, area-specific needs for all areas, training for all staff, employees and volunteers, and appropriate training for other non-staff personnel required to participate in the fire plan. This fire plan shall be approved by the installation FES Flight. Facility managers shall ensure fire exit drills are conducted IAW NFPA 01.

6.2.4. Portable Fire Extinguishers.

6.2.4.1. Fire Emergency Services Flight. The installation FES Flight manages the installation fire extinguisher program and is the authority for all matters involving fire extinguishers. The FES Flight shall provide facility managers information on facility fire extinguisher requirements outlined in appropriate NFPA Standards. These requirements include:

6.2.4.1.1. Provide fire extinguishers IAW NFPA 101 or when specifically required by DoD or AF guidance. Required extinguishers shall be selected, located, inspected and maintained IAW NFPA 10, *Standard for Portable Fire Extinguishers*. Refer to AFMAN 91-201, *Explosive Safety Standards*, for extinguisher requirements in locations that contain explosives.

6.2.4.1.2. Extinguishers are not provided for military family housing (MFH). Should MAJCOMs, DRUs and FOAs direct installation of extinguishers in MFH, procedures shall be developed to ensure occupants are trained in their use and extinguishers are maintained as indicated in paragraph [6.2.4.8](#).

6.2.4.1.3. Directional arrows may be required when needed to indicate the location of extinguishers in warehouses or industrial activities where volume of storage in the facility impairs or prohibits extinguisher visibility. Directional arrows, targets and extinguisher signs should not be used in other occupancies such as clubs and chapels, dormitories, mercantile occupancies or other locations where decor is important to the facility's function.

6.2.4.1.4. Fire extinguishers need not be visible from all locations within a facility. Workplace safety training provided to each employee by the supervisor shall include the location and use of fire extinguishers.

6.2.4.1.5. Refer to the standard for visual inspections of Compressed Gas Cylinders (C-6), published by the Compressed Gas Association (CGA) and 49 CFR, *Transportation*, Part 172, when evaluating the condition of extinguisher cylinders manufactured to meet Department of Transportation (DOT) specifications.

6.2.4.2. Directives Addressing Fire Extinguishers. Directives addressing fire extinguishers shall be coordinated with appropriate fire protection offices.

6.2.4.3. Fire Extinguisher Location. The installation FES Flight shall approve the location of all fire extinguishers, i.e., vehicle-mounted, equipment or facilities.

6.2.4.4. Fire Extinguisher Purchase and Maintenance. Facility managers and using organizations shall budget for purchase and maintenance of fire extinguishers. All fire extinguishers shall meet the requirements of this chapter.

6.2.4.5. Worker Responsibilities. All employees are responsible for fire extinguishers in their work areas. They shall ensure fire extinguishers are readily accessible with unobstructed access and are used only for the intended purpose.

6.2.4.6. Supervisor Responsibilities. Supervisors are responsible for fire extinguishers in areas under their control. They shall:

6.2.4.6.1. Perform visual inspections of fire extinguishers IAW paragraph [6.2.4.7](#).

6.2.4.6.2. Take defective extinguishers to an authorized servicing location, as determined locally and coordinated with the installation FES Flight, for services. Fire extinguishers removed from service shall be immediately replaced.

6.2.4.6.3. Refer questions regarding fire extinguishers, including the extinguisher type, size and required maintenance, to the installation FES Flight.

- 6.2.4.6.4. Mount fire extinguishers in or on vehicles or equipment in approved/listed brackets, or otherwise secure them, to prevent damage as directed by TO or other directive and the installation FES Flight. **Note:** Vehicle fire extinguishers shall only be purchased with the approval of Vehicle Management to ensure the vehicle technical orders and AFIs require the vehicle to carry fire extinguishers. Additionally, FES Flight will determine the size and type of vehicle fire extinguishers.
- 6.2.4.7. Visual Inspection. Managers and supervisors at all levels shall ensure a visual inspection is performed at a minimum of 30-day intervals and documented for all fire extinguishers under their control. Extinguishers with discrepancies shall be removed from service until repaired. This inspection includes:
- 6.2.4.7.1. Extinguisher located in a designated place.
  - 6.2.4.7.2. No obstruction to access or visibility.
  - 6.2.4.7.3. Operating instructions on name plate legible and facing outward.
  - 6.2.4.7.4. Safety seals and/or tamper indicators not broken or missing.
  - 6.2.4.7.5. No obvious physical damage, corrosion, leakage or clogged nozzle.
  - 6.2.4.7.6. Pressure gauge reading or indicator in the operable range or position.
  - 6.2.4.7.7. For wheeled units, the condition of the tires, wheels, carriage, hose and nozzle checked.
  - 6.2.4.7.8. Fullness determined by weighing or “hefting.”
- 6.2.4.8. Maintenance and Tests.
- 6.2.4.8.1. All fire extinguishers shall be maintained and tested at intervals specified in NFPA 10, *Standard for Portable Fire Extinguisher*, appropriate TOs, directives or the manufacturer’s instructions.
    - 6.2.4.8.1.1. Organizations with fire extinguishers not located in real property facilities shall ensure each extinguisher receives annual maintenance by an authorized servicing agency, (e.g., contractor or fire protection organization). Contact the installation FES Flight for specific guidance.
    - 6.2.4.8.1.2. The facility manager or using organization manager ensures maintenance and testing of installation fire extinguishers are accomplished. The installation FES Flight oversees and ensures programs for maintenance and testing of installation fire extinguishers are accomplished.
  - 6.2.4.8.2. The using organization is responsible for transporting wheeled extinguishers to the maintenance location.
  - 6.2.4.8.3. Halon shall not be released into the atmosphere during maintenance and tests. Refer to AFI 32-7086, *Hazardous Materials Management, Chapter 4, ODS Management*, for specific guidance regarding handling of halon.
- 6.2.4.9. Fire Extinguisher Records. These records shall be maintained IAW NFPA 10, as approved by the installation FES Flight.

6.2.4.10. Fire Extinguishers. Ensure all personnel know where fire extinguishers are located and what to do in case of fire. Supervisors shall instruct personnel on fire extinguisher operation upon initial arrival and annually thereafter. **Note:** Personnel assigned for short periods (less than 30 days), either on deployment or TDY, do not require initial training at each base. However, personnel shall be oriented to the locations of fire apparatus (extinguishers, hoses, alarm boxes, etc.) within their immediate temporary duty area. Personnel deploying or TDY for more than 30 days are required to receive orientation and operation training on fire apparatus in their work areas. Refer to fire extinguisher training requirements IAW paragraph 6.2.16 and NFPA 10.

#### 6.2.5. Fire Detection, Suppression and Alarm Systems.

6.2.5.1. Inspections, Testing and Maintenance. Fire detection, suppression and alarm systems, including fire hydrants, are subject to failure if not properly tested, inspected and maintained. Inspection, test and maintenance (ITM) programs are conducted IAW UFC 3-601-02, *O&M: Inspection, Testing, and Maintenance of Fire Protection Systems*. Also see paragraph 6.1.2.

6.2.5.2. Rooms and enclosures protected by total flooding Halon, carbon dioxide (CO<sub>2</sub>) or similar fire suppressing agents shall have caution signs posted outside at all entrances with the legend, "DO NOT ENTER WHEN ALARM IS SOUNDING. HALON 1301 (or CO<sub>2</sub>) BEING DISCHARGED." Caution signs shall be posted inside the room or space near the alarm device, with the legend, "WHEN THE ALARM SOUNDS, VACATE THE ROOM. HALON 1301 (or CO<sub>2</sub>) BEING DISCHARGED." These signs shall be designed IAW **Chapter 29**, *Mishap Prevention Signs and Tags*.

#### 6.2.6. Standpipe and Hose Systems.

6.2.6.1. Standpipe and hose systems shall be kept free from obstructions, used only for the intended purpose, with only fire protection equipment stored in hose cabinets.

6.2.6.2. Standpipe hoses shall be tested IAW UFC 3-601-02. Unlined hose is prohibited on standpipe systems provided for occupant use. Standpipe hose shall be equipped with shut-off type nozzles.

6.2.7. Fire Hydrants. Fire hydrants shall be installed and maintained as required by UFC 3-600-01, *Fire Protection for Facilities Engineering, Design, and Construction*, and UFC 3-601-02.

#### 6.2.8. Smoke Detectors in Family Housing.

6.2.8.1. Smoke detectors shall be installed in all MFH units IAW HQ AFCEE, *Military Family Housing Design Guide*.

6.2.8.1.1. Each MFH unit sponsor is responsible for a monthly test and examination of all household warning devices installed within the quarters. Test and examination of these devices shall include:

6.2.8.1.1.1. Visual inspection for evidence of damage, abuse, tampering or other indications that may render it inoperative.

6.2.8.1.1.2. Ensuring units are securely mounted.

6.2.8.1.1.3. Conducting an operational test IAW the manufacturer's guidance to

ensure the audible alarm is working.

6.2.8.1.2. Vacant units shall not be reoccupied if the household fire warning system is not functioning properly.

6.2.8.1.3. The installation housing office shall provide occupants a brochure detailing detector testing and maintenance procedures.

6.2.8.2. At change of occupancy, smoke detector maintenance shall be conducted IAW UFC 3-601-02. Deficient operation or faulty equipment shall be reported to the agency responsible for maintenance. Disposal of smoke detectors (ionization smoke detectors) should be coordinated through the installation Radiation Safety Officer (RSO) IAW the local requirements for radioactive articles and instruments.

6.2.9. Life Safety. Functional managers, supervisors and building managers are responsible for keeping facilities in a condition that provides a safe workplace IAW NFPA 101. Fires in facilities can result from many circumstances, but are usually attributed to improper use, selection or placement of heaters, coffee makers, holiday decorations or improper storage or disposal of flammable and combustible materials. Specific requirements for fire protection:

6.2.9.1. Smoking Restrictions. Smoking is not allowed inside Air Force buildings. Contact the Unit's Safety Representative (USR) for a list of approved smoking areas.

6.2.9.2. Disposal of Smoking Material.

6.2.9.2.1. Provide an adequate number of ashtrays/ash receptacles for every authorized smoking area.

6.2.9.2.2. Provide ash receptacles or smoking material cans at the entrance to all NO SMOKING areas or IAW local/unit no smoking policy.

6.2.9.2.3. Dispose of smoking material in approved containers (listed by UL, CSA or other recognized testing laboratory) specifically designed for smoking material. Stencil these containers or cans "SMOKING MATERIAL ONLY." Refer to paragraph 5.8.6 for additional information.

6.2.9.2.4. Disposal of waste, trash or any combustible material in ashtrays or smoking material cans is prohibited.

6.2.9.2.5. Smoking material. Saturate and completely extinguish smoking material prior to disposal into outside waste dumpsters.

6.2.10. Heat Producing Appliances.

6.2.10.1. Use UL-listed or host nation equivalent space heaters equipped with automatic shut-off devices that will shut off the heater if it tips over. Space heaters shall also have an overheat protection device, an automatic thermostat control and must be disconnected when not in use.

6.2.10.2. Plug space heaters directly into a wall receptacle. Do not plug space heaters into multiple outlet strips. Do not use an extension cord with an electric space heater.



6.2.10.3. Maintain a 36 inch minimum distance or IAW manufacturer's recommendations between any heat producing appliance and combustibles. **Note:** The more restrictive of the guidance will apply.

6.2.10.4. The use of portable space heaters must be IAW the manufacturers' specifications and have the concurrence of the base energy awareness manager.

6.2.10.5. Do not leave these devices unattended when in use and unplug them at the end of the day or shift.

6.2.10.6. The use of space heaters in any hazardous location is prohibited.

#### 6.2.11. Coffee Makers.

6.2.11.1. Keep coffee makers and the area around them free of combustibles.

6.2.11.2. Refer to the manufacturer's operating instructions and consult the facility manager for approval after coffee makers placement.

6.2.11.3. Unplug coffee makers at the end of the day. **Note:** Coffee makers/machines with integral timers need not be unplugged, e.g., Bunn-type coffee brewers.

6.2.11.4. Do not use timers unless the coffee maker comes with an integral timer.

#### 6.2.12. Heating Systems.

6.2.12.1. Heating devices, such as furnaces or heaters, must be kept clear of combustible and flammable material.

6.2.12.2. All heating equipment must be in good repair.

6.2.12.3. All heating, boiler, air conditioning, air handling and mechanical rooms shall be secured. Only the installation FES Flight, CE or authorized personnel shall have access to these areas.

#### 6.2.13. Decorations.

6.2.13.1. Electric string lights and wiring must be UL (or equivalent) approved and in good operating condition.

6.2.13.2. Unplug all electrical decorations when work area is unoccupied.

6.2.13.3. Decorations shall be noncombustible or fire retardant.

6.2.13.4. Larger decorations, i.e., Christmas trees or fake fireplaces, if authorized, shall not block exits or paths of egress.

6.2.13.5. Decorations utilizing an open flame are prohibited.

6.2.14. Fire Alarm Systems. Supervisors shall ensure all personnel are familiar with the fire alarm systems, know how to report an emergency and how to activate the fire alarm system. At no time shall a fire detection, suppression or alarm system or device be painted, blocked or obstructed in any manner.

#### 6.2.15. Emergency Evacuation Procedures.

6.2.15.1. Supervisors shall establish an emergency action plan. **Note:** Employees shall know primary and secondary escape routes for every area of the building.

6.2.15.2. Ensure escape routes are kept free of obstruction—to include stairways and office doors. Ensure doors leading outside open easily.

6.2.15.3. Consult the installation FES Flight to determine requirements for practice fire evacuation drills. Ensure new personnel are trained in evacuation procedures.

6.2.15.4. Personnel shall immediately evacuate the building whenever the fire alarm activates, unless otherwise provided for in an approved building fire evacuation plan or when non-evacuation testing or maintenance is being conducted on the fire alarm system. Wing/Installation commanders may approve in writing, with coordination from the installation Ground Safety office and FES Flight, any combat ready positions authorized to remain in their work center during a fire alarm activation. Upon direction of the senior fire official, all personnel shall immediately evacuate to include those combat mission ready positions. **Note:** Command post and/or job control personnel are not considered combat mission ready.

6.2.15.5. Do not use elevators during evacuation; use the stairs.

6.2.15.6. Establish a predetermined area for personnel to gather after evacuation so personnel can be accounted for. To minimize confusion, different predetermined meeting locations shall be established for smaller groups within the total organization. For example, each division shall meet in a different place.

6.2.15.7. Appoint Emergency Action Procedures representatives to account for personnel at the predetermined meeting area. This will help emergency response personnel determine who may still be in the building. At least two representatives per section shall be appointed; in case the primary leader is not in the building at the time of the emergency or is unable to evacuate the building, the alternate can fill in. Sections with many personnel (20 or more) in their allocated space may require additional representatives.

6.2.15.8. Assign workers to assist people in wheelchairs or anyone else who would have difficulty descending stairs on their own. Also, ensure people with hearing or sight problems know they are to evacuate. Assign someone to help them evacuate and report to the designated meeting area, if necessary.

6.2.16. Safety, Fire Prevention and Health On-the-Job Training. Training shall be IAW AFI 91-202, *The US Air Force Mishap Prevention Program*.

6.2.17. Employees shall be knowledgeable of the following but not limited to:

6.2.17.1. The fire evacuation signal in their work area.

6.2.17.2. The fire suppression system signal (if different from fire evacuation signal).

6.2.17.3. Other evacuation signals in their work area, if provided.

6.2.17.4. Specific actions to take for a fire or other emergency.

6.2.17.5. When to manually activate fire suppression systems, if provided.

6.2.17.6. Specific actions required to activate fire suppression system, if provided.

6.2.17.7. Specific actions to activate emergency evacuation signaling systems.

6.2.17.8. Primary and secondary egress routes from all work areas.

6.2.17.9. Location of fire extinguishers, if provided.

6.2.17.10. When and how to use fire extinguishers, if provided.

### **6.3. Exits and Exit Markings.**

6.3.1. Refer to 29 CFR 1910, Subpart E, *Means of Egress*, and NFPA 101, for additional guidance and information.

6.3.2. Fire exits shall be clearly marked and exit paths shall be kept clear of equipment and materials, emergency lighting shall be provided and all workers trained in proper evacuation procedures.

6.3.3. Doors, passageways or stairways which are neither exits nor ways to an exit but may be mistaken for an exit, shall be clearly marked "NOT AN EXIT" or a sign indicating their actual use; for example, "STORAGE ROOM" or "BASEMENT."

6.3.4. Exit access shall be arranged so it is unnecessary to travel toward any area of high hazard potential to reach the nearest exit, unless the path of travel is effectively shielded by suitable partitions or other protective barriers.

6.3.5. Nothing shall impair the visibility of the exit sign.

6.3.6. No lock or fastening device shall prevent escape from inside the building.

6.3.7. Areas around exit doors and passageways shall be free of obstructions. The exit route shall lead to a public way.

6.3.8. Floors or means of egress shall be illuminated to at least one (1) foot-candle (measured at all points at the floor), including angles and intersections of corridors and passageways, stairways, landings of stairs and exit doors.

**6.4. Fire Protection and Prevention Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

6.4.1. Are personnel trained initially and annually thereafter on their responsibilities for fire protection and prevention? Reference [6.2.1.1](#)

6.4.2. Are all commercial cooking facilities provided with a system to remove smoke and grease-laden vapors? Reference [6.2.2.1](#)

6.4.3. Are grease ducts and grease removal systems protected by automatic fire suppression systems? Reference [6.2.2.1](#)

6.4.4. Are grease filters installed in all hoods and extraction systems? Reference [6.2.2.2.1](#)

6.4.5. Are the filters and hoods cleaned at least daily? Reference [6.2.2.2.2](#)

6.4.6. Are hood and exhaust ducts thoroughly cleaned every six (6) months, or more frequently when determined by the installation FES Flight? Reference [6.2.2.2.3](#)

- 6.4.7. Are deep fat fryers listed IAW NSF/ANSI Standard 4: *Commercial Cooking, Rethermalization and Powered Hot Food Holding, and Transport*? Reference [6.2.2.2.6](#)
- 6.4.8. Are deep fat fryer thermostats tested annually and after any repairs or as recommended by manufacturer? Reference [6.2.2.2.6](#)
- 6.4.9. Has a written fire plan been developed for the health care facility that includes appropriate staff response to fire emergencies and requirements for education and training? Reference [6.2.3](#)
- 6.4.10. Are fire extinguishers visually inspected at a minimum of 30-day intervals to detect and correct discrepancies? Reference [6.2.4.7](#)
- 6.4.11. Are caution signs posted both inside and outside rooms or enclosures protected by total flooding halon, CO<sub>2</sub>, or similar fire suppressing agents? Reference [6.2.5.2](#)
- 6.4.12. Do hose cabinets of standpipe and hose systems contain only fire protection equipment? Reference [6.2.6.1](#)
- 6.4.13. Is safety, fire prevention and health training accomplished IAW AFI 91-202? Reference [6.2.16](#)

## Chapter 7

### WALKING SURFACES, GUARDING FLOOR AND WALL OPENINGS, FIXED INDUSTRIAL STAIRS, AND PORTABLE AND FIXED LADDERS

**7.1. Specific Hazards Associated with Walking and Working Surfaces.** Many injuries and property damage mishaps occur on walking and working surfaces, with slips and falls the most common mishaps. Good design and maintenance, together with proper lighting, contribute to a safe walking or working surface. Workers are responsible for wearing proper footwear and using walking surfaces in a safe manner. The primary reasons for walking surface mishaps are:

7.1.1. Poor Housekeeping. Obstacles in walk areas, liquid spills, sawdust accumulations and the use of slippery surface cleaners can cause slipping hazards and shall be cleaned up immediately to prevent slips, falls and injuries.

7.1.2. Dangerous Surface Conditions. Cracks, holes, protruding nails, broken surface materials, slippery finishes, surfaces of different elevations and improper design for the intended use can cause worker injuries.

7.1.3. Inadequate Lighting. Incorrect or insufficient lighting may lead to slips, falls or injuries. Building or facility managers shall ensure lighting is sufficient for walking surfaces in their work/facility area and that obstacles are visible.

### **7.2. Requirements.**

#### 7.2.1. Interior Walking and Working Surfaces.

7.2.1.1. Layout. Proper layout, spacing and arrangement of equipment, machinery, passageways and aisles are essential to orderly operations and to avoid congestion. Good layout can best be achieved in the design stage, with recommendations from the installation Ground Safety office, Fire Emergency Services (FES) Flight, BE, CE and Public Health (PH). Whether a facility is in the design stage, being remodeled or when repositioning equipment and machinery, basic layout considerations are important factors in planning a facility for safe operations. All interior walking and working surfaces that are part of the means of egress shall comply with UFC 3-600-01, *Fire Protection Engineering for Facilities*, and NFPA 101, *The Life Safety Code*.

7.2.1.1.1. Equipment and machinery shall be arranged to permit an even flow of materials. Sufficient space shall be provided to handle the material with the least possible interference from or to workers or other work being performed. Machines shall be placed so it will not be necessary for an operator to stand in a passageway, aisle or exit access. Additionally, machine positioning shall allow for easy maintenance, cleaning and removal of scrap. After the initial positioning of equipment and machines is decided, clear zones (workspaces) of sufficient dimensions to accommodate typical work shall be established. If material exceeds established clear zones, rope and stanchions may be used to temporarily extend the workspace. Marking of machine clear zones is optional. The installation Ground Safety office and shop supervisor shall determine the need to mark clear zones based upon hazard potential. Yellow or yellow-and-black hash-marked lines, two (2) to three (3) inches wide, shall be used when marking is necessary.

7.2.1.1.2. Passageways, aisles and exit accesses shall be provided to permit free movement of workers and material, and shall be independent of clear zones and storage spaces and shall be clearly recognizable. Markings shall be used unless the number of workers and location of machines precludes this requirement. In these cases the installation Ground Safety office shall approve the exclusion. Floor markings shall provide a contrast to the floor color, such as yellow lines 2 to 3 inches wide on a gray floor.

7.2.1.1.3. Where powered materials handling equipment (lift truck, etc.) is used, facility layout shall provide enough clearance in aisles, loading docks and through doorways to permit safe turns. Obstructions that could create hazards shall not be permitted in aisles. Aisles shall be at least two (2) feet wider than the widest vehicle used or most common material being transported. Refer to 29 CFR 1910.176., *Handling Materials—General*, for additional information.

7.2.1.1.4. Aisles shall be at least 36 inches wide to permit free movement of workers, equipment and supplies. A minimum of 18 inches shall be provided for passageways formed by or between movable obstructions. Refer to NFPA 101 and UFC 3-600-01 for additional information.

7.2.1.1.5. Sufficient access and working space shall be provided and maintained around all electrical equipment. Refer to 29 CFR 1910.303., *General Requirements—Electrical*, for additional information.

7.2.1.1.6. Coefficient of Friction (COF) of Walking and Working Surfaces. The finished surface shall have a coefficient of friction (COF) of at least 0.5 for level surfaces and 0.8 for sloped surfaces, as measured using ANSI/ASSE A1264.2., *Standard for Provision of Slip Resistance on Walking/Working Surface*, or other nationally recognized standards. Consult the installation CE facility design section when COF guidance for a specific work surface is required. Submit AF Form 332, *Basic Civil Engineer Work Request*, when a COF survey is required. If the safety or health of personnel is a factor, the work request shall be coordinated with the installation Ground Safety office or BE, who may assign a risk assessment code (RAC) if warranted. **Note:** This requirement applies to all types of floors and other walking/working surfaces, including vinyl, tile, wood, carpet, steel, concrete, etc., and any coatings used on them. Hangars shall also meet guidance provided in ETL 96-5, *Hangar Concrete Floor Reflective Coating Criteria*.

7.2.1.1.7. Coating (includes painting/de-painting) of Walking and Working Surfaces.

7.2.1.1.7.1. Walking and working surface coatings shall exhibit anti-skid properties to reduce the risk of worker slips and falls. While all surfaces do not require coating, if coating is needed, only coatings (i.e., paint) or repair materials having anti-skid properties shall be used. The user shall verify anti-skid properties with coating manufacturer or supplier before purchase. **Note:** Painting floors for cosmetic purposes is not permitted. However, urethane, latex or paints of similar composition may be used, if approved locally, for demarcation lines, safety zones and security warnings. Painting needed to brighten a dark work environment to make it easier to see work and avoid obstacles is not considered cosmetic.

7.2.1.1.7.2. All projects involving the coating/recoating/repair of walking and working surfaces shall be submitted through the installation CE, BE and Ground Safety office for evaluation of coating specifications and application processes IAW AFI 32-7086, *Hazardous Material Management*.

7.2.1.1.7.3. Walking and working surfaces coated/painted without anti-skid materials shall be evaluated for removal by the owner/user using Risk Management (RM) processes to identify and categorize the surfaces as low to high risk to prioritize and budget replacement with anti-skid coatings. Working surfaces that are high risk shall be identified to the installation Ground Safety office and/or BE, who may assign a RAC, if warranted. Application and removal of coatings can present health, safety and environmental risks. These activities, including self-help, CE operations and contract operations shall be coordinated with the installation Environmental Management office, BE and Ground Safety office IAW AFI 32-7086 prior to starting the removal/application process. The organization requesting coating removal must meet all health, safety and environmental requirements applicable to the coating materials and removal process.

7.2.1.2. Condition. Floors, aisles and passageways shall be kept clear and in good repair, with no obstructions, free of defects that can endanger workers or interfere with handling of materials, or hinder people leaving during emergencies. Refer to 29 CFR 1910.22., *General Requirements-Walking Working Surfaces*, for additional information.

7.2.1.2.1. Every floor, work area, aisle and passageway shall be maintained free from protruding nails, splinters, holes and loose boards, and kept in a dry condition.

7.2.1.2.2. Floors of all shop areas, service rooms, halls and storerooms shall be kept clean, free of oil, grease, gasoline, water and other slippery substances. Spills shall be immediately cleaned or covered with a noncombustible absorbent material. Drip or oil pans shall be used whenever the possibility of spilling or dripping exists.

7.2.1.2.3. Floors shall not be cleaned with flammable liquids. IAW AFI 32-7086, *Hazardous Materials Management*, floor cleaning chemicals not currently loaded in the standardized Air Force HAZMAT tracking system must be approved by the installation Hazardous Materials Management Program (HMMP) Team prior to use. Adequate ventilation shall be provided and/or respiratory protection may be required. Combustible or explosive dust shall be eliminated at the source. If this is not possible, it shall be minimized during sweeping by spreading a noncombustible sweeping compound over the floor.

7.2.1.2.4. After floors have been properly cleaned, nonskid finishing compounds may be used. In some locations, such as electroplating shops, finishing compounds shall not be applied if there is a possibility of a reaction with shop chemicals.

7.2.1.2.5. When floors are being cleaned or finishing compounds applied, signs shall be posted to warn workers of a slipping hazard and shall remain in place until floors have dried. The size and placement of these signs shall be at the discretion of the supervisor, but shall be visible to those entering the hazardous area. These caution signs shall be yellow with black lettering.

- 7.2.1.2.6. Areas which are usually wet shall have nonslip surfaces where personnel normally walk or work. Signs shall be posted stating “Caution—Wet Floors” when no other controls are available.
- 7.2.1.2.7. Passageways, aisles and exit accesses shall be kept clear for easy access to emergency equipment and to enable firefighters to reach a fire. Additionally, areas adjacent to sprinkler control valves, fuse boxes and electrical switch panels shall not be obstructed. Refer to NFPA Standard 70, *The National Electrical Code (NEC)*, and other NFPA standards for additional information on clearance distances.
- 7.2.1.3. Loading Capacity. Supervisors shall ensure equipment weight and distribution comply with maximum floor loading capacity for all above grade storage areas (including areas above basements). The weights of equipment, such as hoists suspended under a floor, shall also be considered when determining floor loading capacity. The supervisor shall have signs that identify the floor load capacity determined by the installation CE permanently installed in plain view of all workers. CE shall approve the installation of all equipment weighing more than 500 pounds in any multi-story building. Supervisors shall ensure heavy loads are evenly distributed according to the floor’s safe load limit. Refer to 29 CFR 1910.22. for additional information.
- 7.2.1.4. Floor Sloping and Drains. Floor drains are required when floors are subject to water, moisture or other liquids, such as those found in aircraft maintenance functions, battery shops and kitchen areas. Floors shall be sloped to allow liquids to naturally flow to the drains. Drains shall be kept clear to prevent clogging, especially when hazardous or contaminated materials are present. All new construction shall provide for drains in wet process areas. If drains are not available, wet areas shall be immediately roped off, cleaned up and dried before permitting other personnel to enter the area. False floors, platforms, mats or other dry standing places shall be provided where practicable. Protective footwear for wet slippery surfaces shall be provided where appropriate.
- 7.2.1.5. Illumination. Consult the local CE facility design section whenever specific guidance on lighting is required. Submit an AF Form 332, *Base Civil Engineer Work Request*, when a lighting survey is required. If the safety of personnel is a factor, the work request shall be coordinated with the installation Ground Safety office, who may assign a RAC, if warranted. All fluorescent light bulbs contain toxic materials and shall be managed IAW local disposal criteria for hazardous waste. Consult with the installation Environmental Management Office on disposal guidance for hazardous waste materials. When fluorescent lighting fixtures are used, supervisors shall ensure that any stroboscopic effect with moving machinery is avoided. Control of light is important to prevent glare and harsh shadows. Soft shadows are usually acceptable, but harsh shadows should be avoided since they may obscure hazards or interfere with visibility. Supplementary lighting or additional lighting shall be provided where general lighting is not sufficient.
- 7.2.1.6. Guards for Floor and Wall Openings. Every floor opening, such as a hatchway, chute, pit, trap door, manhole and ladderway, shall be guarded. The type of guard used depends on the location, reason for the opening and frequency of use. Refer to 29 CFR



1910.23., *Guarding Floor and Wall Openings and Holes*, for additional guidance. One of the following guards shall be installed:

7.2.1.6.1. Standard Railings and Toeboards.

7.2.1.6.1.1. Railings and toeboards shall be permanently attached leaving only one exposed side, which shall have a removable railing. When the exposed side is not in use, the railing shall be left in place. Refer to 29 CFR 1910.23. for specific detail on construction and installation.

7.2.1.6.1.2. Toeboards are required wherever falling objects may present a hazard. Toeboards can be constructed of any 4-inch high rigid material, either solid or with openings not greater than 1 inch. They shall be securely fastened in place with not more than one-fourth inch clearance from the floor except at the entrance of the opening. Refer to 29 CFR 1910.23. for additional information.

7.2.1.6.2. Floor Opening Cover. A cover shall be used for less frequently used openings where traffic across the opening prevents the use of fixed railings, such as openings located in aisle spaces. In addition, covers or guards shall be used to protect people from the hazards of open pits, tanks, vats, ditches, etc.

7.2.1.6.2.1. Covers shall have at least the same rated load capacity as the floor.

7.2.1.6.2.2. Cover design, installation and related hardware shall not pose a tripping hazard.

7.2.1.6.2.3. The cover shall be in place when the opening is not in use. The opening shall be protected by removable railings leaving only one exposed side when the cover is open or removed. Someone shall be present at the exposed side whenever the worker is not present.

7.2.1.7. Guards.

7.2.1.7.1. Every stairway and ladderway opening shall be guarded by standard railings and toeboards on all open sides, except at the entrance of the opening. If there is danger of a person walking straight into the opening, a swinging gate or offset passage shall be used.

7.2.1.7.2. Every covered opening in a surface, such as a skylight floor opening, shall be guarded by a skylight screen or standard railing with toeboards on all exposed sides. Skylight screen grillwork or slatwork shall be capable of withstanding a load of at least 200 pounds applied at any area of the screen. Refer to 29 CFR 1910.23. for additional information.

7.2.1.7.3. All open-sided floors, platforms and runways four (4) feet or more above the ground or floor shall be guarded by a standard railing on all open sides, except at ramp entrance to a ramp, stairway or fixed ladder. Collapsible or removable railings may be installed on a runway, but shall only be removed when a special task (such as oiling, shafting or filling tank cars) is being performed and other protective measures, approved by the installation Ground Safety office, are used. Railings shall be reinstalled when the task is complete.

- 7.2.1.7.4. Every permanent or temporary wall opening (to include windows) less than three (3) feet above the floor (where there is a four [4] foot or more drop) shall be guarded. Guards include railings, doors, slats, grillwork, half-doors or equivalent protection. The guard may be removable, but shall be installed when the opening is not in use. A toeboard shall be installed when falling materials may present a hazard. Grab handles shall be installed on each side of the opening when the operation requires reaching through or around the unprotected opening. Refer to 29 CFR 1910.23. for additional information.
- 7.2.1.7.5. Guard railings shall consist of securely mounted top rails, intermediate rails and posts. The minimum vertical height shall be 36 to 44 inches from the upper surface of the top rail to the floor, platform, runway or ramp level. Heights greater than 44 inches are permissible, but may require midrails if the opening beneath the top rail is 19 inches or greater. Screens, mesh, vertical posts or panels may be used in place of midrails, provided the material used can withstand a force of at least 200 pounds. Refer to 29 CFR 1910.23(e)(1) for additional information.
- 7.2.2. Exterior Walking and Working Surfaces. The proper layout and condition of exterior surfaces is important to the safe and efficient movement of people and equipment. The placement of walkways and parking areas is controlled by the installation CE. However, changes in workplace requirements, weather conditions and an increase in assigned personnel could require the supervisor to reroute pedestrian or equipment traffic. **Note:** Paragraph [7.2.1.1.6](#), *Coefficient of Friction (COF) of Walking and Working Surfaces*, also applies to exterior walking and working surfaces.
- 7.2.2.1. Loading Docks. Frequently used loading docks shall be located away from principal streets and intersections. Vehicles parked at docks shall not block general vehicular traffic unless control devices, such as cones, barricades or warning signs are used to redirect traffic. Loading docks shall adhere to fall protection requirements in paragraph [7.2.1.7.4](#).
- 7.2.2.1.1. Dock surfaces shall be smooth and even. Where necessary, aisleways shall be marked. Edges of docks shall be marked with four-inch wide yellow lines when there is a chance of workers falling. Where the potential for serious injury exists, removable railings shall be used.
- 7.2.2.1.2. The dock shall be at least two (2) feet wider than the widest vehicle or more common material being transported. Additional clearance shall be provided to permit safe turns.
- 7.2.2.2. Parking Lots. The parking lots shall be smooth, have good drainage and be free of pedestrian tripping hazards. Stony or rough ground shall be avoided. Walkways shall be provided. Entrances and exits shall not have obstructions that block a driver's or pedestrian's view of traffic. Supervisors shall contact the installation Ground Safety office and CE for more detailed information. Specifications for signs are contained in UFC 3-120-01, *Air Force Sign Standard*.
- 7.2.2.3. Walkways. Exterior walkways shall be kept clear of obstacles that block the right-of-way or present slipping and tripping hazards. Facility managers shall ensure

removal of accumulated snow or ice. Abrasive materials, salt or other snow melting material shall be used on walking surfaces when it is impractical or impossible to remove snow and/or ice. Night lighting shall be used to highlight hazards. When loose gravel or crushed rock is used for surfacing, the largest dimensions of material used shall not exceed one-half of an inch. Motorized vehicles shall not be operated over elevated walkways unless the load bearing capacity of the walkway will support the vehicle's weight. Broken, uneven or cracked surfaces shall be repaired.

7.2.2.4. Grounds. All grounds adjacent to work areas shall be kept free of hazardous materials, trash, weeds and unguarded pits, openings or obstacles.

7.2.2.4.1. Materials shall not be stored, left under or piled against buildings, doors, exits or stairways.

7.2.2.4.2. During the growing season, frequent lawn mowing and edging is necessary to keep installation grounds in good condition. Poisonous or toxic plants shall not be used for landscaping without prior approval of the installation medical services. Weeds shall not be permitted to grow excessively or to accumulate. Trees and bushes adjacent to walkways shall be trimmed to permit a clear path for pedestrians.

7.2.2.4.3. All open drainage ditches that present a hazard shall be clearly identified in the daytime, guarded by fences or barriers and illuminated or marked with warning flashers at night.

7.2.2.5. Construction. All construction work shall be clearly identified by signs that can be read from at least 50 feet, in addition to barriers marked with night reflective materials. Illumination or warning flashers shall also be used after dark.

**7.3. Fixed Industrial Stairs and Ramps. Note:** Egress components, such as stairs, ramps, guard rails or hand rails, constructed to any 1970 or newer edition of NFPA 101, *The Life Safety Code*, are acceptable.

7.3.1. Human Factors Associated with Fixed Industrial Stairs and Ramps. Many injuries are the result of falls when people move from one level to another on stairs or ramps. Proper design and construction of stairs and ramps will help prevent these falls. Other aids, such as handrails, reduce the threat of slips. Poor lighting or housekeeping, faulty treads and slippery surfaces are unsafe conditions which often lead to injuries. Others result when people run up or down stairs, fail to use handrails, wear shoes with slippery soles and/or heels or are careless.

7.3.2. Requirements. The selection of a particular type of fixed industrial stairway or ramp is dependent upon the location, intended use and existing environmental conditions, and is normally performed by the installation CE with recommendations from the installation Ground Safety office and FES Flight.

7.3.2.1. Design Consideration. Stairway and ramp designs may have been based on prior use of a facility, whereas current use may dictate modifications or replacement of components. This could include changing the width, angle of rise, length and vertical clearance, as well as increasing load bearing capacity, inclusion of railings or enclosing open risers. The following minimum specifications and requirements shall be used for

inspection criteria, supplemented as necessary with specific design criteria from the installation CE and Ground Safety offices.

7.3.2.2. Strength. Fixed stairs and ramps shall be designed and built to carry a load of 5 times the normal live load anticipated but not less than a moving concentrated load of 1,000 pounds. Refer to 29 CFR 1910.24. for additional information.

7.3.2.3. Width. Fixed stairs, if part of the exit access, shall have a minimum width of 36 inches if the occupant load of the building or structure is less than 50 persons. If the occupant load is greater than 50, the minimum stair width is 44 inches. Fixed ramps, if part of the exit access, shall have a minimum width of 44 inches. The authority having jurisdiction may reduce this requirement to 30 inches in certain cases. For ramps or stairs not part of the exit access, a minimum width of 22 inches shall be provided. Refer to NFPA 101 and UFC 3-600-01 and 29 CFR 1910.24. for additional information.

7.3.2.4. Angle of Rise. Stairs shall meet the requirements of NFPA 101 and UFC 3-600-01. Fixed stairs not part of the exit access shall be installed at angles to the horizontal of 30 to 50 degrees. For existing stairs that are part of the exit access, a maximum riser height of eight (8) inches and minimum tread depth of nine (9) inches is allowed. Tread depth and riser height must be consistent throughout a new facility with a riser height of 4 to 7 inches and a minimum tread depth of 11 inches. Tread depth and riser heights must also be consistent throughout a staircase. Where the slope is less than 30 degrees, a ramp with a non-slip surface shall be installed. [Table 7.1](#) contains recommended dimensions. However, the rise and/or tread combinations are not limited to those given. Any uniform combination of rise and/or tread dimensions may be used. Refer to 29 CFR 1910.24 for additional information.

7.3.2.5. Ramps. Ramps not part of the exit access shall follow guidance in [Table 7.2](#) For ramps that are part of the exit access, a maximum slope of 1 to 8 inches is allowed and shall meet the requirements of NFPA 101.

7.3.2.6. Width of Landings. Landings and platforms not part of the exit access shall not be less than the width of the stairs and a minimum of 30 inches in length, measured in the direction of travel. Refer to 29 CFR 1910.24 for additional guidance. When doors or gates open directly onto a stairway, they shall not reduce the available width of the landing to less than 20 inches. Landings in stairs or ramps that are part of the exit access shall meet the requirements of NFPA 101.

7.3.2.7. Vertical Clearance. Where there is less than seven (7) feet of headroom over stairs, obstructions shall be padded. When they cannot be padded, obstructions shall be color coded yellow or yellow-and-black stripes to highlight the hazards. In all cases, caution signs shall be used to warn people of low clearances. Refer to 29 CFR 1910.24. for additional information.

7.3.2.8. Risers. Stairs having tread depth of less than nine (9) inches shall have open risers. Stairs of nine (9) inches or more may also have open risers. Risers shall be 6-1/2 to 9-1/2 inches high. Rise height and tread width shall be uniform throughout any flight of stairs, including any foundation structure used as one or more treads of the stairs. Risers

in stairs that are part of the exit access shall meet requirements of NFPA 101. Refer to 29 CFR 1910.24. and NFPA 101 for additional information.

7.3.2.9. Treads. All treads shall be slip-resistant and free of projections or lips that could cause a tripping hazard.

7.3.2.10. Grating. Open grating type treads are desirable for stairs which are not enclosed. The use of open treads prevents the buildup of rainwater and snow on the tread surface.

7.3.2.11. Sidewalk Ramps. Sidewalk ramps shall be installed where equipment, such as housekeeping carts or hand trucks, are used.

7.3.2.12. Stair Railings and Guards. **Note:** Refer to 29 CFR 1910.23. and 1910.24. for additional information on stair railings and guards.

7.3.2.12.1. Every flight of fixed industrial stairs with four (4) or more risers shall have standard guardrails or standard handrails as called for below. The width of the stair shall be measured clear of all obstructions except handrails.

7.3.2.12.1.1. Stairs less than 44 inches wide with both sides enclosed shall have at least one handrail, preferably on the right side going down.

7.3.2.12.1.2. Stairs less than 44 inches wide with one side open shall have at least one guardrail on the open side.

7.3.2.12.1.3. Stairs less than 44 inches wide with both sides open shall have one guardrail on each side.

7.3.2.12.1.4. Stairs more than 44 inches wide but less than 88 inches wide shall have a handrail on each enclosed side and a guardrail on each open side.

7.3.2.12.1.5. Stairs 88 or more inches wide shall have one handrail on each enclosed side, one guardrail on each open side and one intermediate guardrail built midway of the width.

7.3.2.12.2. Spiraling and winding stairs shall have a handrail offset to stop people from walking on the parts of the treads that are less than six (6) inches wide.

7.3.2.13. Illumination. Stairs and ramps shall be lighted so all treads and landings are visible. Consult the local CE facility design section whenever specific guidance on lighting is required.

7.3.2.14. Inclined Ladders. Some Air Force facilities have permanent stairways installed which exceed a 50-degree angle. These stairways are commonly referred to as inclined ladders. Where an inclined ladder has been installed, it shall have handrails on both sides and open risers. New construction shall have stairs installed within the preferred range of 30-50 degrees.

7.3.2.15. Maintenance. Stairs and ramps shall be kept clean, free of obstructions or slippery substances, and in good repair at all times. Supervisors will ensure:

7.3.2.15.1. Loose boards, insecure treads, protruding nails and torn or worn stair treads are repaired or replaced immediately.

7.3.2.15.2. Posters, bulletin boards and other objects that could distract a person's attention are not placed in stairwells or rampways.

7.3.2.15.3. Slippery surfaces are replaced or made safe by coating them with nonslip surface materials.

7.3.2.15.4. Treads and risers are of uniform size.

7.3.2.15.5. Stair nosings are securely fastened and rounded or beveled to prevent personnel from catching their heels on the treads.

7.3.2.15.6. Guardrails and handrails are smooth, free of splinters or burrs and securely mounted.

7.3.2.15.7. Outside stairways, entrances, sidewalks, loading docks and ramps are cleared of snow and ice, and that abrasive materials, such as sand, ash or ice melting chemicals, are readily available and used during inclement weather. This also includes all emergency exits and walks leading from them.

#### **7.4. Fixed Ladders.**

7.4.1. Hazards and Human Factors Associated with Fixed ladders. Most falls are caused by using ladders that are in poor condition and/or unsafe acts such as running up and down, jumping, reaching too far out to the sides and workers being physically unfit for this activity. These hazardous acts and conditions can be prevented by proper selection and training of workers; supervisory enforcement of safe ladder use; and proper design, installation and maintenance of fixed ladders and climbing devices.

##### 7.4.2. Requirements.

7.4.2.1. Acquisition. Fixed ladders, and their parts and accessories, and safety devices shall meet requirements of 29 CFR 1910.27., *Fixed Ladders*. Procurement specifications shall include permanent treatment for corrosion control so future treatment shall not be needed. Refer to Military Specifications (Mil Specs) for protective coating criteria.

7.4.2.2. Design and Installation. Fixed ladders provide a means of access to roofs, pits, silos, towers, tanks and other limited-access areas. Fixed industrial stairs shall be provided where access is daily or during each shift for gauging, inspection, regular maintenance or when carrying tools or equipment is normally required and sufficient space is available. Fixed ladders may be used when a stairway cannot be used. The following paragraphs provide general design and installation criteria for fixed ladders.

7.4.2.2.1. Length. Ladders 20 feet or less shall be of a continuous length. When they are more than 20 feet and of continuous length, the following requirements apply:

7.4.2.2.1.1. Landing Platforms. A landing platform is provided for a person to rest or gain access to another section of the ladder. Platforms shall be provided every 30 feet or fraction thereof. Where no cage, well or ladder safety device is provided, landing platforms shall be provided for each 20 feet of height or fraction thereof.

7.4.2.2.1.2. The platform shall not be less than 24 inches wide by 30 inches long and shall be equipped with standard railings. Toeboards are required where the

hazard of objects falling is present. Refer to 29 CFR 1910.27. for additional information.

7.4.2.2.1.3. Ladder Safety Devices, Cages and Wells. Cages and wells merely contain a falling climber rather than restricting the distance of fall. Therefore, new fixed ladders (where fall protection is required) shall include a safety climb device rather than a cage or well. All ladder safety devices such as those that incorporate positioning belts, friction brakes and sliding attachments shall meet the design requirements of the ladders which they serve. Where a cage is installed, it shall extend a minimum of 42 inches above the top of landing, unless other acceptable protection is provided. Cages shall extend down the ladder to a point not less than seven (7) feet nor more than eight (8) feet above the base of the ladder. Refer to 29 CFR 1910.27., *Fixed Ladders*, for specific design and construction information. Ladder safety devices, cages or wells are required on all fixed ladders more than 20 feet.

7.4.2.3. Ladder Pitch. The preferred pitch of fixed ladders shall be 75 to 90 degrees from the horizontal. Any pitch below 75 degrees is substandard and shall be avoided. Ladders with a pitch in excess of 90 degrees are prohibited. Refer to 29 CFR 1910.27. for additional information.

7.4.2.4. Load Capacity. All ladders, platforms, appurtenances and fastenings shall meet the load requirements of 29 CFR 1910.27.

7.4.2.5. Lighting. Adequate illumination shall be available when using ladders. Lamps shall be installed so the light does not reflect in a climber's eyes. Consult the installation CE facility design section when specific guidance on lighting is required.

7.4.2.6. Access. Where unauthorized use of a fixed ladder is a problem, the facility manager or security department shall ensure the ladders are secured from unauthorized access. Ladders available to public access require guarding to prevent unauthorized access. Typically, the bottom seven (7) feet shall be guarded. Examples of guarding include the use of a fence with locked gates and making the bottom portion portable or spring loaded and available only as needed. Additionally, there must be a warning sign prohibiting access by unauthorized persons.

7.4.2.7. Slipping. When the potential for climbers to get mud, oil or grease on their footwear creates a slipping hazard, a mat of crushed rock, a raised platform or a boot scraper shall be provided.

7.4.2.8. Electric Lines. Electrical conductors shall not be installed on or adjacent to fixed metal ladders, unless they are beyond reach and cannot be used as a handrail or grabbed in an emergency. This distance shall be at least five (5) feet from the ladder. If there is any potential for contact with parts of electric equipment or circuits, these parts shall be de-energized and locked out IAW **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*.

7.4.2.9. Iron Rung Ladders. Iron rung ladders shall be built into the walls of each manhole over 12 feet deep. The distance between rungs is the same as other fixed ladders. More detailed design criteria can be found in 29 CFR 1910.27. and ANSI A14.3.

7.4.2.10. Grounding and Bonding. Ladders and related equipment shall be grounded and/or bonded, to drain off accumulated static electricity when static electricity is hazardous to the work operation, such as fuel cell repair or refueling vehicle maintenance. Static discharge plates shall also be provided.

#### 7.4.3. Inspections.

7.4.3.1. A formal, fully documented inspection of all fixed ladders shall be accomplished upon installation and at least every three (3) years thereafter. These inspections shall be performed by the installation CE for ladders installed on real property facilities or real property installed equipment (RPIE). The using organization is responsible for ensuring inspections are done for facilities and equipment which are not real property. When qualified personnel are not available in using organizations, the installation CE shall provide assistance. Inspection documentation shall include the type ladder and safety climb device installed, location, a detailed list of all discrepancies and corrective action status.

7.4.3.2. Climbers shall be alert to potential hazards and perform informal inspections of fixed ladders prior to every use. No attempt to climb shall be made until all hazardous conditions are corrected. Specific hazards to look for during inspections are: loose, worn and damaged rungs or side rails; damaged or corroded bolts and rivet heads; damaged or corroded handrails and brackets on platforms; and deteriorated masonry where fixed ladder anchorages are secured to a structure, including loose or damaged carrier rails or cables.

7.4.4. Maintenance. Repairs made to fixed ladders and related equipment shall meet the following requirements:

7.4.4.1. Materials used shall meet or exceed original construction.

7.4.4.2. Any modification to ladder components, safety climb device or related equipment shall be approved by the installation CE, property manager and Ground Safety office.

7.4.4.3. All welding shall be performed by a welder experienced in the materials of the fixed ladder.

7.4.5. Selection of Personnel. Some individuals become spatially disoriented when working on elevated ladders or platforms. This condition is known as height vertigo. Common reactions to this condition are to “freeze” and hang on to any permanent support or to experience dizziness, nausea, trembling and/or loss of consciousness. Supervisors shall be vigilant in screening and observing workers required to work at heights. If the supervisor suspects an employee may be subject to vertigo, the employee shall be referred to the local medical facility for evaluation prior to resuming any height work. Workers descending into pits or shafts may also experience vertigo. Individuals known to experience vertigo shall be disqualified as ladder users.

7.4.6. Ladder Use. Continued safe use of ladders requires proper climbing practices at all times. Supervisors shall ensure climbers are trained to:

7.4.6.1. Check ladder for defects and slippery substances.



- 7.4.6.2. Ensure ladder and climber's feet are free of slippery substances.
- 7.4.6.3. Raise or lower needed tools and materials by handlines after reaching the work position—never carry.
- 7.4.6.4. Face the ladder and use both hands to grip the rungs or side rails firmly.
- 7.4.6.5. Wear slip-resistant shoes with heels.
- 7.4.6.6. Climb carefully, without haste. Never run up or down, nor slide down the ladder.
- 7.4.6.7. Never jump from the ladder.
- 7.4.6.8. Remove hand jewelry (rings) prior to climbing.

## 7.5. Portable Ladders.

7.5.1. Hazards and Human Factors Associated with Portable Ladders. Falls are the primary hazard associated with portable ladders. Falls result from a number of unsafe acts and conditions such as ladder hazards, which are minimized if workers adhere to proper ladder discipline and if supervisors ensure equipment is inspected, maintained in good condition and properly used. The following practices are prohibited:

- 7.5.1.1. Ladders set on unstable surfaces.
- 7.5.1.2. Ladders placed in front of doors which open towards the ladder without proper guarding.
- 7.5.1.3. Ladders used as scaffolds.
- 7.5.1.4. Personnel reaching too far out to the sides.
- 7.5.1.5. Personnel standing too high to maintain their balance.
- 7.5.1.6. Use of a defective ladder, i.e., broken rail or rung.
- 7.5.1.7. Improvising and using a make-shift ladder.
- 7.5.1.8. Personnel carrying materials in their hands while ascending or descending a ladder, or descending with their back to the ladder.
- 7.5.1.9. Using a ladder with conductive side rails while working on electrical circuits.

### 7.5.2. Requirements.

#### 7.5.2.1. Acquisition and Selection Considerations.

7.5.2.1.1. Portable ladders shall meet ANSI design and construction specifications in **Table 7.3** Personnel needing access to ANSI standards shall contact the installation Ground Safety office for guidance and assistance. **Exception:** Fire department ladders shall be maintained and inspected IAW NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, and NFPA1932, *Standard on Use, Maintenance, and Service Testing of In-Service Fire Department Ground Ladders*.

7.5.2.1.2. There are a variety of ladder styles; selection, to include construction material and proper size, shall be based on where and how the ladder may be used. This chapter addresses step and extension ladders. These ladders are most commonly

constructed from wood, metal and fiberglass. However, the general guidance presented is applicable to most portable ladders used in the Air Force. MAJCOM, DRU and FOA ground safety staffs shall determine its applicability to special purpose ladders not adequately covered by ANSI standards.

7.5.2.1.2.1. Ladders come in four workload ratings. **Table 7.4** gives the basic differences in these ladders. Supervisors shall order Type IA or I ladders whenever possible. Type II ladders shall only be considered when local purchase is required and local manufacturers cannot provide Type IA or I. Type III ladders shall not be procured for industrial use.

7.5.2.1.2.2. The supervisor shall consider the location as well as durability when selecting the ladder. Aluminum ladders are normally lighter than wood while steel ladders are as heavy or heavier. Metal ladders and wood ladders with metal reinforced side rails or metal rungs shall not be used in areas where a worker or the ladder could contact exposed energized electrical circuits. Carrying steel and wood ladders is fatiguing if the worker has to carry them for a considerable distance.

7.5.2.2. Inspections. Thorough visual inspections of ladders shall be made by the supervisor when the ladder is initially received and prior to being placed in service. Workers shall perform a visual inspection prior to each use. Refer to 29 CFR 1910.25., *Portable Wood Ladders*, for additional information. Defects or damage to look for include:

7.5.2.2.1. Evidence the ladder was exposed to excessive heat (such as in a fire) or corrosive substances. When ladders are so exposed, their ability to support the designed working load shall be questioned. The ladder shall be retested IAW ANSI standards.

7.5.2.2.2. Side rails, steps, rungs or related hardware that are cracked, split or deformed.

7.5.2.2.3. Pulleys, cables and ropes which bind or are frayed.

7.5.2.2.4. Rivets, connections and spreaders for looseness or shearing.

7.5.2.2.5. Nonskid base material that is loose or missing. Metal and metal-reinforced single and extension ladders, except aircraft boarding ladders, shall be equipped with safety shoes, spurs, spikes or combinations thereof to prevent slipping.

7.5.2.2.6. Ladders with conductive side rails that are not marked for electrical hazards. Ladders not already marked with safety use instructions by the manufacturer shall be stenciled, "DANGER — DO NOT USE AROUND ELECTRICAL EQUIPMENT," in two-inch high red letters or the largest letters the surface will allow (minimum letter size is one inch).

7.5.2.2.7. Ladders in which rungs and steps designed for use in ascending or descending on metal or plastic ladders are not corrugated, knurled, dimpled or coated with skid-resistant materials.

7.5.2.2.8. Ladders with broken or missing steps, rungs or cleats, broken side rails, or other defects. Ladders with these defects shall not be used.

7.5.2.3. Maintenance. Proper maintenance ensures the safe condition of the ladder. Hardware, fittings and related equipment shall be checked frequently and kept in proper working condition. All bolts and rivets shall be in place and secured. Joints between steps or rungs and the side rails shall be tight. Refer to 29 CFR 1910.26., *Portable Metal Ladders*, for additional information.

7.5.2.3.1. Lubricate metal bearings of locks, wheels, pulleys, etc., as required to keep them working.

7.5.2.3.2. Replace frayed or worn rope.

7.5.2.3.3. Keep safety feet and other parts in good working condition.

7.5.2.3.4. Coat wood, metal and fiberglass ladders with a suitable protective material, when required. Do not paint wood ladders with an opaque coating, since possible defects may be covered up. If protective coatings are considered desirable for wooden ladders, use only transparent coatings or wood preservatives. Protect metal ladders that may come in contact with acids or alkali solutions with a locally approved coating. When location demands, protect metal ladders against corrosion caused by moisture or salt spray. When plastic ladder rails/surfaces have the appearance of exposed fibers or an apparent color change from weather exposure, they shall be washed with a mild liquid detergent solution and allowed to air dry. Spray or brush the ladder rails with acrylic lacquer, epoxy or other locally approved coating sufficient to cover the exposed fibers. Following the first coat, lightly sand the fiberglass surface with "00" sandpaper, or equivalent, to smooth the glass bristles. Refer to ANSI A14.4., *Safety Requirements for Job Made Wooden Ladders*, for additional information.

7.5.2.4. Remove from service ladders with defects which cannot be immediately repaired and ensure they are scheduled for repair or destruction. Use an AF Form 979, *Danger Tag*, to warn workers that the ladder cannot be used. If a ladder is to be discarded, remove it from the maintenance area and cut it in half to prevent further use. Do not attempt to straighten or use a bent ladder made of fiberglass.

7.5.2.5. Requirements Applicable to All Ladders.

7.5.2.5.1. Inspect ladders before climbing to ensure all parts are in good condition. To permit inspection, procure and maintain wood ladders with transparent finish only.

7.5.2.5.2. Handle ladders with care. Do not drop, jar or misuse them.

7.5.2.5.3. Store ladders in a way that provides easy access for inspection and permits safe withdrawal for use. When possible, store ladders on racks. Ensure the racks have enough supporting points to keep the ladders from sagging. Do not place material on stored ladders. Store wood ladders in a location free from exposure to the elements and excessive heat or dampness.

7.5.2.5.4. Properly support ladders being transported (horizontally or vertically) on vehicles. Make sure supporting points are of a soft material, such as hardwood or

rubber-covered iron pipe, to minimize chafing and effects of road shock. Tying the ladder to each support point could reduce damage due to road shock.

7.5.2.5.5. Place portable ladders so the side rails have a secure footing. Ensure the top rest for portable rung and cleat ladders is reasonably rigid and has adequate strength to support the applied load. Never place a ladder on a slippery, icy, slanting or vibrating footing unless it is securely lashed in position.

7.5.2.5.6. Fasten the ladder securely when the ladder can be knocked over by others working in the area. As an alternative, assign someone to steady the bottom or protect the area around the ladder against personnel or vehicular traffic.

7.5.2.5.7. Do not place ladders:

7.5.2.5.7.1. Over machines with exposed moving parts.

7.5.2.5.7.2. In front of doors which open toward the ladder unless the door is blocked open, locked or a person is stationed at the foot of the ladder to direct pedestrian traffic.

7.5.2.5.7.3. On boxes, barrels or other unstable bases to obtain additional height.

7.5.2.5.8. If a ladder is used on a walkway, in an aisle or adjacent to a road, position cones or barricades to warn and direct pedestrians away from the ladder.

7.5.2.5.9. On jobs requiring the use of a ladder, place the ladder directly in front of or under the work. When work cannot be done without overreaching, move the ladder to the proper location or use another approved method (scaffold or work platform).

7.5.2.5.10. Allow only one person on a portable ladder at any time, unless designed for use by two people.

7.5.2.5.11. When ascending or descending a ladder, face the ladder and maintain a firm hold on the ladder.

7.5.2.5.12. Perform work requiring the use of both hands only on stepladders or platform ladders.

7.5.2.5.13. Place straight and extension-type ladders in a position to have at least one (1) foot of slope for each four (4) feet of ladder length. For example, a 12-foot extension ladder must be 3 feet from the supporting structure.

7.5.2.5.14. Use ladders of sufficient length to permit workers to reach their work when standing no higher than the third rung from the top of a straight ladder, or the second step from the top of a stepladder. **Note:** The top of a stepladder is not a step and is not counted as a step when the ladder is greater than five (5) feet in length.

7.5.2.5.15. Ensure ladders are equipped with rubber safety feet to prevent slipping.

7.5.2.5.16. Do not:

7.5.2.5.16.1. Carry anything that will interfere with the free use of both hands when climbing a ladder. Raise material and equipment to the working position using a rope and canvas bucket or another approved method.

7.5.2.5.16.2. Use ladders as guys, braces, skids, horizontal platforms or scaffolds, or for other than their intended purposes.

7.5.2.5.16.3. Consider nonslip bases (safety feet) as a substitute for care in safely placing, lashing or holding a ladder on oily, metal, concrete or slippery surfaces.

7.5.2.5.16.4. Stand on the top cap of trestle or combination ladders, nor the top step of stepladders (three-step aircraft ladders exempted). MAJCOM, DRU and FOA ground safety staffs shall evaluate and provide guidance for military-unique operations.

7.5.2.5.16.5. Place ladders on gratings unless the base can be lashed or secured to prevent slippage.

7.5.2.5.16.6. Leave ladders in place unattended.

7.5.2.5.16.7. Use portable metal or metal reinforced ladders when performing work on or near electrical equipment, but use wood or fiberglass ladders. Keep them clean. Remove all surface buildup of dirt, grease or oils to avoid creating a ready path for electrical current. Refer to 29 CFR 1910.333., *Electrical-Selection and Use of Work Practices*, for additional information. **Exception:** Fiberglass ladders with metal rungs are acceptable.

7.5.2.5.17. Ladders will be stored when not in use. On the flight line and outdoor environments, ladders shall be laid down and secured when not in use. Where possible, workers shall secure or remove the ladder to prevent unauthorized use or tripping hazards. **Exception:** The more modern, durable, enhanced ladders such as the Little Giant ladders can remain standing in environmentally controlled environments, i.e., hangars, spacious warehouses, etc.

#### 7.5.2.6. Additional Requirements for Extension Ladders.

7.5.2.6.1. Where possible, portable non-self-supporting ladders shall be used at a pitch that places the base of the ladder at a distance from the vertical wall one-fourth the working length of the ladder (the length along the ladder between the foot and the top support). The ladder shall be placed to prevent slipping or shall be lashed or manually held in position.

7.5.2.6.1.1. In raising the ladder, place it against the structure and extend the ladder while the bottom end is held in place by either pushing or by a rope furnished to pull the top section in place. Before ascending the top portion of the ladder, check carefully to determine that the devices locking the two sections together are thoroughly engaged. Ensure the top of the ladder extends at least three (3) feet above the support structure.

7.5.2.6.1.2. In lowering the top section, after raising it slightly to disengage the locking devices, allow the ladder to descend slowly while under full control, being careful not to place fingers, hands or feet in position to become caught between rungs of the two sections.

7.5.2.6.1.3. To support the top of the ladder at a window opening, a board shall be attached across the back of the ladder, extending across the window to provide firm support against the building walls or window frames. Refer to ANSI A14.1.,

*Ladders - Wood Safety Requirements*, for additional information.

7.5.2.6.2. Short ladders shall not be spliced together to provide long sections.

7.5.2.6.3. The minimum overlap for the two sections of two-section extension ladders is listed in **Table 7.5**

7.5.2.6.4. Portable rung ladders with reinforced rails shall be used only with the metal reinforcement on the underside. Ladders of this type shall not be used near electrical conductors since the reinforcing itself is a good conductor.

7.5.2.6.5. A ladder shall not be used to gain access to a roof unless the top of the ladder extends at least three (3) feet above the point of support at eave, gutter or roof line.

7.5.2.6.6. Adjustment of extension ladders shall be made by the user only when standing at the base of the ladder, so the worker can see when the locks are properly engaged.

7.5.2.6.7. The middle and top sections of sectional or window cleaner's ladders shall not be used for bottom sections unless equipped with nonslip bases (safety feet).

7.5.2.6.8. Extension (multi-section) ladders shall always be raised so the upper section overlaps and rests on the bottom section. The upper section shall always overlap on the climbing side of the extension ladder.

7.5.2.6.9. Hooks may be attached at or near the top of portable ladders to provide added stability.

7.5.2.7. Personnel Training. Personnel who use ladders at working heights of four (4) feet or more shall be adequately trained in the care and use of different types of ladders. The supervisor or a designated trainer shall conduct this training when a worker is first assigned. Refer to paragraph **7.4.6** for additional information on ladder training. Information presented during safety briefings shall satisfy the periodic training requirement. All training shall include hands-on instruction to include inspection of ladders for defects, possible electrocution hazards, proper positioning and placement of ladders for various job sites. Training shall be documented IAW instructions in AFI 91-202, *The US Air Force Mishap Prevention Program* (paper or electronic system may be used).

## **7.6. Additional Requirements for Stepladders.**

7.6.1. Ladders shall not be used by more than one person at a time unless the ladder was specifically designed for use by two (2) people. Only ladders specially designed to support greater loads shall be used in combination with ladder jacks and scaffold planks when an operation requires more than one person.

7.6.2. Bracing on the back legs of stepladders shall not be used for climbing because it is designed solely for increasing stability.

7.6.3. Stepladders shall be fully opened out and locked in position.

**Table 7.1. Uniform Combination of Stairway Rise and Tread Dimension.**

<b>Uniform Combination of Stairway Rise and Tread Dimension</b>		
<b>Angle Horizontal</b>	<b>Rise (In Inches)</b>	<b>Tread Run (In Inches)</b>
30° 35'	6 ½	11
32° 08'	6 ¾	10 ¾
33° 41'	7	10 ½
35° 16'	7 ¼	10 ¼
36° 52'	7 ½	10
38° 29'	7 ¾	9 ¾
40° 08'	8	9 ½
41° 44'	8 ¼	9 ¼
43° 22'	8 ½	9
45° 00'	8 ¾	8 ¾
46° 30'	9	8 ¾
48° 16'	9 ¼	8 ½
49° 54'	9 ½	8 ¼

**Table 7.2. Ramp Installation Dimension.**

<b>Ramp Installation Dimension (NFPA 101, Life Safety Code, Ramps, Classification)</b>		
	<b>New Ramps</b>	<b>Existing Ramps</b>
Width	44 inches (112cm)	30 inches (76 cm)
Slope	1 in 10 inches	1 in 8 inches
Maximum height slope between landings		12 feet (366 cm)

**Table 7.3. ANSI Standard on Ladders.**

<b>ANSI Standard on Ladders</b>	
<b>NUMBER</b>	<b>TITLE</b>
A14.1	Ladders – Wood Safety Requirements
A14.2	Ladders – Portable Metal – Safety Requirements
A14.3	Ladders – Fixed – Safety Requirements
A14.4	Safety Requirements for Job Made Wooden Ladders
A14.5	Ladders – Portable Reinforced Plastic – Safety Requirements

**Table 7.4. Ladders Workload Ratings.**

<b>Ladders Workload Ratings</b>		
<b>Duty Rating</b>	<b>Ladder Type</b>	<b>Working Load (Pounds)</b>
Extra heavy duty	IA	300
Heavy duty	I	250
Medium duty	II	225
Light duty	III	200

**Table 7.5. Minimum Overlap for Multi- Ladders.**

<b>Minimum Overlap for Multi-Section Extension Ladders</b>	
<b>Size of Ladder (Feet)</b>	<b>Minimum Overlap (Inches)</b>
Up to and including 32	34
Over 32, up to and including 36	36
Over 36, up to and including 48	48
Over 48, up to and including 60	60

**7.7. Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

7.7.1. Are all pieces of equipment and machinery arranged to permit an even flow of materials? Reference [7.2.1.1.1](#))

7.7.2. Are machines positioned so it will not be necessary for an operator to stand in a passageway, aisle or exit access? Reference [7.2.1.1.1](#)

7.7.3. Are machines positioned to allow for easy maintenance, cleaning and removal of scrap? Reference [7.2.1.1.1](#)

7.7.4. Are passageways, aisles and exit accesses provided to permit the free movement of employees and material? Reference [7.2.1.1.2](#)

7.7.5. Are at least 18 inches provided for passageways through or between movable obstructions? Reference [7.2.1.1.4](#)

7.7.6. Are floors kept in good condition and free of defects and obstructions that endanger workers, interfere with handling of materials or hinder people leaving the area during emergencies? Reference [7.2.1.2](#)

7.7.7. Are floors of all shops, service rooms, halls and storerooms kept clean and free of slippery substances? Reference [7.2.1.2.2](#)

7.7.8. Are drip or oil pans used whenever the possibility of spilling or dripping exists? Reference [7.2.1.2.2](#)

7.7.9. When floors are being cleaned or finishing compounds are being applied, are signs posted to warn workers of a slipping hazard? Reference [7.2.1.2.5](#)

7.7.10. Are passageways, aisles and exit accesses kept clear for easy access to emergency equipment and to enable firefighters to reach a fire, if necessary? Reference [7.2.1.2.7](#)

7.7.11. Are areas adjacent to fire sprinkler control valves, fuse boxes and electrical switch panels clear and unobstructed? Reference [7.2.1.2.7](#)

7.7.12. Are signs identifying the floor load capacity permanently installed in plain view of all workers? Reference [7.2.1.3](#)



- 7.7.13. Are drains provided when floors are subject to water, moisture, flooding or when wet processes are used? Reference [7.2.1.4](#)
- 7.7.14. Are all floor openings, such as hatchways, chutes, pits, trap doors, manholes and ladderways properly guarded? Reference [7.2.1.6](#)
- 7.7.15. Are all open-sided floors, platforms and runways four (4) feet or more above the ground guarded on all open sides? Reference [7.2.1.7.3](#)
- 7.7.16. Are grab handles installed on each side of the opening, when the operation requires reaching through or around the unprotected opening? Reference [7.2.1.7.4](#)
- 7.7.17. Are frequently used loading docks located away from principal streets and intersections? Reference [7.2.2.1](#)
- 7.7.18. Are the surfaces of docks smooth and even, and are their edges marked? Reference [7.2.2.1.1](#)
- 7.7.19. Are the dock widths at least two (2) feet wider than the widest vehicle or most common materials being transported? Reference [7.2.2.1.2](#)
- 7.7.20. Do parking lots have a smooth surface, good drainage and are they free of pedestrian tripping hazards? Reference [7.2.2.2](#)
- 7.7.21. Are entrances and exits free of obstructions that block a driver's or pedestrian's view of traffic? Reference [7.2.2.2](#)
- 7.7.22. Are exterior walkways kept clear of obstacles that block the right-of-way or present slipping and tripping hazards? Reference [7.2.2.3](#)
- 7.7.23. Do workers ensure materials are not stored, left under or piled against buildings, doors, exits or stairways? Reference [7.2.2.4.1](#)
- 7.7.24. Are poisonous or toxic plants prohibited for landscaping unless approved by the installation medical services? Reference [7.2.2.4.2](#)
- 7.7.25. Are trees and bushes adjacent to walkways trimmed to permit a clear path for pedestrians? Reference [7.2.2.4.2](#)
- 7.7.26. Is all construction work clearly identified by signs that can be read from at least 50 feet, in addition to barriers marked with reflective materials? Reference [7.2.2.5](#)
- 7.7.27. Are illuminated or other warning flashers also used after dark? Reference [7.2.2.5](#)
- 7.7.28. Are fixed stairs and ramps designed and built to carry a load of 5 times the normal live load anticipated, but not less than a 1,000 pound moving concentrated load? Reference [7.3.2.2](#)
- 7.7.29. Are fixed stairs (not part of the exit access) installed at angles to the horizontal of 30 to 50 degrees? Reference [7.3.2.4](#)
- 7.7.30. Are ramps (not part of the exit access) installed IAW guidance in [Table 7.2](#)? Reference [7.3.2.5](#)
- 7.7.31. When the doors or gates open directly onto a stairway, is the available width of the landing not less than 20 inches? Reference [7.3.2.6](#)

- 7.7.32. Where there is less than seven (7) feet of headroom over stairs, are obstructions padded? Reference [7.3.2.7](#)
- 7.7.33. Where obstructions over stairs cannot be padded, are they color coded with yellow or yellow-and-black stripes to highlight the hazard? Reference [7.3.2.7](#)
- 7.7.34. Are open grating type treads used on stairs which are not enclosed? Reference [7.3.2.10](#)
- 7.7.35. Is every flight of fixed industrial stairs with four (4) or more risers equipped with standard guardrails or standard handrails? Reference [7.3.2.12.1](#)
- 7.7.36. Do stairs less than 44 inches wide, having both sides enclosed, have at least one handrail, preferably on the right side going down? Reference [7.3.2.12.1.1](#)
- 7.7.37. Are spiraling and winding stairs equipped with a handrail offset to stop people from walking on the parts of the treads that are less than six (6) inches wide? Reference [7.3.2.12.2](#)
- 7.7.38. Are stairs and ramps lighted so all treads and landings are visible? Reference [7.3.2.13](#)
- 7.7.39. Are stairs and ramps kept clean, free of obstructions or slippery substances and in good repair? Reference [7.3.2.15](#)
- 7.7.40. Are slippery surfaces replaced or made safe by coating them with nonslip surface materials? Reference [7.3.2.15.3](#)
- 7.7.41. Are guardrails and handrails smooth, free of splinters or burrs and securely mounted? Reference [7.3.2.15.6](#)
- 7.7.42. Are fixed industrial stairs provided as a means of access to roofs, pits, silos, towers, tanks and limited-access areas, where access is daily or during each shift for gauging, inspection, regular maintenance, etc.? Reference [7.4.2.2](#)
- 7.7.43. Is adequate illumination provided when using ladders? Reference [7.4.2.5](#)
- 7.7.44. Where unauthorized use of a fixed ladder is a problem, such as in a public area, is the bottom seven (7) feet guarded? Reference [7.4.2.6](#)
- 7.7.45. Are electrical conductors not installed on or adjacent to fixed metal ladders, unless they are beyond reach and cannot be used as a handrail or grabbed in an emergency? Reference [7.4.2.8](#)
- 7.7.46. Are iron rung ladders built into the walls of each manhole over 12 feet deep? Reference [7.4.2.9](#)
- 7.7.47. Are formal, fully documented inspections of all fixed ladders accomplished upon installation and at least every three (3) years thereafter? Reference [7.4.3.1](#)
- 7.7.48. Are modifications to ladder components, safety climb devices or related equipment approved by the installation CE, property manager and Ground Safety office? Reference [7.4.4.2](#)
- 7.7.49. Do supervisors ensure personnel are properly trained on climbing and using ladders? Reference [7.4.6](#)

- 7.7.50. Do workers abstain from using metal ladders and wood ladders with metal reinforced side rails in areas where they could contact energized electrical circuits? Reference [7.5.2.1.2.2](#)
- 7.7.51. Do supervisors make thorough visual inspections of ladders when the ladder is initially received and before the ladder is placed in service? Reference [7.5.2.2](#)
- 7.7.52. Do workers perform an inspection of ladders prior to use? Reference [7.5.2.2](#)
- 7.7.53. Are hardware, fittings and related equipment checked frequently and kept in proper working condition? Reference [7.5.2.3](#)
- 7.7.54. Are safety feet and other parts of the unit's ladders kept in good working condition? Reference [7.5.2.3.3](#)
- 7.7.55. Are wood ladders not painted with an opaque coating, avoiding a cover-up of possible defects? Reference [7.5.2.3.4](#)
- 7.7.56. When location demands, are metal ladders protected against corrosion? Reference [7.5.2.3.4](#)
- 7.7.57. Are ladders with defects which cannot be immediately repaired, removed from service and action taken to ensure they are scheduled for repair or destruction? Reference [7.5.2.4](#)
- 7.7.58. Are danger tags used to warn workers that the ladder cannot be used? Reference [7.5.2.4](#)
- 7.7.59. Are personnel who use ladders adequately trained by the supervisor in the care and use of different type ladders when a worker is first assigned? Reference [7.5.2.4.1](#)
- 7.7.60. Are ladders stored in a way that provides easy access for inspection and permits their safe withdrawal for use? Reference [7.5.2.5.1.3](#)
- 7.7.61. Are wood ladders stored in a location free from exposure to the elements and excessive heat or dampness? Reference [7.5.2.5.1.3](#)

## Chapter 8

### ELECTRICAL SAFETY

#### 8.1. General Information.

##### 8.1.1. Hazards.

8.1.1.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on the JSA and job safety lesson plan. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process. Example: TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

8.1.1.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

8.1.1.3. Electrical installations and equipment present a shock or electrocution hazard from contact with energized systems and can produce arc flash burns from electrical arcs. Excessive scraping, kinking, stretching and exposure to grease and oils damages power cables, leads to premature failure and causes shocks or burns. Fires can be caused by short circuits, over-heated equipment, or failure of current limiters, thermal sensors and other devices. Explosions may occur if flammable liquids, gases or dusts are exposed to ignition sources generated from electrical equipment.

**8.2. Receptacles.** Electrical receptacles and cover plates shall be free of cracks and securely mounted. Receptacle covers with cracks which expose the interior of the receptacle shall be replaced. It is not necessary to replace the cover for small cracks around the mounting screws. Receptacles in damp or wet locations shall meet NEC requirements and be protected by ground fault circuit interrupter(s) (GFCI). Refer to paragraph **8.9.7** for guidance on GFCIs.

8.2.1. Multiple plug adapters shall not be linked to provide additional or more convenient outlets as this could overload electrical circuits. At no time shall a multiple plug adapter or strip be plugged into another multiple plug adapter or strip.

##### 8.2.2. Dwelling Unit Receptacles.

8.2.2.1. Arc-fault Circuit Interrupters – Bedrooms. Arc-fault circuit interrupters (AFCI) are required to be installed on new, extended or modified branch circuits supplying 120-volt, single phase, 15- and 20-ampere outlets in the bedrooms of dwelling units. This became effective 1 January 2002.

8.2.2.2. Arc-fault Circuit Interrupters – Whole House. AFCI of the combination-type shall be used on branch circuits supplying 120-volt, single-phase, 15- and 20-ampere outlets in those dwelling units designed and constructed after 1 January 2009 and supplying family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways or similar rooms or areas. AFCI branch circuits may be, but are not required to supply the GFCI circuits specified in paragraph **8.9.7** Refer to NEC, Article 210.12, for additional guidance.

8.2.2.3. Ground-fault Circuit Interrupters (GFCI) are required in certain dwelling unit circuits as specified in paragraph 8.9.7. Refer to NEC, Article 210.8, for additional guidance.

8.2.2.4. Tamper-Resistant Receptacles – Effective 1 January 2009. Tamper-resistant receptacles shall be used in all newly installed or replaced 15- and 20-ampere 120-volt, single-phase receptacle outlets in dwelling units. Refer to NEC, Article 406.11, for additional guidance.

8.2.3. Child Development Centers. Electrical receptacles in Child Development Centers shall comply with the requirements of UFC 4-470-14, *Design: Child Development Centers*.

**8.3. Plugs.** Attachment plugs of tool and equipment cords shall be of dead front construction. When in use, plugs shall be inserted fully so no part of the prongs is exposed. The third and/or grounding prong is a safety feature and shall be checked frequently by personnel to ensure it is secure, especially on items unplugged frequently. The prong shall not be cut off, nor an adapter used to allow a three-prong plug to fit a two-prong receptacle, since this negates third wire grounding protection. This paragraph does not apply to double insulated equipment or equipment such as clocks, radios, can openers, etc., which are not normally manufactured with a grounding plug. Plugs, whether molded or clamped, shall be firmly attached to the cord to prevent pulling against wire connection points. Refer to paragraph 8.4.1.11 for guidance on use of two (2) wire extension cords.

**8.4. Flexible Cords and Extension Cords.** Flexible cords and extension cords shall be used IAW guidance outlined in the NEC. Electrical cords shall not be subjected to electrical currents or voltages greater than their rated capacities.

#### 8.4.1. Extension Cords.

8.4.1.1. Extension cords are responsible for numerous fires and their use shall be kept to an absolute minimum. If used, they shall have a single connection. **Exception:** A heavy duty industrial extension cord with a multiple-outlet junction box may be utilized if the equipment amperage/wattage rating does not exceed the extension cord/circuit which it is plugged into. The amperage/wattage shall be verified.

8.4.1.2. Report, replace or dispose of worn, cracked or frayed electrical extension cords, loose or broken electrical wires and worn or broken electrical plugs. Supervisors shall inspect cords frequently for signs of fraying, cracking, wear of any damage that could be an indication of possible short circuiting and for proper size/rating for the equipment it services. Defective cords shall be removed from service. Do not use until repaired or replaced.

8.4.1.3. Electrical extension cords shall be used as outlined in the NEC and not be used as a substitute for fixed wiring. **Note:** Extension cords may be used when it is impractical to power equipment from facility wiring, such as in large hangars, flight line locations, field environments and when using electrical generators.

8.4.1.4. Do not run cords through holes in walls, ceilings, floors, doorways, windows, etc.

8.4.1.5. Do not run cords where concealed behind walls, dropped ceilings or floors.

8.4.1.6. Do not tape, staple or tack extension cords to building surfaces.

8.4.1.7. Cords shall not be spliced, taped, pinched, coiled or otherwise placed where they may be damaged or create a hazard.

8.4.1.8. Electrical extension cords shall not be walked on nor equipment allowed to run over them. If cords must be placed in travel lanes, they shall be properly protected by molded housings, bridges or other covers approved for such use.

8.4.1.9. Cords shall not be kinked, stretched or bent excessively to prevent internal wire damage.

8.4.1.10. Cords shall be disconnected when not in use and at the end of the work shift. **Exception:** Low amp devices such as wall clocks, pencil sharpeners, radios, desk lamps, etc., do not have to be disconnected.

8.4.1.11. Extension cords used with portable tools and equipment shall have three-prong plugs. Two-wire extension cords are prohibited. The extension cord capacity shall be equal to or greater than the amperage rating of item being powered from the cord.

8.4.1.12. Extension cords and surge protectors shall not be series-connected, i.e., daisy chained or piggy-backed.

8.4.1.13. Only junction boxes designed for exterior application shall be used in damp, wet or outdoor locations.

8.4.1.14. Only commercially procured extension cords bearing the Underwriters Laboratory (UL) or host nation equivalent certification may be used. Extension cords shall be rated at 10 amps minimum above the required power draw. Extension cords may not be manufactured or altered.

8.4.1.15. Do not hang over nails, rafters or in a manner that constitutes a safety or fire hazard.

8.4.1.16. Do not place under rugs, carpets or other combustible material.

8.4.1.17. Extension cords shall be kept dry and free from oil or grease.

8.4.2. Tools and equipment connected by flexible cords shall be grounded by a three-wire cord or separate ground wire (except double-insulated equipment). A grommet, stress relief device or NEC approved clamp shall be installed on equipment housings to prevent abrasion of cord insulation and to prevent pull or strain put on the cord's internal wiring.

8.4.2.1. Cords used with heating appliances, such as electric irons, shall be made with high temperature insulating materials.

8.4.3. Users shall inspect cords frequently for signs of fraying, cracking, wearing or damage that could create a short-circuit. Defective electrical equipment and cords shall be removed from service.

8.4.4. When possible, equipment power cords shall be suspended from overhead in rigid raceways.

8.4.5. When disconnecting cords, pull on the plug rather than the cord, to avoid damaging internal connections.

8.4.6. Electrical wiring/conduits shall not be used as clothing hangers or supports of any nature.

8.4.7. High wattage appliances such as heat-producing appliances, refrigerators of all types, coffee makers, etc., shall be plugged directly into a facility outlet. Coffee makers shall be unplugged at the end of the work shift. **Exception:** Commercial coffee urns hard plumbed to the water service and coffee makers/machines with integral timers, i.e., Bunn-type coffee brewers, need not be unplugged at the end of the work day if they are in an occupied/observable space.

8.4.8. Multi-receptacle surge protectors shall only be used to power computers and related equipment such as lights or fans. Surge protectors nor extension cords shall be used with high current items such as coffee makers, refrigerators, microwave ovens, heaters, food preparation equipment, etc. Equipment plugged into surge protectors/extension cords shall not exceed the capacity of the surge protector/electrical cord.

**8.5. Disconnecting Means (Circuit Breakers and Disconnect Switches).** Unless their purpose is evident, circuit breakers and fuse boxes shall be specifically and legibly marked to indicate their purpose. For example, markings should not merely indicate “motor” or “lights,” but “motor, water pump #2” or “lights, front lobby.” Spare circuit breakers will be identified as “spare.” Supervisors, in conjunction with the installation CE, shall ensure electrical fuse, switch and circuit-breaker boxes are marked with correct voltage, current, wattage, foreign source of power or other ratings, as appropriate. Personnel shall not stand directly in front of circuit breakers or switches when activating or deactivating them. Refer to UFC 3-560-01, *Electrical Safety, O & M*, for additional guidance.

8.5.1. Circuit breakers and disconnect switches shall clearly indicate status - open (off) or closed (on). Refer to NFPA 70, *National Electrical Code*, and 29 CFR 1910.304, *Wiring Design and Protection*, for additional guidance.

8.5.2. Circuit breakers, disconnect switches and fuses shall be readily accessible to workers and building management personnel. Work space in front shall be clear and unimpeded and shall not be located where exposed to physical damage or in the vicinity of easily ignitable material.

8.5.3. Circuit breakers shall not be taped in the “on” position. Breakers that trip frequently indicate electrical problems and shall be promptly reported and corrected.

8.5.4. Workers shall not substitute larger fuses or breakers or use bypass wires, pennies, etc.

8.5.5. If circuit breaker fails to close or immediately trips after resetting, a qualified electrical worker (electrician) shall be called to troubleshoot the circuit breaker, i.e., installation CE shall be called immediately.

**8.6. Guarding of Live Parts.** Electrical outlets, switches, junction boxes, etc., shall be in good condition and have cover plates securely installed. Outlets, switches, cover plates, etc., shall be free of cracks or defects that could cause them to be ineffective. Minor superficial cracks at the installation screws that do not expose internal wires do not require replacement. All unused openings (knock out plugs) in switch housings, junction boxes, etc., shall be securely covered. Rigid conduit shall be securely attached to the box and flexible conduit firmly secured where the conduit enters the box to prevent abrasion to the conduit and strain on the connecting points.

## 8.7. Equipment Grounding.

8.7.1. Frames of electrical motors, regardless of voltage, shall be grounded. All covers shall be securely fastened.

8.7.2. Exposed noncurrent-carrying metal parts of fixed equipment that may be energized under abnormal conditions shall be grounded.

**8.8. Restrictions.** While working on or around live electrical equipment, workers are prohibited from wearing garments with exposed metallic fasteners or flammable articles such as celluloid cap visors. Additionally, clothing shall be of the material necessary to comply with NFPA 70E, *Standard for Electrical Safety in the Workplace*, requirements. Articles such as jewelry, earrings, rings, hair fasteners, bracelets, key chains or metallic ID (dog) tags with metal chains shall also be removed and metal framed eyeglasses shall be secured by a band or cord to prevent them from falling into energized electrical circuits or machinery. **Note:** It's best practice to wear nonmetallic eyeglasses and neck lanyards (i.e., ID cardholders) with a breakaway band or cord to prevent them from falling into energized electrical circuits or moving industrial machinery.

**8.9. Electrical Installations and Equipment.** Guidance in NFPA 70, NFPA 70E, 29 CFR 1910 Subpart S – Electrical and AFI 32-1064, *Electrical Safe Practices*, for electrical installations and equipment shall be complied with. Motor data plates shall be legible and not painted.

8.9.1. Electrical Repairs. Only authorized, qualified electricians or appliance workers may install or repair electrical equipment. Work on electrical equipment will be de-energized, locked out and tagged out IAW **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, NFPA 70 and AFI 32-1064. Refer to paragraph **8.18** for work on energized equipment.

8.9.2. Supervisors shall ensure work areas are inspected for electrical hazards. Sufficient workspace shall be provided and maintained around electric equipment to permit safe operation and maintenance IAW 29 CFR 1910.303(g) *600 Volts, nominal, or less*; Table S-1 or 29 CFR 1910.303(h) *Over 600 Volts, nominal*; Table S-2.

8.9.3. Wires shall be enclosed in an electrically-listed box or control panel.

8.9.4. In locations requiring the use of special tools (e.g., non-sparking), only tools certified for those areas shall be used.

8.9.5. When equipment is replaced, a renovation project is planned or new construction is performed, make provisions to comply with lockout/tagout requirements in **Chapter 21**.

8.9.6. Parts of electrical equipment which ordinarily produce arcs, sparks, etc., shall not be operated or used in explosive atmospheres or in close proximity to combustible materials.

8.9.7. Ground Fault Circuit Interrupters (GFCI) shall be used on all 120-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets at job sites where the receptacles are not part of the building/structure permanent wiring. Receptacles on a two-wire, single-phase portable or vehicle-mounted electrical generator rated not more than 5 kilowatts (kW), where electrical generator conductors are insulated from the generator frame and other grounded surfaces, shall be permitted without GFCI protection. Receptacles shall be located outside wet process areas or protected by a GFCI. To protect large areas, GFCI breakers shall be located in the



circuit panel. 120-volt, single-phase, 15- and 20-ampere receptacles installed in locations below shall include GFCI protection. See NFPA 70, *National Electrical Code*, Article 210.8, for exceptions, i.e., for locations where GFCIs are not required.

#### 8.9.7.1. Dwelling Units.

8.9.7.1.1. Bathrooms.

8.9.7.1.2. Garages and accessory buildings with a floor located at or below grade level not intended as habitable rooms and limited to storage areas, work areas and areas of similar use.

8.9.7.1.3. Outdoors.

8.9.7.1.4. Crawl spaces — at or below grade level.

8.9.7.1.5. Unfinished basements — for purposes of this section, unfinished basements are portions or areas not intended as habitable rooms and limited to storage areas, work areas, etc.

8.9.7.1.6. Kitchens — includes receptacles installed to serve countertop surfaces.

8.9.7.1.7. Laundry, utility and wet-bar sinks — where receptacles are installed within six (6) feet (1.8 meters) of the outside edge of a sink.

8.9.7.1.8. Boathouses.

#### 8.9.7.2. Other than Dwelling Units.

8.9.7.2.1. Bathrooms.

8.9.7.2.2. Commercial and institutional kitchens — for the purposes of this section, a kitchen is an area with a sink and permanent facilities for food preparation and cooking.

8.9.7.2.3. Rooftops.

8.9.7.2.4. Outdoors in public spaces — for the purpose of this section, public space is defined as any space that is for use by, or is accessible to, the public.

8.9.7.2.5. Outdoors, where installed for heating, air-conditioning and refrigeration equipment.

8.9.8. Arc-fault Circuit Interrupters. AFCI are required in certain circuits in dwelling units. Refer to paragraph [8.2.2](#) and NEC, Article 210.12, for guidance.

8.9.9. Electrical receptacles located within six (6) feet of any water source, e.g., sinks, water coolers, water fountains, etc., are required to be GFCI-protected.

### **8.10. Additional Electrical Equipment Requirements.**

8.10.1. Close rack/panel/control box doors at all times except as necessary to accomplish authorized repairs.

8.10.2. Operators shall open and close equipment switches quickly and positively and shall not break contact between brushes and commutators or slip rings while equipment is operating.

**8.11. Electronic Equipment.** Turn high voltage equipment off at provided switches and disconnecting means prior to unplugging, unless authorized by applicable technical publications.

8.11.1. Use only approved solvents to clean electronics equipment. Ensure adequate ventilation and wear appropriate PPE when required by applicable guidance, the installation Ground Safety office or BE. Vacuuming, with a vacuum approved for the task, is an effective cleaning method. Clean with compressed air only as a last resort and limit air pressure to less than 30 psi, unless a lower pressure is required by the TO, manufacturer's data or local procedures. Effective chip guarding (diffuser type nozzle discharge tip) and PPE shall be used.

8.11.2. Technicians shall not use lead pencils, screwdrivers or other unapproved tools to make radio frequency energy tests on electronic equipment as serious burns can result from arcs or faults created by these conditions.

8.11.3. Personnel shall not hold meters in their hand while performing measurements on energized circuits or equipment. Use non-conductive, insulated gloves or other effective PPE when necessary to hold meters or metering cables. The holder shall stand on a non-conductive mat or dry surface while using the meter. Refer to paragraph [14.5.8](#) for additional guidance.

8.11.4. Workbenches.

8.11.4.1. Workbenches shall be kept clean at all times.

8.11.4.2. When voltage is applied to equipment being repaired or tested, personnel shall ensure tools and equipment not essential to the test are removed from the bench.

8.11.4.3. Ground metal workbenches used for repairing and testing electronic equipment to a low resistance ground. **Note:** See TO 00-25-234, *General Shop Practice Requirements for Repair, Maintenance, and Test of Electrical Equipment*, for electrostatic discharge control procedures.

8.11.5. Insulating Matting Specific Requirements.

8.11.5.1. Insulating matting shall be used near electrical apparatus or circuits in high voltage maintenance areas as an additional safety measure to protect personnel. It shall be used to protect against accidental shock only and shall not be the only means of protection when handling energized wires and circuits. TOs 00-25-234 and 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*, and MIL-DTL-15562G, *Matting or Sheet, Floor Covering, Insulating for High-Voltage Applications*, provide information and instructions on control, use and marking of insulating matting. Insulating matting shall be permanently marked IAW MIL-DTL-15562G.

8.11.5.2. Supervisors shall consult with installation Ground Safety office to determine if insulating matting is required in their areas of responsibility. This includes areas where potential shock hazards exist and additional protection is needed, floor resistance is lowered due to dampness and where high voltage (above 600 volts) may be encountered, such as high voltage consoles. Areas with electrical repair or test benches (shops), motors or equipment and control panels require insulating matting.

8.11.5.3. Mats shall be cleaned as necessary to prevent contamination, using domestic cleaners, such as carpet cleaners, or other locally approved cleaners required for special situations.

8.11.5.4. Insulating matting shall be replaced when worn to one-half its original thickness or the manufacturer's recommended replacement requirements. **Note:** Shoes with nails, spikes or cleats shall not be worn on insulating matting. Penetration of spikes or cleats to the floor can make the matting ineffective.

8.11.5.5. Insulating matting in front of and around electrical workbenches, high voltage cabinets, switch panels, etc., shall be one continuous length or strip. Where possible, matting shall continue 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 shall determine the amount needed.

8.11.5.6. Insulating matting shall be seamless. Mat markings shall be non-conducting and not impair the insulating qualities of the mat.

8.11.5.7. Matting shall withstand the AC proof-test voltage specified in [Table 14.1](#) or DC proof-test voltage specified in [Table 14.3](#)

8.11.5.8. The voltage test shall be applied continuously for one minute on matting and three minutes on equipment other than matting.

8.11.5.9. Insulating matting shall not be used for nonskid applications such as walkways, hall runners, in front of work benches (non-electric) on work-and-test benches, etc. General purpose low-cost matting shall be used as it is, and is satisfactory for areas where shock protection is not required. No certification for use of general purpose matting is required.

8.11.6. Use stools made of wood, fiberglass or other non-conductive materials when working on electrical or electronic equipment.

8.11.7. Supervisors shall establish procedures requiring all accessories used with electronic and electrical equipment be serviceable and safe for use. Supervisors shall also establish procedures to eliminate or control all hazard potentials to a safe acceptable level.

**8.12. Emergency Equipment (Electrical Safety).** In addition to electrical PPE provided to workers, functional managers shall ensure emergency equipment is available at each operating location where maintenance is performed on energized circuits. Equipment variations depend on local conditions and the squadron commander or functional manager may add additional items. The equipment may be displayed on a board, stored in an unlocked cabinet or made available in a portable kit, and shall be situated in a conspicuous and prominent location at each site, well marked and readily accessible. Equipment shall be protected against chemical, mechanical or environmental deterioration and shall be inspected or tested for serviceability. Emergency equipment shall consist of:

8.12.1. Safety operating instructions (OI) or procedures for the site.

8.12.2. Cardiopulmonary resuscitation (CPR) instructions.

8.12.3. CPR facemask with disposable mouthpiece.

8.12.4. Emergency phone numbers and building number.

8.12.5. First aid kit provided by the unit. This item is required for work more than three to four minutes from nearest medical facility. Installation medical treatment facility (MTF) can provide recommendations on contents of the first aid kit. **Note 1:** IAW OSHA's letter of interpretation for paragraph 1910.151(b) explains that a first aid kit is required if a medical facility is more than three to four minutes away. **Note 2:** On installations with medical clinics that operate on limited hours and medical treatment is rapidly available from FES Flight's emergency medical teams (EMTs), the FES Flight's EMTs shall be contacted.

8.12.6. Disposable gloves, impervious to body fluids, for first aid use.

8.12.7. Nonconductive cane or hook with insulated handle (with less than 180 degrees of bend).

8.12.8. High voltage insulated lineman's rubber electrical gloves (both inner and outer gloves) – if rescuer(s) is(are) likely to contact live wires, conductors or current carrying parts while performing rescue. Voltage rating shall be suitable for voltages encountered in the work area. **Note 1:** Electrical gloves shall be checked before use IAW UFC 3-560-01, *Electrical Safety, O & M*, and American Society for Testing Materials (ASTM) F 496-85, *Specification for In-service Care of Insulating Gloves and Sleeves*, and shall be tested and marked with the next test due date. **Note 2:** High voltage is defined as 600 volts, nominal, or more.

8.12.9. A 15-foot length of natural fiber rope, preferably 1/2 or 5/8 inch diameter. **Note:** Synthetic rope may melt or burn quickly when exposed to an electric arc, heat or flame.

8.12.10. Insulated fuse pullers, where required.

8.12.11. Flashlight with nonmetallic case in operating condition.

8.12.12. Grounding stick (shorting stick).

8.12.13. Wool blanket(s), for extinguishing clothing fires and keeping injured person warm.

8.12.14. Appropriate portable emergency signs constructed of nonconductive materials, such as AF Visual Aids (AFVA) 91-303, *DANGER—DO NOT ENERGIZE—PERSON WORKING ON ANTENNA*; (AFVA) 91-304, *DANGER—DO NOT ENERGIZE—WORK IN PROGRESS ON EQUIPMENT*; (AFVA) 91-305, *DANGER—INTERLOCKS DISABLED*; and (AFVA) 91-306, *DANGER—HIGH VOLTAGE*, are available through Air Force Publications web site at <http://www.epublishing.af.mil>. Refer to **Chapter 29**, *Mishap Prevention Signs and Tags*, for information on safety signs and tags.

8.12.15. Optional site-specific items (rescue breather; insulated lineman's gloves, etc). **Note:** Protect electrostatic sensitive components and equipment IAW TO 00-25-234, *General Shop Practice Requirements for Repair, Maintenance, and Test of Electrical Equipment*.

**8.13. Automated External Defibrillator (AED).** An AED, approved by the installation medical services and training for proper use, may be required if work is remote from medical facility.

**8.14. Lighting.** Consult installation CE facility design office for specific guidance on lighting. Fluorescent lamps contain toxic materials and shall be managed IAW installation disposal criteria for hazardous waste. When fluorescent fixtures are used, supervisors shall ensure that

any stroboscopic effect with moving machinery is avoided. Control of light is important to avoid glare and harsh shadows. Soft shadows are usually acceptable, but harsh shadows shall be avoided since they may obscure hazards or interfere with visibility. Supplementary lighting or additional lighting shall be provided where general lighting is not sufficient.

**8.15. Moisture Guarding.** Weatherproof electrical systems shall be installed where fixtures, lampholders or receptacles are used in wet or damp locations, such as perishable storage areas (includes all refrigerated areas, both storage and food processing). Fixtures subject to moisture, such as those located near steam equipment, shall be of vapor-proof construction to prevent electrical shock or short circuits. Refer to 29 CFR 1910.305, *Wiring Methods, Components, and Equipment for General Use*, for additional guidance.

**8.16. Undervoltage Protection.** Machines not adequately safeguarded to protect workers during undervoltage situations shall have an undervoltage protective device installed. Undervoltage situations occur when a machine automatically resumes motion after a low voltage situation or power interruption and the operator is exposed to hazardous moving parts. The installation Ground Safety office and shop supervisors shall identify machines which need this protection and ensure undervoltage protection devices are installed. Refer to **Chapter 18, Machinery**, and 29 CFR 1910.213, *Woodworking Machinery Requirements*, for additional guidance.

**8.17. Control Switches.** Control switches (on and off) shall be accessible to workers at their normal operating positions to prevent reaching over moving parts to activate the switch. Control switches stop functions shall be identified by the printed word “STOP” and/or the color red. Control switches shall clearly indicate whether they are in the open (off) or closed (on) position. Where these switch or circuit breaker handles are operated vertically rather than rotationally or horizontally, the up position of the handle shall be the closed (on) position. **Exception:** Vertically operated double-throw switches shall be permitted to be in the closed (on) position with the handle in either the up or down position.

8.17.1. Positive pressure switches shall not be wedged for continuous operation. Motor “start” switch shall be protected against accidental and/or inadvertent operation. Electrical controls shall not be blocked or otherwise obstructed. Refer to **Chapter 18** for additional information.

8.17.2. Interlocks shall not be disconnected or bypassed. Interlocks can be disconnected during maintenance or adjustments only when prescribed by applicable TOs or other instructions. During these periods, a sign or AFVA 91-305, *DANGER — INTERLOCKS DISABLED*, or nearest commercial equivalent, shall be placed on the equipment or nearest available equipment. Interlocks installed for safety reasons shall not be circumvented by operators, i.e., an interlock that prevents a machine from operating when a protective guard or panel is removed or opened.

### **8.18. Work on Energized Equipment.**

8.18.1. Electrical circuits and equipment shall be de-energized before being worked on. When authorized by the commander, applicable technical data or manufacturer’s instructions, work may be performed on energized circuits and equipment as necessary to support a critical mission, prevent injury to personnel or to protect property. In such cases, refer to AFI 32-1064, paragraph 5, and UFC 3-560-01, paragraph 3-3, for task specific required number

of qualified workers. Depending on the task, one member of the two or three person team shall act as safety observer. All workers shall be trained in CPR and equipment shutdown procedures and responsible for immediate assistance in an emergency. Install electrical equipment IAW guidance contained in NFPA 70, UFC 3-560-01, *Electrical Safety, O&M*, and AFI 32-1064. Refer to **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, for additional information on lockout/tagout procedures. **Note:** Supervisor may be safety observer.

8.18.2. Additional PPE for Work on or Near Energized Equipment. Refer to NFPA 70E, Sections 130.3. and 130.7., and UFC 3-560-01, Table 4.1., *PPE Criteria*, for additional guidance.

8.18.2.1. A rubber insulating blanket or other suitable guards shall be used when necessary to work adjacent to energized circuits.

8.18.2.2. Clothing made from synthetics, such as acetate, nylon, polyester or rayon, either alone or in blends, is unsafe for work on or near energized electrical circuits or equipment over 50 volts. Synthetics can melt when exposed to electric arcs or open flames and increase the extent of injuries.

8.18.2.3. A flash hazard analysis (FHA) shall be performed for all Air Force operations exposing personnel to energized parts greater than 50 volts. Protective clothing required, if any, shall be based on the FHA performed. Procedures outlined in UFC 3-560-01 and AFI 32-1064 shall be followed.

8.18.2.4. Individuals required to work on or near (within 8 feet of) exposed energized equipment over 50 volts shall wear long sleeved, Arc Thermal Performance Value (ATPV) rated PPE IAW UFC 3-560-01. Long sleeves/outer garments shall be rolled down and buttoned or secured.

8.18.2.5. Individuals operating or servicing electrical switch-gear over 15 kV shall wear an appropriately ATPV-rated blast suit with hood and polycarbonate face shield. Individuals located 8 to 21 feet from the equipment during these operations shall wear ATPV rated flash suits or be adequately protected by a substantial part of the building structure (wall, floor or ceiling, etc.). Sheet metal and gypsum building materials do not provide the required minimum level of blast protection.

8.18.2.6. Clothing shall be free of metal decorations and fasteners or completely and effectively covered to avoid being exposed to electric arc or flames.

8.18.2.7. Plant maintenance workers shall wear electric hazard (EH) rated safety-toe shoes and other PPE, such as safety goggles, hard hat and gloves, based on the specific tasks involved. Personnel shall remove jewelry before working on machinery. Metal eyeglasses shall be secured by a non-metallic band or cord to prevent them from falling into energized electrical circuits. Consult BE and the installation Ground Safety office on questions pertaining to PPE. Refer to **Chapter 14** for additional information.

8.18.2.8. Any tools, e.g., hot sticks, insulating rubber sleeves, used as part of the task must be rated and tested/certified for the line-to-line voltage of the energized equipment. Refer to ETL 06-9, *Arc Flash Personal Protective Equipment (PPE) for High-Voltage*

*Overhead Line Work at 69kV (Nominal) or Less* and UFC 3-560-01, *Electrical Safety O&M*.

8.18.2.9. For additional guidance on working on energized equipment, refer to UFC 3-560-01, and AFI 32-1064, *Electrical Safe Practices*.

8.18.3. Work Near Energized Equipment. Refer to UFC 3-560-01 and AFI 32-1064, paragraph 4, for additional guidance on working near energized equipment.

8.18.3.1. Appropriate danger, warning or caution tags shall be used as a temporary means of warning employees of an existing hazard and shall not be used in place of, or as a substitute for safety, fire prevention and occupational health signs. Refer to **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, **Chapter 29**, *Mishap Prevention Signs and Tags*, AFI 32-1064, *Electrical Safe Practices*, and UFC 3-560-01, for additional guidance.

8.18.3.2. In passing by or near any switchboard, energized equipment or a machine in motion, personnel shall use caution to prevent contact between their bodies or objects being carried or handled, and the apparatus being passed.

8.18.3.3. Air-operated equipment, either pressure or vacuum, used around energized parts shall be equipped with nonconductive nozzles and pressurized air shall be moisture free. Refer to paragraph **8.11.1** for additional guidance.

**8.19. Electrical Safety Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

8.19.1. Are electrical receptacles and cover plates free from dangerous cracks and secured in place? Reference **8.2**

8.19.2. Are receptacles located in damp or wet locations protected by GFCI breakers or receptacles? Reference **8.2**

8.19.3. Is the prohibition of multiple plug adapters enforced to prevent overloading electrical circuits? Reference **8.2.1**

8.19.4. Are cords that show signs of fraying, cracking, wearing or damage removed from service? Reference **8.4.1.2**

8.19.5. Are electrical extension cords used as outlined in the NEC and not used as a substitute for fixed wiring? Reference **8.4.1.3**

8.19.6. Are electrical extension cords not run through holes in ceilings, walls, floors, doorways, windows or similar openings? Reference **8.4.1.4**

8.19.7. Unless their purpose is evident, are circuit breakers and fuse boxes legibly marked to indicate their purpose? Reference **8.5**

8.19.8. Are circuit breakers, disconnect switches and fuses located so that they are not exposed to physical damage or in the vicinity of easily ignitable material? Reference **8.5.2**

- 8.19.9. Are electrical outlets, switches and junction boxes in good condition and free of defects? Reference [8.6](#)
- 8.19.10. Do workers remove jewelry, such as rings, earrings, bracelets and watches, and secure metal framed eyeglasses with a band or cord when they work on or near live electrical equipment? Reference [8.8](#)
- 8.19.11. Do workers ensure electrical circuits are de-energized, and locked out and tagged IAW [Chapter 21](#), *Hazardous Energy Control (Lockout and Tagout)*, prior to performing repairs on energized electrical equipment? Reference [8.9.1](#)
- 8.19.12. Are only qualified operators who are designated in writing by the supervisor allowed to work on electrical installations and equipment? Reference [8.9.2](#)
- 8.19.13. Are electrical receptacles located within six (6) feet of any water source equipped with a GFCI? Reference [8.9.9](#)
- 8.19.14. Are machines safeguarded to protect workers during undervoltage situations in the event of a power interruption? Reference [8.16](#)
- 8.19.15. Are equipment interlocks working properly and not disconnected or bypassed by operators? Reference [8.17.2](#)
- 8.19.16. Is equipment de-energized where possible before personnel perform any maintenance actions? Reference [8.18.1](#)
- 8.19.17. Is a safety observer present when working on energized electrical circuits and equipment IAW AFI 32-1064 and UFC 3-560-01? Reference [8.18.1](#)
- 8.19.18. Are rubber insulating blankets or other suitable PPE and guards used when working adjacent to energized circuits? Reference [8.18.2.1](#)
- 8.19.19. Do personnel working on energized equipment over 50 volts wear long sleeved, ATPV-rated clothing containing no synthetic fibers? Reference [8.18.2.4](#)
- 8.19.20. Do personnel who operate or service electrical switch-gear of voltage greater than 15 kV wear an appropriately ATPV-rated blast suit with hood and polycarbonate face shield? Reference [8.18.2.5](#)
- 8.19.21. When air-operated equipment, either pressure or vacuum, is used around energized parts, is the equipment nozzle made of non-conductive material and any pressurized air moisture free? Reference [8.18.3.3](#)



## Chapter 9

### JEWELRY

#### 9.1. Finger Rings.

9.1.1. Recent mishap statistics reveal that finger injuries associated with rings are among the most frequent lost-time permanent partial injuries, with ring fingers catching on some object the most frequent cause. Because of the potential for serious injury, finger rings shall not be worn by personnel engaged in the following activities identified below. **Note:** This restriction applies to personnel actually performing these tasks on an infrequent basis. It is not intended to apply to administrative and support personnel assigned to or visiting these areas. However, personnel should comply with established and posted installation or unit safety precautions to prevent personal injury.

9.1.1.1. Climbing, ascending or descending activities where personnel could fall or jump from elevated surfaces account for the majority of injuries caused by a finger ring catching on an object. Some examples include personnel working on elevated surfaces, e.g., ladders, scaffolds, platforms, roofs or high reach vehicles, or personnel ascending or descending from large vehicles such as refuelers, wreckers, sweepers, dump trucks and stake bed trucks. The stake bed truck has been associated with a large number of injuries caused by personnel jumping or descending from the bed of this type vehicle.

9.1.1.2. Materials handling operations. Examples include warehousing, parts handling, operating equipment, packing and crating, and attaching and detaching equipment to tow vehicles.

9.1.1.3. Any type of work where individuals are exposed to moving machinery, rotating or revolving parts, or activities that could result in their hands being caught by a moving part and injured; for example, machine or equipment operators or inspectors.

9.1.1.4. Any type of work or inspection where an individual is exposed to an energized electrical circuit.

9.1.1.5. Performing maintenance or inspections on aircraft or ground support equipment, including civil engineering-type or transportation-type maintenance.

9.1.2. It is not possible to list each situation or task where wearing of rings pose a high potential for injury. Supervisors shall conduct a JSA to identify tasks where the wearing of finger rings should be restricted. Once tasks are identified, the supervisor shall include this information as part of the initial employee safety briefing required by AFI 91-202, *The US Air Force Mishap Prevention Program*. In some instances, the supervisor may elect to determine personnel shall not wear rings while engaged in work activities in general, instead of identifying individual tasks. Refer to paragraph 1.5 of this instruction, AFI 91-202, the *NSC Accident Prevention Manual for Industrial Operations (Administration and Programs)*, and the *NSC Supervisors' Safety Manual* for guidance on performing a JSA. Contact the installation Ground Safety office if further assistance is required. **Warning:** Placing tape over rings or wearing gloves on the hand with a ring does not provide protection or eliminate the requirement to remove finger rings.

**9.2. Other Jewelry.** Jewelry that presents a potential for catching, snagging, pulling or tearing shall be evaluated and restricted from wear if it presents a hazard to the worker or operation. Some types of jewelry that shall be evaluated and controlled are watches, bracelets and necklaces. Metal eyeglasses shall be secured by a band or cord to prevent them from falling into energized electrical circuits or moving industrial machinery. Whenever possible, these types of jewelry shall be removed before entering industrial work areas. **Note:** It's best practice to wear nonmetallic eyeglasses with a breakaway band or cord to prevent them from falling into energized electrical circuits or moving industrial machinery.

**9.3. Jewelry in Industrial Areas.** Workers shall not wear rings, earrings, bracelets, wristwatches or necklaces in the vicinity of operating machinery and power tools. While working on or around live electrical equipment or high temperature equipment, highly combustible garments, garments with exposed metallic fasteners or metal articles such as jewelry, earrings, rings, hair fasteners, bracelets or key chains shall not be worn, nor will flammable articles such as celluloid cap visors be worn. Metal eyeglasses shall be secured by a non-metallic band or cord to prevent them from falling into energized electrical circuits.

**9.4. Jewelry Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

9.4.1. Do workers remove rings when they perform activities that involve climbing, ascending or descending, or where they could fall or jump from an elevated surface? Reference [9.1.1.1](#)

9.4.2. Do workers remove rings when performing materials handling activities? Reference [9.1.1.2](#)

9.4.3. Do workers remove rings when performing work that exposes them to moving machinery, rotating or revolving parts? Reference [9.1.1.3](#)

9.4.4. Do workers remove rings when performing work that exposes them to energized electrical circuits? Reference [9.1.1.4](#)

9.4.5. Is any jewelry that presents a potential for snagging, catching, pulling, tearing or loss evaluated and restricted if it presents a hazard to the worker or operation? Reference [9.2](#)

## Chapter 10

### OFFICE SAFETY

#### 10.1. General Information.

##### 10.1.1. Hazards:

10.1.1.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on the JSA and job safety lesson plan. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process. Example: TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

10.1.1.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance. Contact BE for consultative services regarding potential ergonomic concerns.

10.1.1.3. While many mishaps occur in industrial environments, workers performing clerical, administrative, professional and other office tasks experience mishaps and injuries like their industrial counterparts. Office mishaps can be as costly as industrial mishaps. Even minor office mishaps can result in lost workdays. Sound supervision is the key to a successful office safety program.

10.1.1.4. Office Hazards. Falls are the greatest office hazard. People fall from chairs when sitting down, getting up or moving about, tilting back or placing their feet up on a desk. Falls on the same level occur when people slip on wet floors or trip over equipment, cords or litter. Falls from elevations include people standing on chairs or other furniture, falls from ladders or on stairs.

10.1.1.5. Mishaps occur when people overexert themselves trying to relocate bulky, unwieldy or heavy objects. Workers may be struck by falling objects or file drawers pulled out too far. Workers also bump into doors, desks, cabinets or open file drawers, or get their fingers, hair, etc., caught in machinery. Paper, box cutters or scissors may cause cuts. Cumulative trauma may occur from constant reaching, stretching, twisting, bending down and straightening up. Other mishaps include foreign substances in the eyes and injuries from electric shocks and burns.

**10.2. Basic Office Safety Procedures.** Don't assume an experienced worker is always the safest worker. Many office mishaps occur from worker inattention, haste, not using proper equipment and not reporting unsafe conditions. New employees often learn work habits by observing coworkers; therefore, poor and unsafe work habits must be eliminated.

10.2.1. Horseplay. Horseplay shall not be tolerated. Although harm is not intended when workers "fool around," severe injuries and even fatalities may result from horseplay.

##### 10.2.2. Slip, Trip and Fall Prevention.

10.2.2.1. Keep floors clean, dry and free of refuse. Clean up spills promptly. Slip-resistant floor wax is recommended. Keep aisles, exits and doorways clear at all times. Place telephone and electrical cords where they do not pose tripping hazards. If placement in foot-traffic areas is unavoidable, cords and cables shall be properly

protected by molded housings, bridges or other covers approved for such use to prevent tripping. Briefcases, wastebaskets, etc., shall be placed under desks, against a wall or otherwise out of the way. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, for additional information on walking surfaces, and **Chapter 8**, *Electrical Safety*, for additional information on electrical safety.

10.2.2.2. Install anti-slip material on stair treads or other areas to prevent personnel from slipping. Repair or replace stair and floor defects, such as loose tiles, broken steps, torn carpeting, loose or curled mats, worn, frayed or damaged anti-slip material on stairs or inadequate lighting.

10.2.2.3. Keep steps and stairways clear at all times. Wipe-up spilled liquids immediately.

10.2.2.4. Use step stools or ladders to access anything above shoulder level. Furniture, cardboard boxes, trash bins and chairs are not ladder substitutes. Refer to **Chapter 7** before using ladders.

10.2.2.4.1. Do not position a step stool or ladder in front of a door if the door can swing and contact the stool, ladder or individual using it. Station a guard at the door if a step stool or ladder must be placed in a doorway.

10.2.2.5. Outside Areas. Keep parking lots clean, remove debris, have potholes filled and uneven surfaces corrected. In colder climates, ensure control of snow and ice accumulations.

**10.3. Office Ergonomics.** Ergonomics attempt to fit the job to the person, rather than forcing the person to fit the job. Adapting the job to the worker helps reduce stress and eliminates many potential injuries and disorders from overuse of muscles, poor posture and repetitive motion. Refer to OSHA website <http://www.osha.gov/SLTC/ergonomics/> for additional guidance. Contact the installation BE for questions relating to ergonomics or to have an ergonomic assessment completed.

10.3.1. Adjust and position office equipment for good body posture and minimum stress.

10.3.2. To help prevent ergonomic-related problems workers shall:

10.3.2.1. Periodically relax arms by letting them hang down.

10.3.2.2. Keep shoulders relaxed, neck straight and elbows in.

10.3.2.3. Avoid slumped sitting, rounded shoulders, sway back or an overly straight, stiff position.

10.3.2.4. Adjust chair height so feet rest flat on the floor with knees the same height as hips. Adjust the chair to where work is at a comfortable height. If this is not feasible due to desk height, consider using a footrest.

10.3.2.5. Sit close to their work and not bend over it.

10.3.2.6. Locate commonly used items within arm's reach. Elbows should rest at the side of the chest and wrists should be in a neutral position (not fixed or extended) with forearms parallel to the floor.

10.3.2.7. Use a telephone shoulder rest or headset to prevent an awkward neck position and switch sides periodically.

10.3.3. The functional manager or supervisor shall refer military and government civilian workers with possible work related ergonomic illnesses/injuries to the installation clinic. Ergonomic injuries shall also be reported to the installation Ground Safety office.

**10.4. Lifting Requirements.** Procedures in **Chapter 4**, *Manual Material Handling and Lifting Techniques*, shall be used when personnel lift heavy objects, such as files, books, paper, etc. Team lifting shall be evaluated when items are known to weigh more than 25 pounds or when lifting awkward objects. Use a dolly or other material handling equipment, if available, to move heavy or awkward objects. Refer to **Chapter 4** prior to using material handling equipment, as required.

#### **10.5. General Office Equipment.**

10.5.1. Return paper cutter blades to the fully-down and locked position when not in use. Keep fingers away from paper cutter blade during use. Immediately repair loose guards or springs.

10.5.2. Use the proper tool for the job, i.e., a screwdriver to turn a screw, not scissors or a knife.

10.5.3. Do not store heavy objects on tops or edges of tall cabinets, bookshelves or desks where they may fall.

10.5.4. Chairs.

10.5.4.1. Inspect chairs regularly for broken casters or other defects. **Note:** Five (5) or more legged caster chairs are more stable and ergonomically sound than four (4) legged caster chairs. New or replacement caster chairs shall have at least five (5) legs.

10.5.4.2. Do not stand on a chair to change a light bulb, retrieve overhead items or when a ladder or stepstool is needed. Use the appropriate equipment and not a chair.

10.5.4.3. Do not tilt back, lean sideways or reach behind to lift objects while seated in a chair.

10.5.5. File Cabinets.

10.5.5.1. Store heavy material in bottom drawers and load cabinets from the bottom up.

10.5.5.2. To prevent bumping and tripping, close drawers when not in use.

10.5.5.3. Open only one drawer at a time to avoid tipping the cabinet over. **Note:** New file cabinets shall have a locking feature to prevent opening more than one drawer at a time.

10.5.5.4. Do not climb on open file drawers.

10.5.6. Bookcases. Store heaviest books on lower-level shelves.

10.5.7. Electrical Equipment.

10.5.7.1. Electrical extension cords. See paragraph **8.4**.

10.5.7.2. Power strips (portable power taps or surge protectors) shall not be connected in series. Refer to paragraph **37.2.8** for additional guidance.

10.5.7.3. Heating appliances, such as toasters, toaster ovens and coffee makers shall be plugged directly into a hard-wired facility outlet and shall be unplugged at the end of the work shift. Additionally, coffee makers in the workplace shall have an auto-shutoff device or the unit shall be unplugged from the electrical source when left unattended. **Note:** Coffee makers/machines with integral timers need not be unplugged.

10.5.7.4. Ensure electrical equipment is properly grounded to avoid electric shock.

10.5.7.5. Do not place liquids on or near electrical equipment, i.e., radios, copiers or microwave ovens. **Note:** Supervisors may allow liquids around office equipment IAW paragraph **37.2.2**.

10.5.7.6. Keep access to fuse or circuit breaker boxes or electrical controls clear and unobstructed. Refer to paragraph **8.5** for additional guidance on fuse and circuit breakers in the office area.

10.5.7.7. Keep electrical panel doors closed to prevent “electrical flashover” if a malfunction occurs.

10.5.7.8. Only qualified workers, using approved materials, shall install or repair electrical equipment. Work shall be performed IAW NFPA 70, *National Electrical Code*. Refer to **Chapter 8**, *Electrical Safety*, for additional information.

10.5.8. Other Office Machines. Refer to **Chapter 37**, *Office/Shop Computer and Automatic Data Processing Equipment (ADPE) and Facilities*, for office computer guidance.

10.5.8.1. Ensure electrical power cords and installation wiring meet requirements in **Chapter 8**.

10.5.8.2. Machines with exposed moving parts shall be appropriately guarded IAW manufacturer’s specifications (at a minimum).

10.5.8.3. Only properly trained workers shall operate machinery.

10.5.8.4. Consider installing sound absorbent covers when using noisy machines. Consult BE to conduct noise surveys and recommend PPE, as required.

10.5.8.5. Do not position office equipment where it can slip off the edge of a table or desk. Equipment that “creeps” shall be secured or placed on a non-slip pad.

10.5.8.6. Office fans shall be guarded, front and back, to prevent contact with rotating blades.

10.5.8.7. High amperage appliances such as refrigerators and coffee makers shall not be plugged into modular office furniture unless the furniture electrical system is rated and certified by CE for general appliance use. Modular office furniture electrical systems are normally designed only to provide power to office equipment, i.e., personal computers, monitors, printers, etc.

**10.6. Working with Video Display Terminals (VDT).** A Video Display Terminal (VDT) may require a worker to sit for long periods with only small movements of the eyes, head, arms and fingers. A fixed posture for long periods can cause muscle fatigue and, eventually, muscle pain and injury. VDT operators may develop various musculoskeletal disorders such as carpal tunnel syndrome and tendonitis.

10.6.1. Fatigue, eye strain and irritation, blurred vision, headaches, stress, and neck, back, arm, and muscle pain are symptoms of problems with the equipment, work stations, office environment or job design, or a combination of these. Workers shall report symptoms to their supervisor, who will notify the installation medical clinic (Occupational Medicine or Flight Medicine, if available). Corrective action includes:

10.6.1.1. Take a rest break each hour to reduce eye fatigue (eyestrain) when working at a VDT. Change focus by glancing across the room or out a window (at objects at least 20 feet away) from time to time giving eye muscles a chance to relax.

10.6.1.2. Arrange workstations to eliminate glare. Lighting shall allow the operator to see the text and the screen, but not be bright enough to cause glare or discomfort. Office lighting requires control of four factors: quantity, contrast, and direct and reflected glare. Normally, a VDT should be placed at a 90 degree angle to a light source. Refer to OSHA 3092, *Working Safely with Video Display Terminals*, VDT Checklist, for lighting and workstation suggestions. Avoid glare by:

10.6.1.2.1. Installing blinds, louvers or awnings over windows.

10.6.1.2.2. Turning the VDT at a right angle to a window.

10.6.1.2.3. Eliminating reflective surfaces near the VDT.

10.6.1.2.4. Installing glare screens on monitors.

10.6.1.2.5. Using smaller task lights instead of overhead lighting.

10.6.1.3. Worker vision examinations may provide solutions to eye and neck strain. Employees with poor visual acuity may benefit from use of computer glasses, e.g., glasses with a focal length set to the distance from their eye to the computer monitor.

10.6.1.4. Modifications to make computer workstations more comfortable include:

10.6.1.4.1. Monitor stands to place monitor at correct height for comfortable viewing.

10.6.1.4.2. A copyholder to position hard copy at the same distance and plane as the monitor.

10.6.1.4.3. Adjusting chair or table height to the correct height in relation to the keyboard.

10.6.1.4.4. An articulating keyboard arm to adjust the keyboard to the correct height for keying.

10.6.1.4.5. A wrist or forearm rest to minimize wrist extension and stress.

10.6.1.4.6. A lumbar pillow, if the chair does not support the back properly.

10.6.1.4.7. A footrest to provide leg support if not fully supported on the floor.

10.6.1.5. If possible, design jobs so the worker can vary VDT tasks with non-VDT tasks.

## 10.7. Elevators.

10.7.1. Elevators shall stop level with the floor when the doors open to prevent a tripping hazard. Report elevator malfunctions for immediate repair.

10.7.2. Employees shall not try to stop elevators by placing a hand or foot in closing doors.

10.7.3. Employees shall not use elevators during emergency evacuation.

10.7.4. Elevators shall be inspected annually by a certified inspector. Elevator certification shall be posted in the cab of the elevator in view of all passengers. Where vandalism is a problem, the elevator certification may be retained by the building manager and a permanent sign posted in the cab that identifies the location of the elevator certification.

## 10.8. Storage.

10.8.1. Use a suitable ladder or platform to reach objects stored overhead.

10.8.2. Store materials in an orderly fashion. Stack materials in a stable and logical order to prevent collapsing or falling. Put the heaviest and largest items on the bottom of the stack.

10.8.3. Items that could present hazards, such as knives or razors, shall not be left unprotected in desk drawers, storage cabinets, on top of counters or desktops.

10.8.4. Storing flammable and combustible substances.

10.8.4.1. Storage of flammable and combustible liquids shall be prohibited in office occupancies except when required for maintenance and operation of buildings and equipment. Such storage shall be in approved self-closing metal containers stored in a flammable storage cabinet, safety cans or inside a storage room not having a door that opens into a portion of the building used by personnel. Refer to NFPA 30, *Flammable and Combustible Liquids Code*, and paragraph 22.5.3.3 for additional guidance.

10.8.4.2. Electrical grounding or bonding of a flammable storage cabinet is not required. Refer to paragraph 8.19 for additional guidance.

10.8.4.3. Rags or cloths with flammable or combustible residues shall be placed in approved self-closing metal waste containers immediately after use. IAW AFPAM 32-7043, *Hazardous Waste Management Guide*, and OSHA 29 CFR 1910.107(g) (3), container contents shall be disposed of at the end of each shift, at least once daily. Contact the installation environmental management office for disposal guidance. **Note:** Flammable and combustible wastes may be stored in vapor tight containers if required by installation environmental management office.

10.8.4.4. Follow appropriate precautions, including use of PPE, when handling flammable or caustic liquids to prevent injury to eyes or skin.

**10.9. Lighting.** Consult the local CE facility design section when specific guidance on lighting is required. Fluorescent light bulbs contain toxic materials and shall be managed IAW local hazardous waste disposal criteria. Supervisors shall ensure any stroboscopic effect with moving machinery is avoided when using fluorescent lighting fixtures. Work area lighting shall avoid glare and harsh shadows. While soft shadows are usually acceptable, harsh shadows may obscure



hazards or interfere with visibility and shall be avoided. Supplementary or additional lighting shall be provided where general lighting is not sufficient.

**10.10. Heating, Ventilation and Air Conditioning (HVAC).** Facility managers shall ensure:

10.10.1. IAW ANSI/ASHRAE 62.1-2010, *Ventilation for Acceptable Indoor Air Quality*, office HVAC systems shall be inspected as needed. A recommended interval is distinct to individual models (at least semiannually or annually is suggested), to prevent the buildup of dust, mold and/or parasites. Filters shall be changed as needed. Do not cover air vents or obstruct air flow from registers. Do not place furniture, equipment or materials where they interfere with air movement or thermostats.

10.10.2. Temperatures of 68 to 78 degrees F for a comfortable office environment. Whenever possible, workers shall be located away from vents to avoid direct contact with hot or cold air.

**10.11. Pest Control.** Facility managers shall utilize the installation self-help program to control pest problems. If the problem persists, the facility manager shall report the pest control problem to CE Pest Management. Pest control chemicals shall only be applied by appropriately trained personnel.

**10.12. Noise.** Noise is usually associated with industrial work areas, but noise in an office area or from an outside source, e.g., flight line office area, can present problems too. Noise levels can usually be reduced or controlled. Contact BE for assistance with noise problems.

10.12.1. Equipment noise — isolate noisy machines from general work areas or equip them with sound-reducing (absorbing) covers. Keep telephone ringers on low and purchase quieter equipment, e.g., laser printers versus impact printers.

10.12.2. Overall noise levels — use carpeting and draperies to absorb sound and prevent reflections (echoes). Use sound-deadening partitions to divide work spaces. Place filing cabinets and bookcases where they will block unnecessary sound.

10.12.3. Environmental noise originating outdoors can be reduced by closing windows, sealing holes and other access points to the outdoors, and modifying HVAC duct work/pathways.

10.12.4. Ventilation noise may be substantially reduced by proper acoustic engineering when designing/constructing/modifying HVAC systems, e.g., ensuring adequate duct size dissipative silencers, etc.

**10.13. Personal Protective Equipment (PPE).** While Material Safety Data Sheets (MSDSs) provide some chemical hazard information, supervisors shall consult the installation Ground Safety office and BE to ensure proper PPE is identified. If PPE is required, supervisors shall ensure all workers using the material are provided PPE, know how and when to use it, and how to properly maintain it. Supervisors shall monitor and enforce proper PPE use. Refer to [Chapter 14](#) for additional guidance.

**10.14. Training on Office Tasks and Equipment.** Supervisors shall ensure new workers receive appropriate training IAW AFI 91-202. Workers shall receive retraining/additional training whenever surroundings are changed, new equipment is obtained or tasks are altered.

**10.15. Office Safety Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

- 10.15.1. Are all floor areas kept clean, dry and free of refuse? Reference [10.2.2.1](#)
- 10.15.2. Are telephone and electrical cords located where they do not pose a tripping hazard? Reference [10.2.2.1](#)
- 10.15.3. Are all defects, such as floor tiles, broken steps, torn carpet or curled mats identified until repaired or replaced? Reference [10.2.2.2](#)
- 10.15.4. Are stepstools or ladders used to access anything above shoulder level? Reference [10.2.2.4](#)
- 10.15.5. Are office ergonomics considered when attempting to fit the job to the person? Reference [10.3](#)
- 10.15.6. Is team lifting considered when lifting heavy or awkward objects? Reference [10.4](#)
- 10.15.7. Are heavy materials stored in the bottom of file cabinets? Reference [10.5.5.1](#)
- 10.15.8. Are frayed electrical cords, broken electrical wires and outlet covers repaired or removed from service immediately? Reference [10.5.7.1](#)
- 10.15.9. Are heating appliances, such as coffee makers, plugged directly into a facility outlet and unplugged at the end of the work shift? Reference [10.5.7.3](#)
- 10.15.10. Is access to fuses, circuit breakers and electrical controls clear and unobstructed? Reference [10.5.7.6](#)
- 10.15.11. Are flammable and combustible liquids stored in office occupancies limited to that required for maintenance and operation of building and equipment? Reference [10.8.4.1](#)
- 10.15.12. Are rags or cloth containing flammable or combustible liquid residue deposited in approved self-closing metal waste containers immediately after use? Reference [10.8.4.3](#)

## Chapter 11

### WEATHER SAFETY

#### 11.1. Responsibilities.

11.1.1. The supporting Air Force weather organization is responsible for making initial notification of adverse or mission-limiting weather conditions to predetermined support agencies. **Note:** Adverse or mission-limiting weather conditions include strong surface winds, heavy rain, freezing precipitation, thunderstorms, frequent dangerous lightning and damaging winds, snow, heavy rain and hail.

11.1.2. Each Air Force installation shall develop a local procedure to ensure key personnel and agencies involved in high weather risk activities and operations are notified according to the installation weather support document. Normally, these agencies are those having aircraft, petroleum/oil/lubricant (POL) facilities, open air work and recreational activities, explosive loading, aircraft maintenance and utilities work. Key personnel, in turn, shall advise all on-duty supervisors to take proper precautions and timely actions.

11.1.3. Each installation shall employ a lightning safety program with a two-tiered notification system to minimize personnel exposure to lightning hazards. Refer to paragraph **11.2.3** for additional information.

#### 11.2. General Lightning Safety for all AF Activities and Operations.

11.2.1. When lightning is detected or observed within the immediate vicinity of any activity or operation, the following precautions shall be taken:

11.2.1.1. Do not go outdoors or remain out unless it is absolutely necessary. Seek shelter in:

11.2.1.1.1. Dwellings or other buildings that are protected against lightning.

11.2.1.1.2. Protected underground shelters.

11.2.1.1.3. Large metal framed buildings.

11.2.1.1.4. Enclosed automobiles, buses, aircraft and other vehicles with metal tops and bodies.

11.2.1.1.5. Streets that may be shielded by nearby buildings.

11.2.2. Certain locations are extremely hazardous during thunderstorms and shall be avoided:

11.2.2.1. Hilltops and ridges.

11.2.2.2. Areas on top of buildings.

11.2.2.3. Open fields, athletic fields, golf courses.

11.2.2.4. Parking lots, tennis/outdoor multi-purpose athletic courts.

11.2.2.5. Swimming pools, lakes and seashores.

11.2.2.6. Near wire fences, power and telephone poles, clotheslines, overhead wires, towers and railroad tracks.

11.2.2.7. Under isolated trees.

11.2.2.8. Near electrical appliances, telephones, plumbing fixtures and metal or electrically conductive objects.

11.2.2.9. Aircraft dry bays, tanks and wheel wells.

### 11.2.3. Two-tier notification system.

11.2.3.1. A Lightning Watch is in effect 30 minutes prior to thunderstorms being within a 5 nautical mile (nm) radius of any predetermined location or activity as forecast by the supporting Air Force weather organization. **Note:** Lightning is a direct product of a thunderstorm. During a Lightning Watch, operations or activities may continue. However, all personnel must be prepared to implement Lightning Warning procedures without delay. Be alert for any lightning activity, to include audible thunder, and advise supervisory personnel of any observations.

11.2.3.2. A Lightning Warning is in effect when lightning occurs within a five (5) nm radius of the predetermined locations and activities. Personnel in affected locations or engaged in affected activities shall cease all outside activity and seek shelter. Recommended locations that provide safe shelter and locations to avoid are listed in paragraphs [11.2.1.1](#) and [11.2.2](#).

11.2.4. If lightning does not occur within a five (5) nm radius at the valid (forecast) time of the Lightning Watch, the supporting Air Force weather organization shall reassess the Lightning Watch and amend as needed. Lightning warnings shall be canceled when the thunderstorms have passed beyond the five (5) nm radius of the location or activity. A Lightning Watch shall not be canceled if there is potential for more thunderstorms within 30 minutes.

11.2.5. All aircraft fuel service maintenance activities, including liquid oxygen (LOX) servicing, shall cease whenever a Lightning Warning is in effect. Military service stations that have the newer automatic fuel dispensing system (FMU 2550) will not have to be placed in the manual mode during a Lightning Warning. The older fuel dispensing system (FMU 2000) shall continue to be placed in the manual mode during a Lightning Warning. **Exception:** Commercial and Department of Defense (DoD) pipeline receipts, issues from installation exchange (BX) service station, vehicle movements (including refuelers) and pipeline transfers (including bulk storage).

**11.3. Weather Safety Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

11.3.1. Does the base weather station make initial notification to predetermined support agencies in the event of or forecast of adverse weather conditions? Reference [11.1.1](#)

11.3.2. Has the installation developed local procedures to ensure personnel and agencies involved in high weather risk activities are notified and adverse weather precautions are taken in a timely manner? Reference [11.1.2](#)

11.3.3. When lightning is detected or observed, are actions taken to minimize personnel exposure to lightning hazards? Reference [11.2.1](#)

11.3.4. When lightning is detected or observed in the immediate vicinity, do personnel seek shelter in protected buildings or shelters? Reference [11.2.1.1](#)

11.3.5. Is a two-tier notification system established to minimize personnel exposure to lightning? Reference [11.2.3](#)

11.3.6. Is a lightning watch initiated 30 minutes prior to thunderstorms being within a 5 nm radius of any predetermined location or activity as forecast by the supporting AF weather organization? Reference [11.2.3.1](#)

11.3.7. Is a lightning warning in effect whenever any lightning occurs within a five (5) nm radius of any predetermined location or activity as forecast by the supporting AF weather organization? Reference [11.2.3.2](#)

11.3.8. Do all outside activities cease and personnel seek adequate shelter during a lightning warning? Reference [11.2.3.2.1](#)

## Chapter 12

### HAND TOOLS AND PORTABLE POWER TOOLS

#### 12.1. Hazards and Human Factors.

12.1.1. Hand tools are capable of performing many jobs when used properly. Mishaps involving hand tools usually result from misuse. Prevention of mishaps involving hand tools on the job site is a matter of good instruction, adequate training and proper use.

12.1.2. Portable power tools receive power from electricity, air pressure, explosive charges or rotating flexible cable. While the portable tool increases mobility and convenience, it is frequently more hazardous to use than its stationary counterpart. The reason for this is that portable tools are necessarily small, making safety guarding more difficult. Typical injuries from use of portable power tools include electrical shock, burns, cuts, eye injuries from flying particles and muscle strains. Because electric powered hand tools are portable, the operator may allow the power cable to run below the material being worked or sawed and cut the cord.

12.1.3. Using the wrong tool for the task and failure to inspect and remove defective tools from service can cause injuries.

#### 12.2. Tool Procurement.

12.2.1. Specific criteria for tool use shall be contained in technical data requiring use of the tool. Refer to TO 32-1-101, *Use and Care of Hand Tools and Measuring Tools*, for additional guidance and information on tools and equipment. Contact the installation Ground Safety office for guidance when purchasing equipment items, if needed.

12.2.2. Portable powered tools shall conform to military specifications (Mil Spec), if available. If Mil Specs applicable to a portable powered tool have not been published, the procuring document shall include a requirement for the tool to meet or exceed requirements in 29 CFR 1910.243., *Guarding of Portable Powered Tools*, and 29 CFR 1910.304., *Wiring Design and Protection*. When possible, low noise power tools or tools with noise reduction attachments shall be utilized. Refer to AFOSH Standard 48-20, *Occupational Noise & Hearing Conservation Program*, and BE for additional guidance and information.

12.2.3. Whenever possible, tools should be selected that minimize operator exposure to noise, vibration and awkward positions.

12.2.4. When safety and ergonomic equipment, attachments and materials specifically designed for use with a tool are recommended by the manufacturer, safety equipment, attachments and materials that are at least as protective must be provided to the operator and required to be used to ensure proper and safe use of the equipment, e.g., metal foot guards when using a blasting wand capable of causing an injection foot injury.

#### 12.3. General Requirements.

12.3.1. Racks, shelves or tool boxes shall be provided for storing tools when not in use. Workers shall not keep tools in pants or coat pockets. A running power hand tool shall not be left unattended.

12.3.2. Hand tools shall be used so the working force is away from a person's body in case the tool slips. Cheater bars/pipes, used to extend the handle of a tool, will not be used.

12.3.3. Hand tool safety requires the tools be of good quality, appropriate for the job being performed, kept in good repair and maintained only by qualified personnel.

12.3.4. Workers carrying hand tools while on ladders, scaffolds, platforms or work stands shall use carrying bags, i.e., shoulder bags or backpacks, or tool belts for tools that are not in use. Workers shall not drop tools from elevated surfaces or throw tools to each other.

12.3.5. Supervisors and workers shall frequently inspect all hand tools used in the operations under their supervision. Defective tools shall be immediately removed from service. Common tool defects are:

12.3.5.1. Handles. When hammer, axe, pick or sledgehammer handles become cracked, split, broken or splintered, they shall be immediately replaced. Tool handles shall be well fitted and securely fastened by wedges or other acceptable means. Wedges, always used in pairs, shall be driven into the handle when repairing a sledgehammer or maul, to prevent the head from accidentally flying off if the handle shrinks. Fiberglass handles shall not be etched.

12.3.5.2. Tangs. Files, wood chisels and other tools with tangs shall be fitted and used with suitable handles covering the end of the tang. Ends of handles shall not be used for pounding or tapping.

12.3.6. When dressing tools, a slight bevel of about three-sixteenths of an inch shall be ground around heads to help prevent the heads from mushrooming.

12.3.7. Supervisors shall ensure their workers receive thorough instruction and training on use of hand and power tools.

#### **12.4. Non-powered Hand Tools.**

##### 12.4.1. Screwdrivers.

12.4.1.1. Standard, straight blade screwdrivers shall have working edges square and free from chipped areas. If it is not possible to regrind a working edge, the screwdriver shall be replaced. Screwdrivers with cracked or loose handles shall be repaired or replaced. Screwdrivers shall not be used as a prying tool, punch, wedge, chisel, pinch bar, nail puller or be struck with a hammer. Workers shall select a screwdriver tip that matches the screw slot. Standard type screwdrivers shall not be used on Phillips or cross-head type screw slots. Phillips or crosscut screwdrivers shall be used in the correct size relative to the fastener. If the tips of any screwdriver or special fastener are worn or misshaped they shall be repaired or replaced.

12.4.1.2. Small objects shall not be held by hand, under the arm or on the lap when being worked on with a screwdriver. Small work shall be secured to a flat surface or held in a vise.

12.4.1.3. Workers shall ensure they are well braced before applying force to a screwdriver. Firm footing is necessary when using a screwdriver while on a ladder or work stand where loss of balance could result in a fall.

12.4.2. Chisels and Punches. Chisels shall be kept sharp with the edge ground true. Cold chisels and punches with mushroom heads shall not be used. A chisel or punch holding device shall be used when working space permits. The angle of cut shall be away from the body. Safety goggles shall be worn when using a chisel, punch or an alignment drift.

12.4.3. Wrenches. Damaged, bent or broken wrenches, or wrenches with sprung jaws, shall not be used. Wrenches shall not be struck with a hammer unless the wrench is designed for this purpose. Worn box wrenches or sockets shall be replaced. When excessive pressure is required to free a nut or cap-screw, care shall be taken to avoid positions where the hand will strike any part of the object should the wrench slip or the “fastener” break.

12.4.3.1. Workers using open-end wrenches shall:

12.4.3.1.1. Ensure the wrench fits the nut or bolt head.

12.4.3.1.2. Ensure, when attempting to loosen a tight nut or tighten a loose nut, the wrench seats squarely on the sides of the nut.

12.4.3.1.3. Always PULL on a wrench—not push on it. There may be situations where pushing is the only way to work the wrench. In these situations use the base of the palm to push, keeping an open hand. On adjustable wrenches always place the wrench on the nut so the pulling force is applied to the stationary jaw side of the handle.

12.4.3.1.4. Use box wrenches for torque, where possible. This will decrease the chance of the wrench slipping off the nut or bolt.

12.4.3.2. Pipe wrenches shall have sharp jaws to prevent slippage. Using too small a wrench will cause the jaws to crack or break.

12.4.4. Hammers. Hammers vary in hardness and are designed for specific uses. A hammer of suitable size and weight for the task shall be used. Hammers with loose or damaged handles shall not be used. A hammer shall be discarded if it shows dents, cracks, chips, mushrooming or excessive wear. Redressing is not recommended.

12.4.4.1. Workers shall strike a hammer blow squarely, with the hammer’s striking face parallel with the surface being struck. The sides of hammer heads are not hardened and shall never be used for pounding.

12.4.4.2. Using specific hammers.

12.4.4.2.1. Common nail hammers. If a nail cannot be withdrawn from an object after full rotation of the hammer, then a piece of wood shall be placed under the hammer head and the remainder of the nail withdrawn. This increases the leverage and reduces strain on the handle.

12.4.4.2.2. Hardened hammers. Hammers with highly-tempered steel heads shall not be used on hard steel objects.

12.4.4.2.3. Ball peen hammers. Ball peen hammers of proper size and weight shall be used for striking cold chisels and punches, and straightening unhardened metal.



12.4.4.2.4. Consult manufacturers for designs and uses, to include safety procedures, when making a determination for hammers used in specific applications such as bricklaying, riveting, scaling, chipping or work where nonferrous materials are required.

12.4.5. Saws. Use the proper saw for the assigned task. Crosscut saws shall be used for cutting (wood or lumber) across the grain, ripsaws for cutting with the grain and hacksaws for cutting metal.

12.4.5.1. Hand Saws.

12.4.5.1.1. Hand saws shall be selected for the specific job. Saws with broken teeth or broken or cracked handles shall not be used. Saw teeth shall be kept sharp and well set to prevent binding. If a saw binds while cutting, the worker shall not attempt to force it through the stock.

12.4.5.1.2. If the saw sticks in damp or gummy wood, a small amount of oil or paraffin applied to the blade will make it cut smoothly. Wedges may be used to hold the cut open if oil or paraffin does not prevent the saw from sticking.

12.4.5.1.3. Nails shall not be sawed. Saws shall not be dropped. Saws with dull teeth can usually be sharpened and returned to use, but if the saw cannot be restored, replace it.

12.4.5.1.4. When not in use, saws shall be wiped off with an oil moistened rag and kept in racks or hung by the handle to prevent damage to the teeth.

12.4.5.2. Hacksaws. A hacksaw shall be adjusted in the frame to prevent buckling and breaking, but shall never be tight enough to break off the pin that supports the blade. The blade shall be installed with the teeth pointing forward. Pressure shall be applied on the forward stroke only. If the blade is twisted or too much pressure is applied, the blade may break, causing injury to the user.

12.4.6. Pliers, Hand Snips and Cutters. Pliers are designed for gripping and cutting operations and shall not be used as a substitution for a wrench or any purpose for which it was not intended. Hand snips are designed for cutting sheet-metal. Hand snips shall not be hammered on to make a cut. Cutters are designed for use on wire, rods or bolts, and shall not be used to pull nails or as a pry bar.

12.4.7. Knives. Pocketknives, hook-bill knives, exacto knives or other similar extremely sharp knives shall be carried in a holder or sheath. The blade of a hook-bill knife shall be covered when not in use. Retractable cutters (razors) shall have the blades retracted into their handles when carried or not in use. Workers shall always cut away from the body. Hacking motions shall never be applied when cutting.

12.4.8. Crowbars and Wrecking Bars. Crowbars and wrecking bars of sufficient size and weight shall be chosen to do the job safely and easily. Makeshift bars, such as pipes or other metal objects, shall never be used in place of crowbars and wrecking bars. Crowbars shall have a point or toe to grip the object to be moved and a heel to act as a pivot or fulcrum. In some cases, a block of wood under the heel shall prevent the crowbar from slipping and injuring the user or fellow workers. Damaged crowbars shall not be used.

12.4.8.1. Case-hardened steel tools shall never be used to strike crowbars or wrecking bars. Only plastic, wood or soft metal objects shall be used to hammer on pry-type bars.

12.4.9. Files. The right kind of file for the job shall be selected. Files shall never be cleaned by being struck against a vise or other metal object, because they chip and break easily. They shall not be used as a pry bar. Broken files shall be discarded and not made into a center punch, chisel or other type of tool, since the hardened steel may fracture in use. Replace defective handles immediately.

12.4.10. Shovels, Rakes, Ice Chippers and Sod Lifters. None of these tools shall be used as prying tools. If the handle has been cracked or broken, replace defective handle immediately. These tools shall be properly stored when not in use. When shovels, rakes, hoes and similar tools are not in use at the job site, they shall be positioned where the working surface cannot be stepped on.

12.4.11. Chains. Chains, when used on a job, shall be the right size. Using too small a chain shall cause the links to stretch and lose strength. The chain shall be inspected before and after each use. The chain shall not be held in the hand when pressure is applied, nor shall an employee stand closer than one-half the length of the chain when the chain is under tension.

**12.5. Powered Portable Hand Tools.** Portable power tools increase mobility and convenience but are frequently more hazardous to use than their stationary counterparts. Personnel required to use portable power tools in their work shall be thoroughly trained in safe operating practices. Safe operating procedures shall be set up for each type of tool (consistent with this standard and the manufacturer's instructions). Supervisors and organizations that issue power tools/equipment for self-help projects must ensure workers are properly trained on the equipment used and training is documented. Additionally, supervisors shall be responsible for the safe condition of tools and equipment used. **Note:** Contractors may use their own tools per the authorized contract agreement.

12.5.1. Cords and Hoses.

12.5.1.1. Care shall be taken to prevent cords and hoses that supply power to portable tools from becoming tripping hazards on the job site.

12.5.1.2. Only rubber-sheathed cords approved by Underwriters Laboratories (UL) that meet the requirement of NFPA 70, *National Electrical Code*, shall be used on portable electric tools and extension lamps.

12.5.1.3. All power tool cords include a ground wire in addition to the power wires, unless used with double insulated tools, where the ground wire may be omitted.

12.5.1.4. Tools shall never be raised or lowered by electrical power cords. This includes the air hose for air powered tools.

12.5.1.5. Special type cords (rubber covered or plastic) shall be used in areas where oils or solvents may be encountered.

12.5.1.6. Heavy-duty plugs, clamped securely to the cords, shall be used on all power tools. Workers shall not attempt to unplug power cords by jerking them from their connections. Personnel using electric power hand tools shall be aware of the location of

the power supply cord at all times. **Note:** It's best practice to disconnect power cords when changing out tool accessories such as die sets, arbors, bits, etc.

#### 12.5.2. Switches and Controls.

12.5.2.1. To ensure greater operator safety, the power tools listed below shall be equipped with a constant-pressure switch or control that will shut off power when the pressure is released. Portable power tool switches shall be protected against accidental operation. Refer to 29 CFR 1910.243., *Guarding of Portable Powered Tools*, for additional information.

12.5.2.1.1. Hand-held powered circular saws with a blade diameter over two (2) inches.

12.5.2.1.2. Electric, pneumatic or hydraulic chain saws.

12.5.2.1.3. All hand-held gasoline-powered chain saws.

12.5.2.1.4. Percussion tools without positive accessory holding means.

12.5.2.2. The portable hand-held power tools listed below shall be equipped with a constant- pressure switch or control and may have a lock-on control, provided turn-off can be accomplished by a single motion of the same finger (or fingers) that turns it on:

12.5.2.2.1. Drills.

12.5.2.2.2. Tapers.

12.5.2.2.3. Fastener devices.

12.5.2.2.4. Horizontal, vertical and angle grinders with wheels over two (2) inches in diameter.

12.5.2.2.5. Belt sanders.

12.5.2.2.6. Reciprocating saws.

12.5.2.2.7. Saber, scroll and jigsaws with blade shanks over 1/4 inch (nominal).

12.5.2.2.8. Other similarly operating powered tools.

12.5.2.2.9. All other handheld powered tools such as routers, planers and shears may be equipped with a positive "on-off" control. Use of Ground Fault Circuit Interrupter (GFCI) devices is recommended with these tools.

12.5.3. Fire Hazards. Electric powered hand tools shall not be used near flammable materials or in explosive atmospheres unless approved to meet NEC requirements for the type of area and atmosphere in which the tool is to be used.

12.5.4. Grounding. All portable electric tools with exposed metal parts shall be grounded IAW the NEC. An incomplete grounding circuit can subject the user to electrical shock. Approved three-wire cords shall be used to effectively ground these tools. An incomplete grounding circuit can subject the user to electrical shock. Double-insulated portable electric hand tools (grounding wire not required) are authorized. The ground prong of a three-wire plug shall never be removed. If a cord is found with the ground prong removed, it shall be removed from service, rendered unusable and turned in for repair or replacement.

12.5.5. Damp or Wet Locations. Electric powered tools used in damp or wet locations, such as in tanks, boilers or outdoors, shall be grounded, unless double insulated. GFCI devices shall be used IAW the NEC.

12.5.6. Electric Power Tools. Electric power tools often present the same hazards as other electrical facilities and equipment. Personnel using electric power tools shall be familiar with accepted safe operating standards and the hazards of electricity associated with tool use.

## 12.6. Specific Requirements.

12.6.1. Portable Circular Saws. All portable, power-driven circular saws with a blade diameter over two (2) inches shall be equipped with guards above and below the base plate shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to cover the blade.

12.6.1.1. A circular saw with a sticking spring-operated guard shall be removed from service and repaired before workers are allowed to use it. Most circular saw injuries occur from contact with the blade, electric shock or burns, tripping over cords or saws, losing balance while using the saw, dropping the saw on oneself or another person and kickbacks from pinching blades in the cut. Flying sawdust or small particles can also cause severe eye injuries. Refer to 29 CFR 1910.243. for additional information.

12.6.1.2. Workers shall not stand directly behind the saw while cutting operations are in progress. Kickbacks may occur, and if the lower guard sticks, the moving saw blade could come in contact with the operator's body, causing severe injury. The saw's telescoping saw guard shall be checked frequently while in use to ensure it works freely, encloses the teeth as completely as possible and covers the unused portion of the blade when it is cutting. Both upper and lower guards shall be kept clean and free of sawdust or dirt accumulations. Workers shall remove the power cord from the power supply when checking the guards; cleaning, installing or removing the blade; and while performing maintenance.

12.6.1.3. Periodic inspections are essential to discover operating defects. A systematic inspection schedule and maintenance record for each tool will help prevent mishaps and ensure maximum use of the tool at a minimum operating cost. During the inspection, defective tools shall be taken out of service immediately and tagged for repair. Workers shall be instructed to inspect tools used on the job site and shall be trained to recognize defects and improper functioning. The extent of this inspection and the responsibility for correcting defects shall be clearly outlined so there is neither unnecessary duplication of effort nor misunderstanding regarding the responsibility for maintenance. Additional guidance on carpentry and/or woodworking equipment can be found in [Chapter 18, Machinery](#), and 29 CFR 1910.243.

12.6.2. Chain Saws. The following precautions shall be observed by all users of chain saws:

12.6.2.1. Do not operate a chain saw when fatigued.

12.6.2.2. Use safety footwear, snug-fitting clothing, protective gloves and eye, hearing and head protection devices. Use leggings as described in [Chapter 14](#), *Personal Protective Equipment (PPE)*, when possible.

12.6.2.3. Use caution when handling fuel. Allow the engine to cool before refueling. Move the chain saw at least 10 feet from the fueling point before starting the engine.

12.6.2.4. Do not allow other persons near the chain saw when starting or cutting. Keep bystanders and animals out of the work area.

12.6.2.5. Do not start cutting until you have a clear work area, secure footing and a planned retreat path from the falling tree or limb, etc.

12.6.2.6. Hold the chain saw firmly with both hands when the engine is running. Use a firm grip with thumbs and fingers encircling the chain saw handles.

12.6.2.7. Keep all parts of the body away from the saw chain when the engine is running.

12.6.2.8. Ensure the saw chain is not contacting anything before starting the engine.

12.6.2.9. Carry the chain saw with the engine stopped, the guide bar and saw chain to the rear and the muffler away from the body.

12.6.2.10. Do not operate a chain saw that is damaged, improperly adjusted or not completely and securely assembled. Ensure the saw chain stops moving when the throttle control trigger is released. Replace the guide bar whenever the guide bar is worn to a point where the chain will tilt sideways. Keep the chain sharp. A dull chain requires extra pressure by the operator, lessening control over the saw.

12.6.2.11. Shut off the chain saw engine before setting it down.

12.6.2.12. Use extreme caution when cutting small size brush and saplings because slender material may catch the saw chain and be whipped toward you or pull you off balance.

12.6.2.13. When cutting a limb under tension, be alert for spring back so you will not be struck when the tension in the wood fibers is released.

12.6.2.14. Keep saw handles dry, clean and free of oil or fuel mixture.

12.6.2.15. Operate the chain saw only in well-ventilated areas.

12.6.2.16. Do not operate a chain saw while in a tree unless you have been specifically trained for the operation.

12.6.2.17. Ensure all chain saw service, other than items listed in the owner's manual maintenance instructions, is performed by competent chain saw service personnel. For example, if improper tools are used to remove the flywheel or to hold the flywheel to remove the clutch, structural damage to the flywheel could occur and subsequently cause the flywheel to burst.

12.6.2.18. Guard against kickback. Kickback is the upward motion of the guide bar that occurs when the saw chain at the nose of the guide bar contacts an object. Kickback can lead to loss of control of the chain saw. To reduce kickback:

12.6.2.18.1. Hold the chain saw firmly with both hands.

12.6.2.18.2. Do not overreach.

12.6.2.18.3. Do not let the nose of the guide bar contact a log, branch, ground or any other obstruction.

12.6.2.18.4. Cut at high engine speeds.

12.6.2.18.5. Do not cut above shoulder height.

12.6.2.18.6. Follow manufacturer's maintenance instructions when sharpening or performing maintenance on the chain saw.

12.6.2.18.7. Use devices that reduce kickback hazards, such as low-kickback chain, guide bar nose guards, chain brakes and special guide bars.

12.6.2.19. Use the appropriate guide bar scabbard when transporting the chain saw.

12.6.3. Powder-Actuated Tools. Cartridge-type explosives power this group of hand tools, which involve hazards normally encountered with ammunition and other explosives. These tools are used to sink fasteners into non-brittle surfaces, such as driving studs into steel or concrete, and tightening rivets.

12.6.3.1. Training. Workers shall be thoroughly instructed in the safe use of any powder-actuated tool before being permitted to operate it. All training shall be conducted by an authorized/qualified instructor. At the end of training, the worker shall satisfactorily complete a written examination provided by the manufacturer of the tool. After successfully passing the test, the worker shall receive a qualified operator's card, issued and signed by both the instructor and applicant. All operators shall have this card in their possession while using the tool. The worker must be able to:

12.6.3.1.1. Understand the manufacturer's instruction manual.

12.6.3.1.2. Clean the tool correctly.

12.6.3.1.3. Recognize any visibly worn or damaged parts or defective operation.

12.6.3.1.4. Recognize the number-color code system to identify powder load levels.

12.6.3.1.5. Use the tool correctly within the limitations of its use and correctly operate the tool in the presence of the instructor.

12.6.3.1.6. Know what PPE is required when using tools.

12.6.3.2. When a tool of this type is suggested for a task, a thorough study of the operation shall be made. Kinds of materials encountered, size and strength of explosives needed and possible dangers to nearby workers shall all be considered before tools are issued to operators. In the event of a misfire, the operator shall hold the tool firmly against the work surface for a period of 30 seconds and then follow the explicit instruction set forth in the manufacturer's instruction manual. A sign, at least 20 cm x 25 cm (8" x 10"), using boldface type that is not less than 2.5 cm (1") in height, shall be posted in plain sight where powder-actuated tools are used. A sign shall be posted in the area of tool use and in areas adjacent to tool use where walls, floors or working surface penetration may pose a hazard. At a minimum, the sign shall bear wording similar to the following: **DANGER: POWDER-ACTUATED TOOL IN USE.**

12.6.3.3. These tools, their ammunition and charges shall all be secured.

12.6.3.4. Each tool shall be equipped with a steel muzzle guard at least 3-1/2 inches in diameter, mounted perpendicular to the barrel and designed to confine flying fragments or particles that might create a hazard. When a standard shield or guard cannot be used, or when it does not provide adequate coverage to catch all flying particles, a manufacturer's special shield or guard, fixture or jig that provides equal protection may be used instead. To use the tool inside boxes or recessed areas, the guard shall be secured to the muzzle so it can be easily adjusted.

12.6.3.5. Cartridge-powered tools shall be constructed to prevent operation if they are not fitted with a muzzle guard or protective jig of the manufacturer's design.

12.6.3.6. All tools of this type shall be constructed so they cannot be fired unless the operator is holding the tool against a work surface with a force at least five (5) pounds greater than the total weight of the tool.

12.6.3.7. Powder-actuated tools equipped with standard muzzle guards shall not fire if the guard is tilted more than eight (8) degrees from contact with the working surface.

12.6.3.8. No fastener of any kind shall be driven into masonry closer than three (3) inches to a corner or edge. Unless jigs or special guards are used to stop flying particles, fasteners shall not be fired into steel closer than 1/2 inch to an edge, corner or joint.

12.6.3.9. Projectile firing tools shall be constructed to prevent discharge if dropped.

12.6.3.10. Powder actuated tools shall not be used in explosive or flammable atmospheres.

## 12.7. Personal Protective Clothing and Equipment.

12.7.1. Clothing. Each portable power tool operator shall wear suitable work clothes. Operators shall, if necessary, wear caps or other garments to keep their hair from contact with rotating or moving parts of the tool. Refer to [Chapter 14](#) for additional information on PPE requirements. No worker shall wear loose sleeves, neckties, rings or other clothing or jewelry that could become tangled in a hand power tool. Refer to [Chapter 9, Jewelry](#), for additional information on wearing jewelry while operating power tools.

12.7.2. Protective Eyewear and Respirators.

12.7.2.1. Operators shall wear protective eyewear and/or face shields when using hand power tools that may cause flying particles, including overhead. Refer to [Chapter 14](#) for additional information.

12.7.2.2. If respirators are required by BE, refer to paragraph [14.4.5](#) for guidance on respiratory protection.

12.7.3. Hearing Protection. Refer to paragraph [3.1.2.11](#) for guidance.

**12.8. Hand Tools and Portable Power Tools Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

- 12.8.1. Are tools stored on racks or shelves or in boxes when not in use? Reference [12.3.1](#)
- 12.8.2. Are power tools unplugged and properly stored when not in use? Reference [12.3.1](#)
- 12.8.3. Do workers carry tools in tool belts or other carrying devices such as shoulder bags or backpacks when climbing ladders or while working at elevated heights such as scaffolds, platforms or work stands? Reference [12.3.4](#)
- 12.8.4. Are workers not allowed to drop tools from elevated surfaces, or throw tools back and forth to each other? Reference [12.3.4](#)
- 12.8.5. Are tools inspected for defects, and defective tools immediately removed from service? Reference [12.3.5](#)
- 12.8.6. Are screwdrivers used only for their intended purpose and not as chisels, punches or pry bars? Reference [12.4.1.1](#)
- 12.8.7. Is small work requiring the use of a screwdriver secured in a vise or by other suitable means and not held by hand, under the arm or in the lap? Reference [12.4.1.2](#)
- 12.8.8. Are chisels, punches and hammers with mushroom heads removed from service? Reference [12.4.2](#)
- 12.8.9. Are hammers used for their designed purpose and function? Reference [12.4.4](#)
- 12.8.10. Are handsaws selected and used for their designed purpose, i.e., crosscut saw for cutting across wood grain, a rip saw for cutting with wood grain and a hacksaw for cutting metal? Reference [12.4.5](#)
- 12.8.11. Are blades such as knives, razor blades, utility knives, exacto knives, etc., properly protected or sheathed? Reference [12.4.7](#)
- 12.8.12. When power hand tools are used, is care taken to prevent cords and hoses from becoming tripping hazards? Reference [12.5.1.1](#)
- 12.8.13. Are power tools equipped with a constant pressure switch or control that shuts off the tools when released? Reference [12.5.2.1](#)
- 12.8.14. Are switches on power tools protected against accidental start-up or operation? Reference [12.5.2.1](#)
- 12.8.15. Are portable electric tools with exposed metal parts properly grounded or double insulated? Reference [12.5.4](#)
- 12.8.16. Are all portable circular saws with a blade diameter over two (2) inches equipped with guards above and below the base plate shoe? Reference [12.6.1](#)
- 12.8.17. When the saw is withdrawn from the stock being cut, does the lower guard automatically and instantly return to cover the blade? Reference [12.6.1](#)
- 12.8.18. When using a circular saw, does the operator stand to the side and not directly behind the saw while cutting is in progress? Reference [12.6.1.2](#)
- 12.8.19. Do workers remove the power source to saws before making any adjustments, cleaning or performing any maintenance on them? Reference [12.6.1.2](#)



- 12.8.20. Do workers who operate chain saws wear safety footwear, snug-fitting clothing, protective gloves and eye, hearing and head protection? Reference [12.6.2.2](#)
- 12.8.21. Is the chain saw engine allowed to cool before refueling and the chain saw started a minimum of ten (10) feet from the fueling point? Reference [12.6.2.3](#)
- 12.8.22. Do workers plan a path of retreat in the event of an unplanned or premature falling tree or limb? Reference [12.6.2.5](#)
- 12.8.23. Are chain saws that are not properly maintained, adjusted or properly assembled removed from service until repairs are made? Reference [12.6.2.10](#)
- 12.8.24. Are chain saws only operated in well ventilated areas? Reference [12.6.2.15](#)
- 12.8.25. Are workers well trained and familiar with the operation of the tool and the characteristics of the materials involved before being permitted to operate powder-actuated tools? Reference [12.6.3.1](#)
- 12.8.26. Is each tool equipped with a steel muzzle guard at least 3-1/2 inches in diameter, mounted perpendicular to the barrel and designed to confine flying fragments or particles when the tool is operated? Reference [12.6.3.4](#)
- 12.8.27. Are tools designed to operate only when the operator is holding the tool against a work surface with a force at least five (5) pounds greater than the total weight of the tool? Reference [12.6.3.6](#)
- 12.8.28. Do operators ensure that no fastener of any kind will be driven into masonry within three (3) inches to a corner or edge? Reference [12.6.3.8](#)
- 12.8.29. Are tools designed to prevent discharge if dropped? Reference [12.6.3.9](#)
- 12.8.30. Do operators wear protective goggles or face shields and other protective equipment, such as a respirator, when operations require it? Reference [12.7.2](#)

## Chapter 13

### FALL PROTECTION

#### 13.1. General Information.

13.1.1. Worker fall protection requires an in-depth evaluation of risks. Supervisors will:

13.1.1.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on the Job Safety Analysis (JSA) and job safety lesson plan. **Note:** A JSA is not required if existing guidance covers all safety requirements of an operation or process, such as TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

13.1.1.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance on workplace hazards.

13.1.2. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of industrial work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph **2.3** for additional information.

13.1.3. Additional Information. Competent person means a person who can identify hazardous or dangerous conditions in personal fall arrest systems (PFAS) or any component thereof, and their applications and uses with related fall protection equipment. Refer to paragraph **1.9** for information on qualified person.

**13.2. Specific Requirements.** Fall protection is required for workers working in elevated locations on open-sided floors and platforms and near floor and wall openings. **Note:** Fall protection is not required when working from portable ladders.

13.2.1. Fall prevention and protection must be considered for maintenance work or storing of equipment at heights. At the planning and design phase of a project, fall hazards shall be considered and eliminated whenever possible. When elimination or prevention of fall hazards is not feasible, the design must include certified and labeled anchorages IAW 29 CFR 1910.66, *Powered Platforms for Building Maintenance*, and ANSI Z359.1, *Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components*. Where fall protection is required near weight handling equipment, care must be taken to prevent potential conflicts between the weight handling equipment and fall protection measures.

13.2.2. General Industry. Passive fall protection shall be provided whenever workers can fall four (4) feet or more. This four (4) foot rule applies to all walking and working surfaces and includes open-sided floors and platforms, wall openings and window wall openings at a stairway landing, floor, platform or balcony with a drop of four (4) feet or more. Refer to paragraph **13.3.1** for types of fall protection.

13.2.3. Aircraft Flight Line Operations. Refer to **Chapter 24**, *Aircraft Flight Line – Ground Operations and Activities*.

13.2.4. Construction Operations. Fall protection shall be provided when workers can fall six (6) feet or more. This six (6) foot rule applies to all walking and working surfaces, including scaffolding, roofs, open-sided floors and platforms, wall openings and window wall openings at a stairway landing, floor, platform or balcony with a drop of six (6) feet or more.

13.2.4.1. Fall protection is not required for inspections, investigations or assessments of workplace conditions prior to the actual start of construction work or after all construction what has been completed.

13.2.4.2. Fall protection is not required on inspections or assessments of flat roofs. However, fall protection is required on inspections or assessments of sloped roofs. Additionally, if an inspection team turns into a working team, i.e., tightening a screw, making an adjustment on a lightning protection system, etc., the team will don fall protection equipment.

13.2.4.3. If the inspection is within six (6) feet of the edge of the roof, fall protection will be required.

13.2.5. Erecting or Dismantling Fall Protection. Workers shall be provided with a safe means for erecting or dismantling fall protection systems and features.

13.2.6. Dangerous Equipment and Machinery. Regardless of the fall distance, fall protection must be provided when working over dangerous equipment and machinery.

**13.3. Protection From Falls.** Workers shall be protected from falls of four (4) feet or more.

13.3.1. Types of Fall Protection.

13.3.1.1. Passive. Passive fall protection, such as guardrails, work stands and platforms (aircraft maintenance stands, i.e., B-1, B-4, B-5, etc.), nets, ladder cages and other devices can prevent a worker from falling, but are not directly connected to the worker. Nets do not prevent a worker from falling, but does prevent a worker from hitting the next level. If passive fall protection is not feasible, active fall protection is the preferred option.

13.3.1.2. Active. Active fall protection, such as positioning and restraint systems, ladder climbing devices and PFAS, require the worker to wear a harness and attach himself/herself to an anchorage or lifeline. Positioning and restraint systems prevent a worker from falling while a PFAS permits a worker to fall, but limits arresting loads to generally safe levels.

13.3.1.2.1. Positioning and restraint systems. Fall restraint systems, also referred to as work positioning systems, are similar to a PFAS; however, fall restraint systems restrict a worker's range of movement so the individual cannot fall to the surface below.

13.3.1.2.2. See paragraph [13.4.6](#) for detailed guidance on PFAS.

13.3.1.3. Procedural Controls. Procedural controls, such as using TO designated aircraft surfaces, are the least preferred method of fall protection, but may be considered when active and/or passive measures are ineffective, would create a greater hazard or are not feasible. Procedural fall protection requires aggressive risk management and shall be documented in a JSA coordinated with the installation Ground Safety office before

procedural controls are used. **Note:** Consistent with OSHA guidelines, cost shall not be a consideration for selecting procedural controls.

13.3.1.3.1. Job Safety Analysis (JSA). A JSA shall be performed where procedural controls are the only practical means of providing fall protection. The JSA, and any changes, shall be prepared by a qualified person, as defined in **Attachment 1, Terms**, and developed specifically for the worksite. JSAs shall be kept up to date and maintained at the work center for the work site, i.e., Maintenance Supervisor or Superintendent, Flight Chief, Supervisor office, TODO offices, etc. Implementation of the JSA shall be under the supervision of a competent person, as defined in **Attachment 1, Terms**. Refer to AFI 91-202 for additional guidance on the JSA. Procedures and equipment identified in the JSA shall be considered the minimum mandatory requirements for operations covered in the JSA, and shall include:

13.3.1.3.1.1. An assessment of the operation and fall hazard.

13.3.1.3.1.2. Why active and passive fall protection systems (i.e., guardrails, PFAS or net systems) are not feasible or would create a greater hazard.

13.3.1.3.1.3. Description of the fall protection measures available and each location where conventional fall protection methods cannot be used (these will become controlled access zones).

13.3.1.3.1.4. A corrective action plan describing planned upgrades (equipment, cost and timetable, prioritized by the shop) and appropriate Risk Assessment Codes (RACs), to partially or totally eliminate need for procedural controls.

13.3.2. Air Force item managers (Depot) shall perform the necessary functions, i.e., describing planned upgrades, costs, timetables and prioritization, for Air Force equipment not meeting fall protection standards.

#### **13.4. Fall Protection Equipment.**

13.4.1. Railings. Refer to **Chapter 7, Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders**, and 29 CFR 1910.23, *Guarding Floor and Wall Opening and Holes*, for information on railings.

13.4.2. Fixed Work Platforms. Refer to **Chapter 17, Scaffolding**, for additional guidance.

13.4.3. Mobile Work Platforms. Vehicle-mounted elevating and rotating work platforms, manual and self-propelled mobile work platforms or similar equipment may be used to protect workers provided guards, railings, a PFAS or other similar devices are incorporated in the platform design. Refer to **Chapter 16, Mobile Elevating Work Platforms**, and 29 CFR 1910.29, *Manually Propelled Mobile Ladder Stands and Scaffolds (Towers)*, for additional information.

13.4.4. Safety Nets. Nets may be used when workers are more than 25 feet above ground, water or other surfaces where ladders, catch platforms, temporary floors, fixed or mobile work platforms or PFAS are impractical. Refer to 29 CFR 1926.105, *Safety Nets*, for additional guidance. Safety nets shall:

13.4.4.1. Have a net mesh size not exceeding 6 by 6 inches. New nets shall be certified and labeled by the manufacturer to meet a 17,500 foot-pounds minimum impact resistance test. Edge ropes shall have a minimum breaking strength of 5,000 pounds.

13.4.4.2. Extend at least 8 feet beyond the edge of the work surface where workers are exposed and be installed as close under the work surface as practical, but not more than 25 feet below such work surface. Safety nets shall be installed with sufficient clearance under them to prevent worker's contact with the surface or structures below when subjected to an impact force equal to the drop test. **Note:** The worker fall to net distance determines the actual distance the net shall extend. If the fall is 5 feet or less, the net shall extend outward 8 feet; if over 5 feet and up to 10 feet, the net must extend outward 10 feet; if over 10 feet, the net must extend outward 13 feet (See [Table 13.1](#)).

**Table 13.1. Minimum Required Horizontal Distance.**

<b>Minimum Required Horizontal Distance</b>	
<b>Vertical distance from working level to horizontal plane of net</b>	<b>Minimum required horizontal distance of outer edge of net from the edge of the working surface</b>
Up to 5 feet	8 feet
More than 5 feet, up to 10 feet	10 feet
More than 10 feet	13 feet

13.4.4.3. Be drop tested and inspected. Operations shall not be started until each net is drop tested and inspected. A 400-pound bag of sand not more than 30 inches ( $\pm 2$  inches) in diameter shall be dropped from the working height above the net into the center of each net after the following: initial installation but before use, whenever relocated, after major repair and at 6-month intervals if left in one place. Additionally, pre-used nets shall be inspected whenever a drop test is accomplished.

13.4.4.4. Be certified prior to use. When drop testing is not feasible, the supervisor, team leader or team designated competent worker shall certify the net and net installation. The certification record shall identify each net/installation, date each net/installation was determined in compliance and signature of person making the determination and certification. The most recent certification record shall be available at the worksite.

13.4.4.5. Be constructed with forged steel safety hooks or shackles, with a 5,000 pound minimum breaking strength. The hooks or shackles shall be used to fasten the net to its supports and connections between net panels, ensuring the full strength of the net.

13.4.4.6. Comply with 29 CFR 1926.502, *Fall Protection Systems Criteria and Practices*.

13.4.5. Ladder Safety Devices. Cages or wells shall be provided on ladders more than 20 feet in length, up to a maximum of 30 feet. Ladders over 30 feet shall be broken into sections with landing platforms spaced no more than 30 feet apart. Ladder safety devices may be used on tower, water tank and chimney ladders in lieu of cages, and no landing platform is required. Ladder safety devices shall: limit worker fall to less than two (2) feet, meet the design requirements of the ladders they serve, permit the worker to ascend or descend without having to continually handle any part of the device and be attached to a frontal

centered D-ring or other specifically designed frontal attachment point on a full body harness.

13.4.6. Personal Fall Arrest Systems (PFAS). PFAS systems require an anchorage point, connecting means, lanyard and shock absorber. Refer to 29 CFR 1926.502, *Fall Protection Systems Criteria and Practices*, and 29 CFR 1910.66, Appendix C, *Personal Fall Arrest System*, for additional information. Refer to 29 CFR 1926.104., *Safety Belts, Lifelines, and Lanyards*, for additional guidance on basic PFAS guidelines (safety harnesses, lanyards, lifelines). **Note:** To prevent worker injury or death, PFASs shall not be used without a rescue plan; refer to paragraph [13.7](#).

13.4.6.1. Selection. PFAS shall be selected by a qualified person, match the particular work situation and minimize free fall distance (not to exceed six [6] feet). PFAS equipment shall meet or exceed requirements in ANSI Standard Z359.1., *Personal Fall Arrest Systems, Subsystems and Components*. Only commercially manufactured fall arrest equipment shall be used.

13.4.6.2. PFAS equipment shall have the manufacturer's name, identification code and date of manufacture stamped on the equipment or permanently attached tag and shall be marked to indicate compliance with ANSI Z359.1.

13.4.6.2.1. The service life of fall protection equipment manufactured of synthetic fiber shall be five (5) years (unless otherwise specified by the manufacturer), or sooner if determined unserviceable per paragraph [13.4.6.10.5](#). The five (5) year service life begins once the equipment is put in service, assuming the new unused equipment is stored in a climate-controlled location, i.e., in a plastic bag not exposed to vapors, and in a cool location out of direct sunlight.

13.4.6.3. Horizontal lifelines (Skylines), commonly used in aircraft hangars, wash racks, corrosion control or other aircraft maintenance areas, shall be designed by a qualified person as defined in 29 CFR 1910.66, Appendix C, *Personal Fall Arrest System*, Section 1. The number of workers attached to the lifeline at any time shall not exceed lifeline/anchorage point design limits.

13.4.6.4. Full body harness.

13.4.6.4.1. Only a full body harness shall be used with a PFAS. It shall provide support across the lower chest, over the shoulders and around the thighs and, when properly fitted and used, shall prevent the worker falling out of the harness should a fall occur. While working on or near exposed energized electrical equipment operating at 50 volts or more the safety harness worn over arc flash rated protective clothing shall be arc flash rated IAW UFC 3-560-01 and ASTM F887-05. **Warning:** Body belts may not be used.

13.4.6.4.2. The lanyard attachment point shall be located in the center of the wearer's back near shoulder level or above the wearer's head.

13.4.6.4.3. Harness load bearing straps shall have a minimum width of 1-5/8 inch and be finished to prevent fraying.

13.4.6.5. Lanyards. Lanyards of synthetic materials shall have free ends lightly seared to prevent unraveling. Knots weaken a lanyard and shall not be used in lanyard end terminations. Lanyards (and shock absorbers) subjected to impact loading from a falling person or weight test shall be removed from service and replaced. Refer to paragraphs [13.4.6.11.8](#) and [13.5.3.4](#) for additional guidance. **Warning:** Wire rope or rope covered wire lanyards, some plastics (such as nylon) and wet lanyards are conductive and shall not be used near electrical hazards.

13.4.6.6. Energy (shock) absorber components. Each PFAS may include a shock absorber. Shock absorbers shall be designed so activation is obvious, i.e., ripped stitches, telltale strips visible, etc. Shock absorbers with any signs of activation shall be removed from service.

13.4.6.7. Anchorage. Anchorages for lifelines and lanyards shall support at least a 5000 pound load for each person connected to the anchorage. Anchorages not meeting this rating can be used as part of a complete PFAS which maintains a safety factor of at least two (2) and is under the supervision of a qualified person. Only one PFAS shall be connected to an anchorage point unless specifically certified for more.

13.4.6.8. Connectors. PFAS connectors (hardware used to connect a system together such as a carabiner, D-ring, O-ring, oval ring, snaphook, etc.) shall be drop forged, pressed or formed steel or made of equivalent materials and purchased new with a clean finish, free of rust, scale or foreign matter.

13.4.6.8.1. Snaphooks and carabineers shall be self-closing, self-locking, designed to take 2 consecutive and deliberate actions (double locking) to open and load rated for at least 5000 pounds.

13.4.6.8.2. Connectors shall withstand a 5000 pound load multiplied by the maximum number of PFAS attached to the connector and shall not be exposed to sharp edges, abrasive surfaces or physical hazards, such as thermal, electrical or chemical sources.

13.4.6.9. Fall arrester components. Fall arresters, as in self retracting lifelines, shall be automatic in their locking (fall stopping) function. Workers shall follow manufacturer's instructions to test the locking mechanism after connection to their harness/lanyard. Self-retracting lifeline systems will be positioned over the worker as the worker moves. Pulling on the lifeline cable to provide more slack without moving the overhead carrier (trolley) will result in a pendulum swing should the worker fall. Energy shock absorbers will not be used in conjunction with deceleration devices (self-retracting lifelines).

13.4.6.10. PFAS Inspection. (**Note:** Inspections shall be documented IAW TO 00-25-245, *Testing and Inspection Procedures, Personnel Safety and Rescue Equipment*.)

13.4.6.10.1. PFAS users shall comply with TO 00-25-245 and manufacturer's instructions for inspection, maintenance, cleaning and storage. If defects or damage to equipment or inadequate maintenance of equipment is found, the equipment shall be immediately tagged "unserviceable" and removed from service. Unserviceable PFAS will be destroyed to prevent further use.

13.4.6.10.2. Workers shall inspect their PFAS prior to the first use of the day and/or shift for mildew, wear, damage and other deterioration.

13.4.6.10.3. Supervisors shall ensure all PFAS components receive a thorough inspection at least quarterly. This inspection shall be documented and maintained for at least one year.

13.4.6.10.4. Supervisors shall maintain manufacturer's instructions and performance testing information for PFASs used by their workers.

13.4.6.10.5. PFAS components requiring removal from service:

13.4.6.10.5.1. Components with illegible or absent markings.

13.4.6.10.5.2. Absence of any element which affects equipment form, fit or function.

13.4.6.10.5.3. Defective or damaged hardware elements including distorted hooks or faulty hook springs, tongues unfitted to shoulder buckles, loose or damaged mountings, non-functioning parts, cracks, sharp edges, deformation, corrosion, chemical attack, excessive heating, alteration, deterioration, contact with acids or other corrosives and excessive wear.

13.4.6.10.5.4. Defects or damage to straps or ropes including fraying, unsplicing, unlaying, kinking, knotting, roping, broken or pulled stitches, excessive elongation, chemical attack, excessive soiling, cuts, tears, abrasion, mold, undue stretching, alteration, needed or excessive lubrication, excessive aging, contact with heat, fire or corrosives, internal or external deterioration and excessive wear.

13.4.6.10.5.5. Lanyards after an impact load and shock absorbers with any signs of activation.

13.4.6.11. PFAS Use, Maintenance and Storage Requirements.

13.4.6.11.1. Equipment shall be stored and maintained IAW the manufacturer's instructions. Unique issues, due to local conditions, shall be addressed with the manufacturer.

13.4.6.11.2. Equipment shall be stored to preclude damage from environmental factors such as heat, light, excessive moisture, dirt, oil, chemicals and their vapors or other degrading elements.

13.4.6.11.3. Rope, synthetic materials and rope-covered lanyards shall not be used while welding, cutting, or in areas with sharp edges, open flames or excessive heat.

13.4.6.11.4. Lanyards, connectors and lifelines subject to damage by work operations such as welding, chemical cleaning and sandblasting, shall be protected or other securing systems used.

13.4.6.11.5. Lanyards shall be kept as short as practical to minimize free fall distance, shall not permit a vertical fall of more than six (6) feet as specified in paragraph [13.2](#), nor allow the worker to contact any lower level or obstruction.



Lanyards shall not be attached to a dropline, lifeline or fixed anchorage point in a manner that reduces lanyard strength.

13.4.6.11.6. It is common practice to interchange lanyards, connectors, lifelines, deceleration devices and body harnesses; however, components from different manufacturers may not be safely interchangeable. Always check with the manufacturer(s) before mixing components.

13.4.6.11.7. Only use PFAS components for their designed purposes.

13.4.6.11.8. PFAS components subjected to impact loading shall be immediately removed from service and replaced.

13.4.6.11.9. Supervisors shall ensure workers using a PFAS can be properly rescued or can rescue themselves should a fall occur. Availability of rescue personnel, ladders or other rescue equipment shall be determined prior to using a fall arrest system. **Warning:** Hanging in a harness for an extended period of time can be fatal. IAW ANSI Z359.4, *Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components*, prompt rescue means getting to the subject within six (6) minutes after an accidental fall.

13.4.6.12. Electricians. Fall protection equipment for electricians shall be Arc Thermal Performance Value (ATPV) rated IAW UFC 3-560-01.

13.4.7. Equipment For Un-stepped Communications Poles. All Communications-Electronic (C-E) field technicians required to climb un-stepped communications poles will use the squeeze pole fall protector (pole choker) arrest system. Users of the pole chokers will comply with TO 00-25-245 and manufacturer's instructions regarding inspection, maintenance, cleaning and storage of PFAS equipment. Refer to [Chapter 30](#) for additional guidance.

**13.5. Supervisor, Qualified Person and Competent Person Fall Protection Duties and Responsibilities.** A supervisor, who is designated in writing, shall be responsible for procurement of fall protection/fall arrest systems required by the organization or shop. The supervisor shall be familiar with the shop's typical work assignments and fall protection/fall arrest systems required for each operation. The supervisor shall ensure each worker/qualified person/competent person using a fall protection/fall arrest system is trained and evaluated on proper use, application and inspection of fall protection/fall arrest systems.

13.5.1. The supervisor shall:

13.5.1.1. Conduct JSA, as required.

13.5.1.2. Prepare, review, approve and modify plans for fall protection and prevention, rescue and evacuation and training lessons.

13.5.1.3. Ensure initial and recurring training and training evaluations are provided to shop personnel on fall protection/fall arrest systems prior to initial use. Refer to paragraph [13.6](#) for additional guidance.

13.5.1.4. Ensure appropriate design, selection, certification, evaluation and analysis of fall protection/fall arrest systems and equipment.

13.5.1.5. Prepare and accomplish self-inspection checklist annually IAW TO 00-25-245. Checklist shall include all relevant information on fall protection/fall arrest systems, i.e.,

proper care, maintaining and inspection of fall protection/fall arrest systems equipment, training program, etc. The self-inspection shall be documented and maintained until the next self-inspection is performed.

13.5.1.6. Conduct fall protection/fall arrest system inspections and support accident investigations.

13.5.2. A qualified person, typically an engineer, shall: identify and certify anchorage points on facilities and structures. Help develop and evaluate fall protection plans. Assist supervisors and competent persons in selecting fall protection systems.

13.5.3. The competent person, typically an experienced worker, shall:

13.5.3.1. Assist supervisors and qualified persons in determining feasibility and safety of fall protection for workers and selecting appropriate fall protection systems.

13.5.3.2. Perform on site observations of job work conditions, use of fall protection systems and correct application of the fall protection plan.

13.5.3.3. Identify hazardous conditions and suspend work tasks until hazards are corrected. 13.5.3.4. Inspect PFAS equipment to determine if components subjected to impact loading are undamaged. If damaged, remove and replace.

**13.6. Training.** Workers/competent persons shall be trained and evaluated prior to using any PFAS. Training shall include: methods of use, application, inspection and storage, as well as any manufacturer's recommendations; application limits, proper anchoring and tie-off techniques, estimation of free fall, deceleration and total fall distance to prevent striking a lower level; applicable fall protection, fall prevention, rescue and evacuation plans. Recurring training shall be conducted annually, when work conditions change or new fall arrest systems are used, and documented on AF Form 623, Individual Training Record Folder, AF IMT 55, Employee Safety and Health Record, or civilian equivalent, IAW AFI 91-202.

**13.7. Rescue Plan.** Each fall protection plan shall include a rescue plan. PFAS use shall be suspended if a means to rescue a fallen worker is not available.

13.7.1. Self rescue by a fallen worker may be possible, depending on location and work conditions. However, the supervisor shall ensure a rescue plan is in place to rescue workers should they be injured or unable to self rescue.

13.7.2. Workers suspended in a full body harness often lose consciousness after a fall. This is caused by restrictions in blood flow to the extremities caused by the harness. The rescue plan must ensure a rescue can be affected very quickly to prevent permanent injury or death.

13.7.3. When potential for serious injury exists due to a fall and no threat requires immediate movement of the fallen worker, the worker should remain in place and encouraged to remain still while emergency services personnel are called to assist.

**13.8. Where non-Air Force professional rescue agencies cannot promptly rescue a fallen AF worker, the installation Ground Safety office and Fire Emergency Services (FES) Flight may establish training for fire protection workers and adequate installation personnel as authorized or competent rescuers.** Training shall be documented IAW AFI 91-202.

Coordination with the installation Fire Chief is required to determine if the FES Flight is able to support a fall rescue operation.

**13.9. Fall Protection Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

13.9.1. Are workers provided fall protection when exposed to falls of four (4) feet or more? Reference [13.2.2](#)

13.9.2. Are active and passive means of fall protection considered before using procedural controls? Reference [13.3.1.3](#)

13.9.3. Has a JSA been performed and coordinated with the installation safety office prior to the use of procedural controls for protecting workers from falls? Reference [13.3.1.3](#)

13.9.4. Are all PFAS components marked to indicate compliance with ANSI Z359.1.? Reference [13.4.6.2](#)

13.9.5. Are wire rope, rope covered wire lanyards, plastics (such as nylon) and wet lanyards prohibited where an electrical hazard may be present? Reference [13.4.6.5](#)

13.9.6. Can anchorage connectors withstand a 5000 pound load for each PFAS connected? Reference [13.4.6.7](#)

13.9.7. Do workers inspect their PFAS prior to each use for mildew, wear, damage and other deterioration? Reference [13.4.6.10.2](#)

13.9.8. Does the supervisor ensure all PFAS components receive a thorough inspection at least quarterly and keep the record of inspection for at least one year? Reference [13.4.6.10.3](#)

13.9.9. Are PFAS components subjected to impact loading immediately removed from service and not be used again until inspected and determined by a competent person to be undamaged and suitable for reuse? Reference [13.4.6.11.8](#)

13.9.10. Are workers/competent persons trained and evaluated on the fall protection/fall arrest system prior to use? Reference [13.6](#)

13.9.11. Is recurring fall protection training conducted annually, when work conditions change or when new fall protection/fall arrest systems are procured? Reference [13.6](#)

13.9.12. Is a rescue plan included in each fall protection plan to assure prompt rescue of fallen workers? Reference [13.7](#)

## Chapter 14

### PERSONAL PROTECTIVE EQUIPMENT (PPE)

**14.1. General Information.** This chapter covers the use, selection, care and maintenance for protective equipment for eyes, face, head and extremities, protective clothing, respiratory devices and protective shields/barriers. For issues involving Radio Frequency or laser radiation, refer to AFOSH 48-9, *Radio Frequency Radiation (RFR) Safety Program*, and AFOSH Standard 48-139, *Laser Radiation Protection Program*.

**14.2. Job Safety Analysis (JSA).** Refer to paragraph 1.5 and AFI 91-202, *The US Air Force Mishap Prevention Program* for additional guidance on JSA.

#### 14.3. Responsibilities.

14.3.1. Commanders and/or Functional Managers shall ensure all work centers conduct and document hazard assessments to determine if hazards are present and take actions necessary to protect workers from injury, illness or death. They shall ensure PPE is not used as a substitute for elimination, substitution, e.g., substitution of safer chemicals, engineering controls (ventilation, isolating or guarding against hazards), or administrative controls (worker rotation, training), when possible. Only after engineering and administrative controls have been applied to the maximum extent practicable, or until controls can be installed, will PPE be the primary means to protect personnel against hazards. **Note:** If PPE is required for the performance of a task, then it shall be provided by the commander and/or functional manager. Subordinates are not responsible for providing their own PPE.

14.3.2. Supervisors shall conduct and document hazard assessments in each workplace where their employees are performing duties. If PPE is required, the supervisor shall ensure that PPE is provided, used and maintained in a sanitary serviceable condition.

14.3.2.1. Supervisors are responsible for maintaining discipline with regard to personnel wearing properly fitted PPE, when required, and shall consult the installation Ground Safety office and BE concerning the selection and use of PPE. **Note:** All personnel must have job safety training. Supervisors shall document job safety training for all personnel. Refer to AFI 91-202 for further information.

14.3.2.2. Supervisors shall contact BE when workplace operations change to schedule appropriate evaluation when new hazardous materials are introduced, processed or procedures are changed, or engineering controls are modified or added.

14.3.3. Air Force personnel shall:

14.3.3.1. Promptly report safety, fire and health hazards to supervision or management.

14.3.3.2. Comply with PPE requirements.

14.3.3.3. Ensure provided PPE is used when required, adjusted to properly fit and maintained in a sanitary and serviceable condition.

14.3.3.4. Notify their supervisors if they wear contact lenses. This information is vital to emergency medical personnel who may need to remove a lens from the individual's eye.

14.3.3.5. Notify their supervisors in advance if they have a medical condition or are taking medications that could interfere with their safe performance of assigned duties.

14.3.3.6. Notify supervisors of any changes in medical status which might impair their ability to safely wear PPE (e.g., weight changes, facial scarring, dental changes, disfigurement, etc.).

#### 14.4. General Requirements.

14.4.1. Personal Protective Equipment (PPE). PPE shall be used whenever there are hazards that can do bodily harm through absorption, inhalation or physical contact. This equipment includes respiratory protective devices, special clothing and protective devices for the eyes, face, head, torso and extremities. All PPE shall be approved for the work performed and shall be maintained in satisfactory condition. The installation Ground Safety office and BE shall be consulted. BE is responsible for selecting respirator and filter types, initial training and fit testing for users requiring respiratory protection. Supervisors shall instruct personnel in the use and care of this equipment. Training shall be documented IAW AFI 91-202. Refer to OSHA 29 CFR 1910.133., *Eye and Face Protection*, and AFOSH Standards 48-137, *Respiratory Protection Program*, and 48-20, *Occupational Noise & Hearing Conservation Program (HCP)*, for additional guidance and information.

14.4.2. Eye and Face Protection. (**Note:** Protective eye and face devices must comply with ANSI Z87.1., *Occupational and Educational Eye and Face Protection Devices*.) Personnel shall be provided and use appropriate eye or face protection, as directed by applicable technical data or as determined by an appropriate risk assessment, when exposed to hazards from flying particles, molten metal, liquid chemicals, corrosives, caustics, chemical gases, vapors or ionizing and non-ionizing radiation. This requirement also applies to management, supervisors and visitors within the hazardous area. Selection shall be based on the kind and degree of hazard present. **Note:** Eye protection is required to protect against small particles of falling debris whenever a task is above eye level and the worker must look up into the area being worked on.

14.4.2.1. Protective equipment must meet the following minimum requirements:

14.4.2.1.1. Provide adequate protection against the particular hazards for which they are designed.

14.4.2.1.2. Be reasonably comfortable when worn under designated conditions.

14.4.2.1.3. Fit snugly without interfering with movement or vision of wearer.

14.4.2.1.4. Be durable.

14.4.2.1.5. Be capable of being disinfected (unless disposable items are used).

14.4.2.1.6. Be easily cleaned.

14.4.2.1.7. Be kept clean and in good repair.

14.4.2.2. Supervisors shall ensure eye and face protection properly fits their employees before use in hazardous area.

14.4.2.3. Eye and face protection must have the manufacturer's identification clearly marked on the equipment. Etching is not allowed on the lenses of safety glasses. Safety

glasses from manufacturers already meet ANSI Z87.1 requirements. If not, return to manufacturer prior to use.

14.4.2.4. When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and strictly observed.

14.4.2.5. Metal framed glasses shall be secured with a cord or strap to prevent them from falling into energized circuitry.

14.4.2.6. Safety spectacles are designed with special sturdy frames. Normal street frames with safety lenses are not acceptable substitutes and shall not be worn as a substitute for safety spectacles.

14.4.2.7. Prescription safety spectacles shall only be fitted by qualified optical personnel.

14.4.2.8. Eye goggle headbands that are slack, worn out, sweat soaked, knotted or twisted shall be replaced when they no longer hold the goggles in the proper position.

14.4.2.9. Employees who wear prescription lenses shall be provided eye protection that incorporates the prescription in its design, or shall wear eye protection that can be worn over the prescription lenses. The protective equipment must not interfere with the wearer's vision or proper position of the protective equipment.

14.4.2.10. Contact lenses alone do not provide eye protection and shall not be worn in eye hazard work environments without the use of appropriate safety eyewear.

14.4.2.10.1. If an individual who must wear corrective lenses uses spectacle inserts with a full-face piece respirator, the spectacle inserts for the respirator shall be purchased by the government using a prescription provided by the user.

14.4.2.10.2. If an individual who must wear corrective lenses elects to wear contact lenses with any respirator, the contact lenses shall be purchased by the individual.

14.4.2.10.3. Some vapors and gases can penetrate contact lenses, and possibly get trapped between the lens and eye, and cause serious harm to the worker. Supervisor and worker should contact BE to evaluate the potential hazards associated with the assigned task and make a decision on the appropriate eyewear.

14.4.2.11. When working with potentially injurious light radiation, affected employees shall wear PPE with filtered lenses that have a shade number appropriate to the protection required. Refer to [Chapter 27, Welding, Cutting and Brazing](#), for additional information.

14.4.2.12. Face shields shall only be used as secondary eye and face protection in areas where splashing, rather than hazardous impact, is the problem. In the case of primary protection, other protective devices such as safety goggles shall be worn. Refer to 29 CFR 1910.133., for additional information.

14.4.2.13. Pitted or scratched lenses that reduce visibility shall be removed from service and not used.

14.4.2.14. Dirty lenses can reduce vision and contribute to a mishap. Workers shall clean lenses as frequently as necessary to maintain good vision.

14.4.2.15. Previously used PPE shall be disinfected before reissue to another worker.

14.4.2.16. Workers shall maintain and disinfect eye and/or face protection equipment IAW the following instructions:

14.4.2.16.1. Several methods for disinfecting eye-protective equipment are acceptable. The most effective method is to disassemble the goggles or spectacles and thoroughly clean all parts with soap and warm water. Carefully rinse all traces of soap and replace defective parts with new ones. Swab thoroughly or immerse all parts for 10 minutes in a solution of germicidal deodorant fungicide. Remove parts from solution and suspend in clean place after air drying at room temperature or with heated air. Do not rinse after removing parts from the solution because this will remove the germicidal residue.

14.4.2.16.2. Ultraviolet disinfecting equipment or spray type disinfecting solutions may be used in conjunction with the washing procedure.

14.4.3. Head Protection. Personnel working in areas where there is a potential for injury from falling or flying objects, bumping head against a fixed object or electrical shock or burns shall be provided and use protective helmets. Typical examples of these areas are construction sites and warehouses. Protective helmets must comply with ANSI Z89.1., *Personal Protection – Protective Headwear for Industrial Workers*, and 29 CFR 1910.135., *Head Protection*.

14.4.3.1. Safety Helmets (Hard Hats). Commanders, supervisors and team members shall ensure all those working on or near underground or aerial installation, construction and certain maintenance-related jobs wear an approved hard hat at all times. Specifically, it shall be worn while working construction, all Red Horse-type building construction, working on or around poles, overhead structures, vaults, manholes, excavations, demolitions and tower and antenna construction jobs. The chinstrap shall be worn during work aloft. Refer to paragraph [14.4.3.2](#) for additional guidance on chinstraps. These safety helmets (hard hats) provide protection from impact and penetration of falling objects and from high-voltage electric shock and burns. Main helmet components consist of a protective shell, inside suspension system designed to act as an energy-absorbing mechanism and a chinstrap to secure the helmet to the head. The crown strap shall form a cradle to support the helmet on the wearer's head. The distance between the top of the head and the underside of the shell shall be adjusted to the manufacturer's requirement for the particular helmet being used. Any part of the helmet that comes into contact with the wearer's head must not irritate the skin.

14.4.3.1.1. ANSI Safety Helmet Classification.

14.4.3.1.1.1. Type I (Impact Type). Type I helmets reduce the force of impact from a blow to the top of the head.

14.4.3.1.1.2. Type II (Impact Type). Type II helmets reduce the force of impact from a blow received off center or to the top of the head.

14.4.3.1.1.3. Class G. (Electrical – General). Class G helmets reduce the danger of contact exposure to low voltage conductors.

14.4.3.1.1.4. Class E (Electrical). Class E helmets are intended to reduce the danger of exposure to high voltage conductors.

14.4.3.1.1.5. Class C (Conductive). Class C helmets do not provide protection against contact with electrical conductors.

14.4.3.1.2. Color Identification. Safety helmets shall not be painted, as certain paints may hide cracks or defects in the outer shell and destroy or degrade the insulating characteristics of the shell. Helmets are manufactured in a wide variety of colors and units shall purchase helmets manufactured in a color that meets their particular requirement rather than painting them. Colored helmets shall meet the requirements of ANSI Z89.1.

14.4.3.1.3. Identification Markers. Affix identification markers on shells without making holes through the shell and without the use of any metal parts or metallic labels. (Holes could cause the helmet to fail the electrical insulation test and degrade the impact design of the helmet.) **Note:** Helmet markings shall allow the wearer to identify the type of helmet by looking inside the shell for the manufacturer, ANSI designation and class. For example: Manufacturer's Name, ANSI Z89.1., and Applicable Type and Class designations.

14.4.3.1.4. Use of Decals. Decals on safety helmets are only authorized if approved by the unit's MAJCOM, DRU or FOA, and with the following restrictions:

14.4.3.1.4.1. Decals shall be limited to unit or MAJCOM emblems and the individual's name. **Note:** Decals may also possess a composite tool kit (CTK) identification/tracking number.

14.4.3.1.4.2. Decals or emblems shall be stick-on type only, no more than three (3) inches in nominal diameter.

14.4.3.1.4.3. Names shall be stick-on with each letter no more than 1/2 inch by 1/2 inch.

14.4.3.1.5. Inspection. Inspect safety helmets prior to each use. Any of the following defects is cause for immediate removal from service:

14.4.3.1.5.1. Suspension systems with evidence of material cracking, tearing, fraying or other signs of deterioration.

14.4.3.1.5.2. Any cracks, perforations of brim or shell, deformation of shell or evidence of exposure to excessive heat, chemicals or radiation.

14.4.3.1.5.3. Any accumulation of conductive material on or inside the shell that cannot be removed prior to use. This applies to helmets used in electrical hazardous environments.

14.4.3.1.6. Maintenance. Do not place objects inside safety helmets between the shell and suspension device. This space is designed into the helmet so the impact force is not transmitted to the wearer's head.

14.4.3.1.6.1. Keep safety helmets free of abrasions, scrapes and nicks, and do not deliberately drop, throw or otherwise abuse them because this causes them to lose their protective qualities. Do not store helmets in direct sunlight or where exposed to extreme heat as this may degrade the degree of protection offered. **Note:**



Shells constructed of polymer plastics are susceptible to damage from ultraviolet light and gradual chemical degradation. This degradation first appears as a loss of surface gloss called chalking, and with further deterioration, the surface will begin to flake away.

14.4.3.1.6.2. Do not drill ventilation holes in safety helmets.

14.4.3.1.6.3. Shells shall be scrubbed with a mild detergent and rinsed in clear hot water (approximately 140 degrees Fahrenheit [F]). After rinsing, carefully inspect the shell for any signs of damage. Dry with clean soft cloths or air dry. If the use of a solvent is necessary to remove tars, paints, oils or other materials, the manufacturer shall be consulted since some solvents may damage the shell.

14.4.3.2. Chinstraps. Chinstraps shall be made of nonconductive material not less than 12.7 mm (1/2 inch) in width. An adjustable chinstrap is designed to fit under the chin to secure the helmet to the head. Safety helmets are of little use if they do not fit securely on the head and remain in place when impacted by a falling object. The chinstrap shall be used when working on elevated surfaces where there is a possibility of the hard hat falling off and impacting workers on the lower level.

14.4.3.3. Bump Caps. Bump caps are constructed of lightweight materials and provide minimal protection against bumps or lacerations to the head. They do not afford adequate protection from high impact forces or penetration by flying or falling objects and shall not be used as a substitute for hard hats. Their use shall be determined by supervisors, in conjunction with the installation Ground Safety office.

14.4.3.4. Hair Protection.

14.4.3.4.1. Men and women who work around chains, belts, rotating devices, suction devices, blowers, etc., shall cover their hair, especially long hair, to prevent it being caught in moving equipment. While such equipment is normally guarded, long hair can fit between the mesh of guards and be drawn into the moving parts.

14.4.3.4.2. The length of hair which poses a hazard varies with the operation performed and the control measures used.

14.4.3.4.3. The supervisor, being most knowledgeable of the operation, shall determine what constitutes an acceptable hair length. Normally, hair longer than 4 inches and in close proximity to moving components shall be considered hazardous. However, the supervisor may request the installation Ground Safety office assistance.

14.4.3.4.4. Bandannas, disposable caps, hairnets and turbans may be used, providing they cover the hair completely and do not themselves present a hazard to the wearer.

**Note 1:** The effect of long hair shall be considered when conducting a workplace JSA. **Note 2:** Flight line excluded, i.e., these items cannot be worn on the flight line due to a potential foreign object damage (FOD) hazard.

14.4.4. Hearing Protection. Exposure to high noise levels can cause hearing loss or impairment, in addition to physical and psychological stress. Specifically designed protection may be required, depending on the type of noise encountered and the auditory condition of the employee. AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, is the primary Air Force directive on hazardous noise exposure policies,

responsibilities and procedures, including hearing protective device information. Contact BE for information on the Air Force Hearing Protection Program. Refer to AFOSH Standard 48-20 for additional guidance and information.

14.4.5. Respiratory Protection. IAW AFOSH Standard 48-137, *Respiratory Protection Program (RPP)*, BE, as the OPR for the Air Force RPP, recommends/approves all respiratory protection devices and shall be consulted on respiratory protection required for specific shop activities and job site(s), if required. AFOSH Standard 48-137 and 29 CFR 1910.134., *Respiratory Protection*, provides guidance on control of occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, vapors or in oxygen-deficient environments. Operations that generate hazardous dusts, such as those that contain lead, cadmium, beryllium and asbestos, may require use of protective clothing to prevent injury and spread of contamination. At locations where neither BE nor occupational or environmental health personnel are readily available, supervisors shall contact the support medical facility or the next higher headquarters for assistance with respiratory protection guidance. OSHA has expanded standards for many of these chemicals and they direct strict workplace compliance to include identifying regulated areas. Consult with BE on any operation that generates dust to include aircraft and parts sanding.

14.4.6. Torso Protection. The torso is the largest exposed area of the body. A variety of protective clothing is available to protect personnel from heat, hot metals, liquids, impacts, cuts, corrosives, caustics and radiation. Items such as vests, jackets, aprons, coveralls and full body suits have been specifically designed for this purpose. Supervisors must consider the hazards involved with an operation before selecting the proper protective equipment, which may be a combination of several different pieces of PPE. For example, cloth coveralls protect wood workers against minor cuts and abrasions; however, coveralls alone would be inappropriate for operating a table saw. The addition of a leather apron and eye protection would be more appropriate. **Note:** A back support belt is designed to provide lower lumbar and abdominal muscle support when lifting. However, there is no definitive proof that back support belts serve any protective function; therefore, the Air Force does not recognize back support belts as PPE. Back support belts are only worn with supervisory approval and proper training of safe lifting techniques. They shall not be relied upon solely to protect the back from injury. Back support belts should be unfastened when the individual is not presently involved in a lifting motion, to prevent the possibility of muscle atrophy from prolonged usage.

14.4.7. Hand and Arm Protection. When an employee's hands or arms are exposed to hazards, such as skin absorption of harmful substances, severe cuts, lacerations, abrasions, punctures, chemical burns or harmful temperature extremes, appropriate hand or arm protection shall be provided and used. Sleeves, padded arm protectors, hand pads and other items shall be worn to protect the hands and arms when hot or sharp materials are handled. There is a wide assortment of gloves, hand pads, sleeves and wristlets for protection against various hazardous situations. Before purchasing any protective equipment, contact BE, who will evaluate the hazard and provide the necessary specifications such as material type, thickness, and coverage area, then ensure the manufacturer's recommended use for the glove matches the particular application and anticipated hazards involved. Supervisors shall select appropriate hand protection based on the characteristics required for the task to be performed,

dexterity required, conditions present, duration of use, frequency, physical stresses, limitations of protective clothing and degree of exposure to identified hazards.

14.4.7.1. Multi-Use Gloves. These gloves are generally worn to protect the hands from injuries caused by handling sharp or jagged objects, wood or similar hazard-producing materials. These gloves are usually made of cloth material, such as cotton flannel, with chrome leather palms and fingers or synthetic coating. All-leather gloves are also acceptable. **Note:** Supervisors unable to find appropriate glove(s) in the Air Force inventory, must use proper Air Force channels to procure PPE from outside sources. Before purchasing gloves or any protective clothing (outside Air Force sources), the supervisor shall obtain manufacturer documentation which indicates the equipment meets the appropriate test standards for the hazards anticipated.

14.4.7.2. Selection of Gloves for Protection against Chemical Hazards. Chemical protective gloves shall be worn by personnel working in battery shops or where acids, alkalis, organic solvents and other harmful chemicals are handled. Refer to the TO, JSA and BE evaluation for assistance in selecting the proper glove.

14.4.7.2.1. Toxic properties of the chemicals used must be determined and taken into consideration when selecting the proper protective gloves. Example: Some chemicals cause local effects on the skin or pass through the skin and cause systemic effects.

14.4.7.2.2. A glove shall be selected on the basis of the chemical component with the shortest breakthrough time, since it is possible for solvents to carry active ingredients through polymeric materials.

14.4.7.2.3. Chemical-resistant gloves can be used for most dry powders.

14.4.7.2.4. Employees must be able to remove gloves in such a manner as to prevent skin contamination.

14.4.7.2.5. Contaminated PPE that cannot be decontaminated shall be disposed of in a manner that protects employees from exposure to hazards. Functional managers shall ensure disposal of contaminated PPE is consistent with applicable environmental regulations. Reusable PPE that can be decontaminated can be stored in sealed ziplock type bags.

14.4.8. Electrical Workers' Clothing and Equipment (Refer to AFI 32-1064, *Electrical Safety Practices*).

14.4.8.1. Insulated Protective Equipment. Personnel who work on energized high voltage circuits or power supply lines shall wear electrical workers' nonconductive rubber gloves (with leather outer gloves) as prescribed by TOs, manufacturer's manuals or other safety directives. Other insulating clothing and equipment, such as blankets, hoods, sleeves, matting and line tools designed for the voltage levels encountered, shall be used as required.

14.4.8.1.1. Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of causing damage. Insulating gloves shall be given an air test along with the inspection.

14.4.8.1.2. Insulating equipment with any of the following defects will not be used:

14.4.8.1.2.1. A hole, tear, puncture or cut.

14.4.8.1.2.2. Ozone cutting or checking.

14.4.8.1.2.3. An embedded foreign object.

14.4.8.1.2.4. Any swelling, softening, hardening or sticky texture or loss of elasticity.

14.4.8.1.2.5. Any other defect that damages the insulating properties.

14.4.8.1.3. Insulating equipment found to have defects that might affect its insulating properties shall be removed from service and returned for testing.

14.4.8.1.4. Insulating equipment shall be cleaned as needed to remove foreign substances.

14.4.8.1.5. Insulating equipment shall be stored in a location and manner as to protect it from light, temperature extremes, excessive humidity, ozone and other injurious substances and conditions.

#### 14.4.8.2. Electrical Equipment.

14.4.8.2.1. Each item shall be clearly marked with proper Class number and Type (I or II). The Class numbers identify the design requirements of gloves, blankets and sleeves made of rubber. Refer to **Table 14.1** for the rubber insulating voltage requirement for each class. Material used for non-ozone-resistant equipment (gloves) other than matting shall be marked Type I. Material used for ozone-resistant equipment (gloves) other than matting shall be marked Type II.

14.4.8.2.2. Electrical protective equipment shall be maintained in a safe, reliable condition.

14.4.8.2.3. Maximum use voltages shall conform to those listed in **Table 14.1**

14.4.8.3. Arc-Flash Resistant Clothing. A flash hazard analysis (FHA) shall be performed for all Air Force operations, including aircraft maintenance operations, exposing personnel to energized parts at 50 or more volts IAW NFPA 70E, *Electrical Safety in the Workplace*, Section 130.3., and UFC 3-560-02, *Electrical Safety*. Protective clothing required, if any, shall be based on the FHA performed.

14.4.9. Selection of Gloves for Protection against Electrical Shock or Burn. Electrical workers' gloves are designed to insulate workers from shock, burns and other electrical hazards. These gloves shall NOT be the only protection provided and shall never be used with voltages higher than the insulation rating of the gloves. Workers shall ensure gloves being used have been tested IAW this standard.

14.4.9.1. Rubber protective gloves shall never be used without leather outer protective gloves, also referred to as leather gauntlets.

14.4.9.2. Only seamless rubber insulating gloves shall be used.

14.4.9.3. Gloves shall be marked clearly and permanently on the cuff portion with the name of the manufacturer or supplier, type, size, voltage class and class color.

14.4.9.4. Markings shall be non-conducting and not impair the insulating qualities of the glove.

14.4.9.5. Type II material (gloves, blankets and sleeves) is equipment other than matting which has been designed to be ozone-resistant. Material used for Type II insulating equipment shall be capable of withstanding an ozone test with no visible effects. The ozone test shall reliably indicate that the material will resist ozone exposure in actual use. Any visible signs of ozone deterioration of the material, such as checking, cracking, breaks or pitting, is evidence of failure to meet the requirements for ozone-resistant material.

14.4.9.6. Gloves shall be capable of withstanding the alternating current (AC) proof test voltage specified in **Table 14.2** after a 16-hour water soak.

14.4.9.7. Procedure for testing gloves.

14.4.9.7.1. Glove (right side out) shall be filled with tap water and immersed in water to a depth IAW instructions in **Table 14.3**

14.4.9.7.2. Water shall be added to or removed from the glove, as necessary, so the water level is the same inside and outside the glove.

14.4.9.7.3. When the AC test is used on gloves, the 60-hertz proof test current may not exceed the values specified in **Table 14.2** at any time during the test.

14.4.9.7.4. After the 16-hour water soak, the 60-hertz proof test current may exceed the values given in **Table 14.2** by not more than 2 milliamperes. **Note:** If gloves do not pass the proof test requirements of **Table 14.2**, they shall not be used for electrical protection.

14.4.9.7.5. Rubber protective gloves shall be visually inspected prior to each use. They shall be placed in glove bags and stored in a bin or locker away from tools and materials to prevent damage.

14.4.9.8. Surface irregularities present on rubber goods from imperfections on forms or molds or inherent difficulties in the manufacturing process may appear as indentations, protuberances or imbedded foreign material and are acceptable under the following conditions:

14.4.9.8.1. The indentation or protuberance blends into a smooth slope when the material is stretched.

14.4.9.8.2. Foreign material remains in place when the insulating material is folded and stretches with the insulating material surrounding it.

14.4.9.9. Rubber insulating gloves in storage shall be dielectric tested every 12 months. Rubber gloves that are removed from storage and issued to a worker are in active use and shall be tested before first issue and every six (6) months thereafter. Refer to UFC 3-560-01, *Electrical Safety O&M*, for additional requirements.

14.4.9.10. Rubber insulating sleeves shall be dielectric tested before first issue and every 12 months thereafter.

14.4.9.11. The supervisor shall stamp the dates of the dielectric test and issue date on the gloves. The supervisor shall maintain a record of all electrical equipment test dates and establish procedures to control its issue, inspection, testing and use.

14.4.9.12. Rubber insulating equipment meeting the following national consensus standards are deemed to be in compliance with this instruction.

14.4.9.12.1. ASTM D120, *Specification for Rubber Insulating Gloves*.

14.4.9.12.2. ASTM D178, *Specification for Rubber Insulating Matting*.

14.4.9.12.3. ASTM D1051, *Specification for Rubber Insulating Sleeves*. **Note:** These standards contain specifications for conducting AC and direct current (DC) proof tests, breakdown test, water soak procedure and the ozone test mentioned in this standard.

14.4.10. Foot and Leg Protection—Safety Shoes, Toe Caps, Leggings, etc. Protective footwear shall be provided and worn when there is a reasonable possibility of foot injuries from heavy or sharp objects and electrical and/or static electricity. Use appropriate foot guards, safety shoes or boots and leggings for protection of feet and legs from falling or rolling objects, sharp objects, molten metal, hot surfaces and wet slippery surfaces. Leggings protect the lower leg and feet from molten metal or welding sparks. Safety snaps permit their rapid removal.

14.4.10.1. Supervisors shall identify those areas, operations and occupations which require protective leg or footwear. All individually issued safety footwear used in Air Force operations shall meet the requirements of ASTM F2412, *Standard Test Methods for Foot Protection*, and ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*.

14.4.10.2. Safety shoes shall be sturdy and have an impact-resistant toe. Only shoes meeting or exceeding the ANSI Class 75 impact standard are approved for the Air Force. Refer to 29 CFR 1910.136., *Foot Protection*, for additional information. Metal insoles in shoes protect against puncture wounds. Additional protection, such as metatarsal guards, may be necessary for some job tasks. Nonskid shoes shall be worn where floors may be wet or slippery. Electrical hazard shoes are not designed to be a replacement for electrically rated matting in high voltage situations. These shoes are designed to be used when working on low voltage circuits and as a secondary means of protection. **Note:** When exposed to cold temperatures and foot crushing hazards, if cold weather footwear which also provides crushing protection is not available, personnel shall be issued footwear which protects against the possibility of frostbite.

14.4.11. Chemical Protective Clothing. The purpose of chemical protective clothing and equipment is to shield or isolate individuals from chemical, physical and biological hazards encountered during hazardous materials operations. Many chemicals pose invisible hazards and offer no warning properties. It is important for employees to realize that no single protective clothing item can protect against all hazards. Other protective methods, such as engineering or administrative controls, shall be used to limit chemical contact before considering use of PPE.

14.4.11.1. Chemical Protective Clothing Selection. Workplace supervisors shall contact BE to determine the appropriate PPE for all processes.

14.4.11.2. Ensemble Selection Factors:

14.4.11.2.1. Hazard Consideration. Chemicals present a variety of hazards such as toxicity, corrosiveness, flammability, reactivity and oxygen deficiency, or a combination of hazards may be present.

14.4.11.2.2. Requirements. The proper type of chemical protective clothing or equipment depends on job requirements, and includes requirements from TOs, MSDSs and manufacturer's recommendations.

14.4.11.2.2.1. Check with BE before purchasing chemical protective clothing or equipment.

14.4.11.2.2.2. Some chemicals require PPE made out of specific materials. Ensure PPE is made from specific materials designed to protect against specific chemicals for the duration of exposure.

14.4.11.3. Chemical Protective Clothing Limitations—Breakthrough Time (see definition, [Attachment 1](#)). Chemicals allowed to remain on protective clothing or equipment can diffuse through the material, even if it is in storage. Chemical protective clothing that is reused must be cleaned before storage. In some cases it may be more cost effective to select chemical protective clothing with a relatively short breakthrough time and discard it after use.

14.4.11.3.1. Duration of Exposure. Maximum duration of exposure to a chemical shall be considered when selecting chemical protective clothing.

14.4.11.3.2. Performance Characteristics.

14.4.11.3.2.1. Resistance to abrasions, cuts, heat, ozone and punctures or tears shall be considered to maintain the integrity of the material.

14.4.11.3.2.2. Flexibility may be an important factor if inflexible equipment interferes with the worker's ability to successfully accomplish his or her task.

14.4.11.4. Training.

14.4.11.4.1. Supervisors shall ensure employees are trained on hazards of chemical protective clothing. Heat stress; physical and psychological stress; and impaired vision, mobility and communication significantly increase the risk of injury. Selecting personal protective clothing must encompass an "ensemble" of clothing and equipment which provides both an appropriate level of protection and allows workers to carry out duties involving the chemicals. Over-protection as well as under-protection can be hazardous and shall be avoided. Refer to paragraph [1.5](#) for training documentation.

14.4.11.4.2. Supervisors shall ensure their employees are properly trained on pre-use inspection, maintenance, cleaning and storage of chemical protective clothing and equipment.

14.4.11.4.2.1. Pre-Use Inspection. Typical inspection procedures for chemical

protective clothing shall include checks for imperfect seams and seals and discrepancies in the material coating, such as pinholes, rips and tears, surface cracks, malfunctioning closures and signs of deterioration. Pinholes may be detected by holding the material up to a light in a dark room. Gloves can be checked by inflating the glove to see if the glove holds the pressure or emits bubbles under water. Manufacturer's manuals shall be consulted for specific inspection recommendations.

14.4.11.4.2.2. Cleaning. Chemical protective clothing that is reused shall be cleaned before storage. Residual chemicals on chemical protective clothing can permeate the material during storage and reduce the useful life of the clothing. It can also contaminate the inside of the clothing.

14.4.11.4.2.3. Disposal. The supervisor shall ensure chemical protective clothing classified as hazardous waste is correctly discarded.

14.4.11.4.2.4. Respiratory Training Documentation. IAW AFOSH 48-137, *Respiratory Protection Program*, document respiratory training.

14.4.12. Knee Protection. Knee pads may be used by workers who are required to kneel while performing most of their work or by workers with known knee problems that could be compounded by working in a kneeling position.

14.4.13. Other:

14.4.13.1. Shop supervisors shall ensure shop personnel use the protective clothing and equipment that will protect them from work hazards. It is the responsibility of workers to keep their PPE in a clean, sanitary state of repair and use the equipment when required.

14.4.13.2. Workers shall keep their hands and face clean, change clothes and wash skin contaminated with solvents, lubricants or fuels, and keep hands and soiled objects out of their mouth. No food or drink shall be brought into or consumed in areas exposed to toxic materials, chemicals or industrial shop contaminants nor shall drinking water sources such as water fountains be located in those areas. **Note:** Cleaning supplies in a break room shall be stored in a storage locker or equivalent. After exposure to any contaminant, shop personnel shall wash their hands before eating or smoking. Safe drinking water shall be provided in or reasonably near all shops. Waste food from the lunch area shall be kept in a receptacle that is tightly covered and kept clean. Restrooms, provided with hot and cold running water, shall be kept clean and in a sanitary condition. Shop personnel required to wear protective clothing shall be provided with change rooms equipped with clothing lockers having separate storage facilities for clean and soiled clothing. Clothing used daily and issued by the shop shall be cleaned and stored in shop lockers or fenced areas within the building. Clothing and protective equipment shall be inspected daily for satisfactory condition by using workers. In addition, supervisors or a designated employee shall spot check equipment and clothing. Refer to 29 CFR 1910.141., *Sanitation*, for additional information.

14.4.13.3. Shop supervisors shall provide on-site laundry and shower facilities IAW 29 CFR 1910.141. and 29 CFR 1910.1000. through 1910.1052. Additionally, showers and



laundry facilities shall be provided when the installation Ground Safety office or BE determine an occupational hazard warrants them.

14.4.14. Welding, Cutting and Brazing Specific PPE. Key portions of 29 CFR 1910.252., *Welding, Cutting and Brazing*, covering protective equipment, are included here. Workers engaged in or exposed to welding, cutting or brazing activities shall be provided the proper PPE. The appropriate protective clothing required for specific welding operations varies with the size, nature and location of the work performed. Refer to 29 CFR 1910.132., *Personal Protective Equipment*, and AFOSH Standard 48-137, *Respiratory Protection Program*, for additional guidance.

14.4.14.1. Personal protective clothing may interfere with the body's heat dissipation, especially during hot weather or in confined spaces. Workers may need frequent breaks.

14.4.14.2. Leg Protection. For heavy work, flame-resistant leggings or other equivalent means shall be used to provide additional protection for the legs.

14.4.14.3. Hand and Arm Protection.

14.4.14.3.1. All welders and cutters shall wear protective flame-resistant gloves. All gloves shall be in good repair, dry and capable of providing protection from electric shock by welding equipment. Insulated linings shall be used to protect areas exposed to high radiant energy.

14.4.14.3.2. Cape sleeves or shoulder covers with bibs made of leather or other flame-resistant materials shall be worn during overhead welding, cutting or other operations, when necessary.

14.4.14.4. Torso Protection.

14.4.14.4.1. Clothing shall provide sufficient coverage and be made of suitable materials to minimize skin burns caused by sparks, spatter, ultra violet radiation or electrical shock.

14.4.14.4.2. All outer clothing, such as coveralls, shall be reasonably free from oil and grease.

14.4.14.4.3. Front pockets and upturned sleeves or cuffs shall be prohibited. Sleeves and collars shall be kept buttoned to prevent hot metal slag and sparks from contacting the skin.

14.4.14.4.4. Durable flame-resistant aprons made of leather or suitable materials shall be used to protect the front of the body when additional protection against sparks and radiant energy is needed.

14.4.14.5. Eye and Face Protection requirements.

14.4.14.5.1. All welding helmets shall meet 29 CFR 1910.252. requirements.

14.4.14.5.2. Eye and face protective equipment shall be inspected for serviceability prior to each use. For sanitary purposes, eye and face protectors shall not be shared by other employees. Helmets shall be used during all arc-welding or arc-cutting operations, excluding submerged arc-welding. Where the work permits, submerged arc-welders shall be enclosed in separate booths coated on the inside with non-

- reflective material. When two or more welders are exposed to the hazards of each other's welding operations, goggles shall be worn under the welder's helmets to provide protection from harmful rays and flying debris. Helpers or attendants shall be provided with the proper PPE, to include eye protection.
- 14.4.14.5.3. Goggles or other suitable eye protection shall be used during all gas welding or oxygen cutting operations.
- 14.4.14.5.4. All operators and attendants of resistance welding or brazing equipment, or while chipping slag, shall use transparent face shields or goggles, depending on the particular job, to protect their faces or eyes as required.
- 14.4.14.5.5. Suitable tinted goggles or spectacles shall be provided for torch brazing operations or soldering operations. Spectacles shall be equipped with side shields.
- 14.4.14.6. Specifications for PPE.
- 14.4.14.6.1. Helmets and goggles shall be made of a material which is an insulator for heat and electricity. Helmets, face shields and goggles shall not be readily flammable and shall be capable of withstanding sterilization.
- 14.4.14.6.2. Helmets shall be arranged to protect the face, neck and ears from direct radiant energy from the arc.
- 14.4.14.6.3. All parts shall be constructed of a material which will not readily corrode or discolor the skin.
- 14.4.14.6.4. Goggles shall be ventilated to prevent fogging of the lenses as much as practicable.
- 14.4.14.6.5. Easily removed filter and cover lenses or plates shall be provided to protect each helmet, goggle filter lens or plate.
- 14.4.14.6.6. All glass for lenses shall be tempered and substantially free from striae/scratches, air bubbles, waves and other flaws. Except when a lens is ground to provide proper optical correction for defective vision, the front and rear surfaces of lenses and windows shall be smooth and parallel.
- 14.4.14.6.7. Lenses shall bear some permanent distinctive markings identifying the lens' source and shade.
- 14.4.14.6.8. All filter lenses and plates shall meet the radiant energy transmission test prescribed in ANSI Z87.1, *Occupational and Educational Eye and Face Protection Devices*.
- 14.4.14.6.9. Hand-held screens for shielding the face and eyes shall not be used since they may be inadvertently held in the wrong position and not provide the proper protection.
- 14.4.14.7. Hearing Protection. Refer to paragraph [3.1.2.11](#) for guidance.
- 14.4.14.8. Respiratory Protection. When mechanical or natural ventilation fails to reduce air contaminants to allowable levels or when implementation of such controls is not feasible, respiratory protective equipment shall be used to protect personnel from

hazardous concentrations of airborne contaminants. Only approved respirator equipment shall be used. Consult BE and AFOSH Standard 48-137 for additional guidance.

14.4.14.9. Head Protection. Caps made from flame resistant material shall be worn under helmets, when necessary, to prevent head burns.

#### 14.5. Specific Requirements.

14.5.1. 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 protects 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, *General Shop Practice Requirements for Repair Electrical Equipment*, and MIL-DTL-15562G, *Matting or Sheet, Floor Covering, Insulating for High Voltage Application*, provide information and instructions for control, use and marking of insulating matting. Approved electrical insulating matting is permanently marked IAW MIL-DTL-15562G.

14.5.2. Upon request, the supervisor, with the assistance of the installation Ground Safety office, shall inspect areas with electrical facilities and determine if insulating matting is required for worker protection. Typical examples of areas where insulating matting is required include locations where potential shock hazards exist and additional resistance is required; floor resistance is lowered due to dampness; high voltages (above 600 volts) may be encountered, such as high voltage consoles; and areas with electrical repair or test benches (shops), motors or equipment and control panels.

14.5.3. Cleaning shall 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.

14.5.4. Insulating matting shall be replaced when worn to one-half its original thickness or the manufacturer's suggested replacement requirements. **Note:** Shoes with nails or metal scraps in soles shall not be worn on insulating matting.

14.5.5. Insulating matting on floors in front of and around electrical workbenches, high voltage cabinets, switch panels, etc., shall be of one continuous length or strip. Where possible, the matting shall continue 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 shall determine the amount needed.

14.5.6. Insulating matting shall be seamless and markings shall be non-conducting and not impair the insulating qualities of the equipment.

14.5.7. Matting shall be capable of withstanding the AC proof test voltage specified in [Table 14.1](#)

14.5.8. The voltage test shall be applied continuously for one minute (1) on matting and applied continuously for three (3) minutes for equipment other than matting.

14.5.9. Insulating matting shall not be used for nonskid applications such as walkways, hall runners, in front of workbenches (non-electric) 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.

#### 14.5.10. Light Reflective Products.

14.5.10.1. Light reflective and luminescent materials are particularly effective for reducing mishaps caused by poor visibility or darkness. Reflective coatings are available in the primary safety code colors so standard signs and markings can be made with these materials. Materials used must remain reflective when wet.

14.5.10.2. Personnel exposed to a traffic environment or flight line operations during hours of darkness, periods of reduced visibility or as part of construction or maintenance activities, shall be provided and use reflective vests/accessories or shall use organizational clothing with sewn-on reflective tape (red or orange reflective colors provide better contrast in a snowy environment). **Note:** Personnel whose job requires them to perform some function in the traffic/flight line environment shall be provided reflective equipment to enhance their visibility. For personnel transiting this environment incidental to their assigned task(s), issue of reflective equipment shall be at the discretion of the supervisor/commander.

14.5.11. Heat Reflective and Protective Clothing. Radiant heat is a problem in operations such as heat treating of metals, foundry operations and heating plants. Heat reflective qualities of clothing and other surfaces are considerably affected by color and surface characteristics. Polished metallic aluminum is an effective surface to reflect radiant heat. Helmets, suits, gloves and boots with this type of surface are available and shall be used when necessary to prevent heat stress and physical injury. Frequent breaks and drinking plenty of water are also critical to prevent heat-related injuries. **Note:** If metallic coating on heat reflective clothing is conductive, it shall not be worn where there is the possibility of electrical shock.

14.5.12. Cold-Testing and Clothing. Protective clothing used in cold-testing or cold storage areas must be adequate to protect workers from hazards involved with the task and cold temperatures. Supervisors shall ensure JSAs conducted for this type operation identify protection for working in cold temperatures. Frostbite can be avoided by wearing appropriate protective clothing and by taking frequent breaks to warm extremities. Supervisors shall ensure cold weather clothing is provided when needed for work in cold temperatures.

14.5.13. Personal Fall Arrest Systems (Safety Harnesses, Lanyards, Lifelines, and Straps). See [Chapter 13](#), *Fall Protection*.

**Table 14.1. Rubber Insulating Equipment Voltage Requirements.**

<b>Rubber Insulating Equipment Voltage Requirements</b>			
<b>Class of Equipment</b>	<b>Maximum Use Voltage (1) AC rms</b>	<b>Retest (2) AC rms</b>	<b>Retest Voltage (2) DC avg.</b>
0	1,000	5,000	20,000
1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000

<b>Rubber Insulating Equipment Voltage Requirements</b>			
<b>Class of Equipment</b>	<b>Maximum Use Voltage (1) AC rms</b>	<b>Retest (2) AC rms</b>	<b>Retest Voltage (2) DC avg.</b>
4	36,000	40,000	70,000

**Notes:**

1. The maximum use voltage is the AC voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits. However, the phase-to-ground potential is considered to be the nominal design voltage: (a) If there is no multiphase exposure in a system area and if the voltage exposure is limited to the phase-to-ground potential, or (b) If the electrical equipment and devices are insulated or isolated or both so that the multiphase exposure on a grounded wire circuit is removed.
2. The proof test voltage shall be applied continuously for at least 1 minute, but no more than three (3) minutes.

**Table 14.2. Alternating Current (AC) Proof Test Requirements (Gloves Only).**

<b>Alternating Current (AC) Proof Test Requirements (Gloves Only)</b>					
Class of Equipment	Proof test Voltage rms V	<b>Maximum Proof Test Current, mA</b>			
		267-mm (10.5-in) Glove	356-mm (14-in) Glove	406-mm (16-in) Glove	457-mm (18-in) Glove
0	5,000	8	12	14	16
1	10,000	.....	14	16	18
2	20,000	.....	16	18	20
3	30,000	.....	18	20	22
4	40,000	.....	.....	22	24

**Table 14.3. Glove Test – Water (NOTES:**

<b>Glove Test – Water</b>				
Class of Glove	<b>AC Proof Test</b>		<b>DC Proof Test</b>	
	<b>mm.</b>	<b>In.</b>	<b>mm.</b>	<b>In.</b>
0	38	1.5	38	1.5
1	38	1.5	51	2.0
2	64	2.5	76	3.0
3	89	3.5	102	4.0
4	127	5.0	153	6.0

**Notes:**

1. The water level is given as the clearance from the cuff of the glove to the water line, with a tolerance of + or – 13 mm (+ or – 0.5 in.).
2. If atmosphere conditions make the specified clearances impractical, the clearances may be increased by a maximum of 25 mm (1 in.).

**14.6. Personal Protective Equipment (PPE) Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

- 14.6.1. Do supervisors ensure PPE is provided, used and maintained in a sanitary, serviceable condition? Reference [14.3.2](#)
- 14.6.2. Do supervisors ensure that required PPE job safety training is documented as required by AFI 91-202? Reference [14.3.2](#)
- 14.6.3. Do supervisors advise workers it is mandatory to comply with PPE requirements on-and off-duty? Reference [14.3.3.2](#)
- 14.6.4. Do workers notify their supervisors if they have a known medical condition or are taking medications that could affect their ability to safely perform a hazardous task or operation? Reference [14.3.3.5](#)
- 14.6.5. Are workers provided appropriate eye or face protection when exposed to hazards from flying particles, molten metal, liquid chemicals, corrosives, caustics, chemical gases, vapors or potentially injurious radiation? Reference [14.4.2](#)
- 14.6.6. Do management, supervisors and visitors wear appropriate PPE while within a hazardous area? Reference [14.4.2](#)
- 14.6.7. Are protective helmets provided for and used by workers exposed to injury from falling or flying objects, bumping head against a fixed object or electrical shock or burns? Reference [14.4.3](#)
- 14.6.8. Do protective helmets have the manufacturer's name, ANSI designation and the class identified inside the shell? Reference [14.4.3.1.3](#)
- 14.6.9. Do workers who work around chains, belts, rotating devices, suction devices, blowers, etc., cover their hair to prevent it being caught in machinery? Reference [14.4.3.4.1](#)
- 14.6.10. Is specifically designed hearing protection provided to workers who need it IAW AFOOSH Standard 48-20? Reference [14.4.4](#)
- 14.6.11. Is BE contacted for advice on the proper respirator protection to use prior to exposing personnel to a potentially hazardous atmosphere? Reference [14.4.5](#)
- 14.6.12. Is appropriate hand or arm protection provided when a worker's hands or arms are exposed to hazards? Reference [14.4.7](#)
- 14.6.13. Are chemical protective gloves worn by personnel handling acids, alkalis, organic solvents and other harmful chemicals? Reference [14.4.7.2](#)
- 14.6.14. Are workers able to remove gloves without causing skin contamination? Reference [14.4.7.2.4](#)
- 14.6.15. Is contaminated PPE that cannot be decontaminated disposed of in a manner that protects employees from exposure to hazards? Reference [14.4.7.2.5](#)
- 14.6.16. Is protective footwear provided and worn when there is a reasonable possibility of foot injuries? Reference [14.4.10](#)
- 14.6.17. Are other protective methods, such as engineering or administrative controls, used to limit worker contact with hazardous chemicals before considering PPE use? Reference [14.4.11](#)

14.6.18. Do supervisors select chemical protective clothing based on the performance characteristics relative to tasks performed, conditions present, duration of use and potential hazards identified? Reference [14.4.11.1](#)

14.6.19. Do supervisors review MSDS requirements, then verify proper selection of chemical protective clothing with BE before original issue? Reference [14.4.11.1](#)

14.6.20. Do personnel exposed to vehicle or aircraft traffic during hours of darkness or periods of reduced visibility, or as part of construction or maintenance activities, use reflective vests/accessories? Reference [14.5.10.2](#)

14.6.21. Do supervisors ensure proper cold weather clothing is provided and used for working in cold temperatures? Reference [14.5.12](#)

## Chapter 15

### GROUNDS, LAWN CARE AND MOWING SAFETY

#### 15.1. General Information.

##### 15.1.1. Hazards.

15.1.1.1. Foot Protection. Workers shall wear safety-toe shoes or metal toe-guards when operating powered push mowers or edgers. Safety-toe shoes or metal toe-guards are optional when using mowers equipped with an installed rear drag plate or edgers with nylon filament line cutters (and requirements of paragraph 15.2.1 are followed). However, workers shall wear shoes of sturdy construction. Open-toed sandals, tennis shoes constructed of cloth or canvas, etc., are not authorized for wear during mowing tasks.

15.1.1.2. Eye Protection. Use suitable eye protection (safety glasses, goggles, face shields or a combination) when operating powered edgers or weed eaters. Appropriate eye protection shall be worn when mower operators are exposed to flying rocks, dirt or other hazards.

15.1.1.3. Hearing Protection. Portable powered landscaping equipment usually has high-speed cutting edges and produces high noise levels. Workers shall wear hearing protection while working with or near operating hazardous noise producing equipment. Refer to paragraph 3.1.2.11 for guidance.

15.1.1.4. Other. Workers may need gloves when using walk-behind mowers. In addition, they shall wear hard hats (e.g., IAW ANSI Z89.1, Type II helmets) when using a riding or towed mower around tall brush, low hanging tree limbs or other overhead hazards. Guard all mower discharge chutes with shields or approved grass catchers to deflect or stop foreign objects being thrown and to prevent operator contact with the blade. Place a legible safety message indicating “CAUTION,” “WARNING” or “DANGER — DO NOT USE WITHOUT GUARD OR GRASS CATCHER IN PLACE” on or near the mower’s discharge opening. **Note:** Push and self-propelled mowers manufactured IAW ANSI B71.1., *Outdoor Power Equipment – Walk-Behind Mowers and Ride-On Machines with Mowers — Safety Specifications*, requirements are equipped with a rear protective guard.

15.1.1.5. PPE, when required, shall be selected to protect against the identified or potential hazard. Refer to Chapter 3, *Physical Hazards*, and Chapter 14, *Personal Protective Equipment (PPE)*, for additional guidance. Contact the installation Ground Safety office or BE for further assistance.

15.1.1.6. Training. Supervisors shall ensure workers are trained on equipment to be operated using manufacturer’s instructions or JSA prior to operation of equipment. Supervisors will provide such instruction at time of initial assignment and refresher training, as needed. All training shall be documented.



15.1.1.7. Inspection/Maintenance. The operator will inspect the equipment prior to initial setup and prior to use. Inspection will include all manufacturer's required and recommended inspection items to include as a minimum:

15.1.1.7.1. Tire pressure and condition; fuel, oil coolant levels and lubrication.

15.1.1.7.2. The operator will also ensure machine guards are properly installed and functioning.

15.1.1.7.3. Immediately upon starting the equipment, braking devices will be checked to ensure proper functioning.

15.1.1.7.4. Operators may perform minor maintenance required to ensure safe operation of the equipment.

15.1.2. Requirements. All personnel shall observe all safety precautions in this chapter and those recommended by the manufacturers of the equipment. Always read the owner's manual before operating the equipment. Refer to 29 CFR 1910.243. *Guarding of Portable Powered Tools*, and ANSI B71.1, for further guidance on the operation and maintenance of powered lawn equipment.

## 15.2. Landscape and Grounds Maintenance.

15.2.1. Mowing. Maintenance of installation grounds involves various sizes and types of lawnmowers. The two basic mower types are reel (several helical blades rotating around a horizontal shaft, [Figure 15.1](#)) and rotary (one or more knife like blades attached to a vertical shaft, [Figure 15.2](#)). They may be pushed, self-propelled, ridden or towed. The most significant dangers with mowers are being struck by the blade or a foreign object thrown by contact with blades and noise-induced hearing loss. **Note 1:** Ensure electric mowers, trimmers and attached extension cords are effectively grounded. However, listed or labeled portable tools protected by an approved system of double insulation, or its equivalent, need not be grounded. **Note 2:** Never use electric mowers and grass trimmers while it is raining or the grass is wet, excluding light dew.

**Figure 15.1. Reel Mower.**



**Figure 15.2. Rotary Mower.**



### 15.2.2. Powered Push Mowers.

15.2.2.1. Powered Mowers — Walk-Behind, Riding-Rotary, Converted Sulky and Reel Power Lawnmowers. These mowers shall meet design specifications in 29 CFR 1910.243., *Guarding of Portable Powered Tools*, and ANSI B71.1. For example: Deadman controls shall automatically interrupt power to a drive when the operator's actuating force is removed, and may operate in any direction to disengage the drive.

15.2.2.2. Follow manufacturer's requirements during vertical or horizontal mowing of grades with riding or towed mowers.

15.2.2.2.1. Prior to mowing, operators shall clear the area of all people and inspect for foreign objects, raised sprinkler heads, holes, soft ground, obstructions or any other condition that could impact the safety of the operation.

15.2.2.2.2. Operators shall never pull the mower backwards while the engine is running because the safety guard on the back may lift the mower off the ground and injure the operator.

15.2.2.2.3. Always mow in a horizontal direction across the face of a steep slope, e.g., hills or banks exceeding a 30-degree angle, and keep firm footing at all times.

15.2.2.2.4. Stay clear of the front of self-propelled mowers during and after starting. Control the mower by hand pressure on the handle, not by foot pressure on the housing.

15.2.2.2.5. Do not attempt to clean grass from the chute when the mower is running. Disconnect the spark plug lead connection, or if electrical, the power, when cleaning, repairing or inspecting the mower.

15.2.2.2.6. Do not leave the mower running unattended.

15.2.2.2.7. Edgers. Check to make sure the guard is in place. Never use the edger when people are in line with the blade. Use proper PPE. Always disconnect power when inspecting or repairing the edger.

### 15.2.3. Commercial Mowing and Turf Care Equipment.

15.2.3.1. Commercial mowing and turf care equipment (**Figures 15.3 – 15.5**) is used for mowing and maintaining areas too large or rough for residential type mowing equipment, but not large enough to warrant an agricultural tractor mower (described in paragraph **15.2.4**). Commercial mowing equipment shall meet requirements in ANSI B71.4., *Safety Specifications for Commercial, Turf Care Equipment*. As with residential mowers, operators shall read the owner's manual before operating the equipment.

**Figure 15.3. Commercial Reel Mower.**



**Figure 15.4. Commercial Rotary Mower.**



**Figure 15.5. Commercial Zero Turn Radius (ZTR) Rotary Mower.**



15.2.3.2. If commercial mowers are used in areas where they can exceed the maximum slope allowed by the manufacturer, a rollover protective structure (ROPS) and seatbelt shall be installed on the mower and used whenever the vehicle is in motion.

15.2.3.3. While operating gang reel mowers on a slope, raise the upper reels as a counterbalance to prevent the mower from sliding or turning over. Ensure special equipment designed for steep hills or grades is available or workers can cut by hand using manual tools.

15.2.4. Tractor Operations. **Chapter 26**, *Agricultural Tractors and Implement Attachments*, provides guidance on agricultural tractors. An agricultural tractor (**Figures 15.6 – 15.8**) is a two or four wheel drive or tracked vehicle of 20 or more horsepower designed to furnish the power to pull, carry, propel or drive implements designed for agriculture. (**Note:** While some commercial mowing equipment may exceed 20 horsepower, they are not designed as tractors and fall under guidance in paragraph **15.2.4**). Also refer to 29 CFR 1926.1002., *Protective Frames (ROPS) for Wheel-Type Agricultural and Industrial Tractors Used in Construction*, for additional guidance on agricultural tractors used for landscape maintenance. These tractors shall have ROPS and seatbelts installed and used whenever the vehicle is in motion and shall pass field upset tests (side and rear) specified in 29 CFR 1926.1002, which shall be indicated by a manufacturer's label permanently attached to the ROPS.

15.2.4.1. When pulling a load, operators will hitch only to the draw bar. The draw bar hitch shall be kept between 13 and 17 inches off the ground.

15.2.4.2. When moving a front load, the load shall be kept low to the ground and the rear wheels as level as possible.

15.2.4.3. Operators shall avoid holes and obstacles both on the ground and overhead. Speed shall be reduced with heavy loads when vision is limited or when operating on rough terrain.

15.2.4.4. When stuck, operators shall try carefully to back out. Increasing engine speed or fastening a post to the rear wheels greatly increases the chances of tipping over backward; therefore, these methods shall not be used. Operators shall get help, if required.

15.2.4.5. When traveling on highways, operators shall abide by local traffic rules, avoid travel during heavy traffic periods and check brakes for equal application for highway use. Lighting and markings required by local and state vehicle codes shall be used. Slow-moving vehicle emblems shall be used IAW 29 CFR 1910.145(d)(10).

15.2.4.6. Grass shall not be mowed with a tractor on slopes greater than a 4-inch rise or drop per foot of travel. Lower gears shall be used when going downhill and the wheels shall be allowed to control the tractor speed.

15.2.4.7. Sickle-bar mower (**Figure 15.9**) blades shall be positioned high side. They shall be positioned on the high side of the slope so the pull of gravity will not cause the tractor to turn over.

15.2.4.8. The engine shall be shut off before the operator dismounts from the tractor or makes adjustments to either the tractor or towed equipment.

15.2.4.9. Riders shall not be allowed on tractors, the draw bar or towed equipment, except where the equipment is specifically designed to allow riders or passengers.

15.2.4.10. Fenders are guards for the worker's protection. Fenders shall be kept in place at all times.

15.2.4.11. Tractors shall only be left on an incline after the engine has been turned off, gear shift has been placed in the park position (or the lowest gear if standard transmission), and the wheels have been braked and blocked. Where possible, tractors shall be parked on level ground.

15.2.4.12. The power take-off guard shall always be in place.

15.2.4.13. An operator shall dismount or mount a tractor only when it is stopped. The steps and platform shall be kept clean of debris.

15.2.4.14. Hearing protection and safety-toe shoes shall be worn by the operator, when required. Hard hats shall be worn when operating in an overhead hazard area. BE shall be consulted to determine the need for respiratory protection.

**Figure 15.6. Agricultural Tractor, Two Wheel Drive.**



**Figure 15.7. Agricultural Tractor, Four Wheel Drive.**



**Figure 15.8. Agricultural Tractor, Tracked.**



**Figure 15.9. Agricultural Tractor Sickle Bar Mower, Mounts to Tractor Three Point Hitch.**



#### 15.2.5. General Rules for Maintaining Lawn Care Equipment.

15.2.5.1. Always refuel with the engine off and allow the engine to cool first. Do not permit smoking in the area. Refuel mowers prior to use instead of refueling before storing inside a building. Complete refueling outside at least 25 feet away from the building and any open flame source.

15.2.5.2. Use boards or ramps to load and unload mowers from vehicles.

15.2.5.3. Ensure the engine is off and the spark plug wire is disconnected. Always shut off the fuel supply line when parking mowers inside or outside at the end of the duty day. As storage space permits, leave 1 to 3 feet separation space between parked gasoline-operated riding mowers.

15.2.5.4. Clean mowers or perform other maintenance on mowers only after turning the engine off and disconnecting the spark plug wire.

15.2.5.5. Follow manufacturer's guidelines for operation and use of mowers, tractors and other lawn care equipment.

15.2.5.6. Batteries. See guidance in [Chapter 31, Batteries – Maintenance, Handling and Storage Requirements](#).

### 15.3. Tree and Hedge Trimming.

15.3.1. If these services are performed in-house, supervisors shall have trained/certified workers that are proficient IAW the AFOSH Standards, AFIs, OSHA Standards, ANSI, etc., for the task at hand. Depending on the task and the JSA, training could entail climbing, working from a high reach lift, proper tree cutting/trimming techniques and procedures/requirements for working around electrical lines. Workers shall be trained for emergency conditions, such as adverse weather. All workers shall receive training in emergency rescue and life saving first aid techniques, and fall protection/prevention. All training shall be documented. Refer to paragraph **15.3.5** and 29 CFR 1910.269. for additional guidance.

15.3.2. Two or more workers and an on-site job supervisor, fully qualified in tree maintenance, shall be assigned when tree maintenance involves climbing, working from a high reach lift and while cutting down any tree other than small low trees that would pose no hazards to people, facilities and utility lines. The area around trees being trimmed or cut and in the vicinity of operating chippers and stump grinders shall be effectively marked with cones, streamers or barricades and controlled to warn personnel against the danger of entry.

15.3.3. Fall Protection. Fall protection equipment, ropes, D-rings, cutting tools, equipment and climbing gear shall be inspected to ensure it is in safe condition prior to each use. Any equipment or climbing gear that is frayed, worn, broken or defective shall be removed from service immediately. Each climber shall have at least one lifeline and one handline, normally nylon, 1/2 inch by 125 feet. At least 2 – 3/4 inch polypropylene or equivalent lines (250 feet long each) shall be provided for each crew. The nominal breaking strength of 1/2 inch ropes used for climbing shall not be less than 2,385 pounds. Climbing and safety ropes shall not be spliced for repair or added length. The ends of ropes shall be wrapped to prevent fraying. A climbing rope shall always be used, even when work is performed from a ladder or lift device. Refer to **Chapter 13, Fall Protection**, for additional fall protection requirements.

15.3.4. Personal Protective Equipment (PPE). Workers involved in tree maintenance shall wear hard hats, gauntlet gloves, eye protection and high-top safety boots when operating power saws or equipment. Hearing protection shall be worn where hazardous noise level sources, such as power chain saws, chippers and stump grinders, are operating. Ballistic nylon patch leg coverings shall be used while operating power saws. Clothing for tree-climbing operations shall be long sleeve shirts, pants and clothing that are not baggy or loose.

15.3.5. Supervisors shall complete (and have available for use) a JSA for both routine and emergency tree maintenance operations. Critical elements with serious potential to affect workers' safety, such as tree climbing, tree cutting and removal, trimming near electrical lines, use of chain saws, use of high-reach lifts and use of cutters or chipper equipment, shall be included.

#### **15.4. Fertilizers, Herbicides and Insecticides.**

15.4.1. Fertilizers can become a combustible material and may explode if stored at temperatures over 130° F. When fertilizers become wet and start to decompose, they give off gas that will burn. Some fertilizers also give off toxic gases when burning. When fertilizer has started to burn, a large quantity of water shall be applied to the burning surface to extinguish the flame and cool the rest of the fertilizer. The installation Fire Emergency Services (FES) Flight shall be notified of any evidence of heating, smoking, combustion or fire in fertilizer. No more than 60 tons of fertilizer (mixtures containing 60 percent or more

by weight or ammonium nitrate) shall be stored in a location unless the location and storage facility have been approved by the FES Flight.

15.4.2. When spreading fertilizer, pellets shall not be directed toward other people. If personnel enter the area, the spreader shall be turned off. Fertilizer spreaders shall be cleaned and lubricated daily. Safety glasses and gloves shall be worn during fertilizing spreading operations.

15.4.3. Herbicides and Insecticides. The use of herbicides/insecticides for weed/insect control poses a significant potential safety and health hazard. Herbicides and insecticides shall be applied per manufacturer's instructions and used only by certified personnel. Due to absorptive properties of herbicides/insecticides, ensure appropriate PPE is worn as determined by BE's OEH risk assessment. Refer to paragraph 2.4 and [Chapter 14](#) for additional guidance.

## 15.5. Irrigation Systems.

15.5.1. Trenching and Shoring. The walls and faces of irrigation system excavations and trenches over five (5) feet in depth, where workers may be exposed to danger of a cave-in, shall be guarded by a shoring system, sloping and benching system, or other equivalent means consistent with 29 CFR 1926, *Subpart P – Excavations*. Trenches less than 5-feet deep with hazardous soil conditions (determined by a competent person) shall also be protected. Refer to paragraph 25.9 and 29 CFR 1926, *Subpart P – Excavations: 1926.650., Scope, Application and Definitions Applicable to Subpart P, 1926.651., Specific Excavation Requirements, 1926.652., Requirements for Protective Systems*, for additional guidance.

15.5.2. Confined Spaces. Irrigation systems located in pits shall be evaluated by the installation CSPT IAW [Chapter 23](#), *Confined Spaces*. Potential hazards that may exist in irrigation pits include gases, low oxygen levels, high water levels and in some cases, high water pressure. Before entering an irrigation pit, oxygen and combustible gas levels shall be tested. Potential cracks, leaks and weak pipes may pose hazards. Upon finding any of these conditions, the pit shall be ventilated and worn or broken parts replaced before use of the pit is permitted. Before commencing repair work, the worker shall ensure water and electrical power have been turned off.

**15.6. Grounds, Lawn Care and Mowing Safety Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

15.6.1. Are all mower discharge chutes guarded with shields or approved grass catchers and appropriate safety messages placed near the discharge opening? Reference [15.1.1.4](#)

15.6.2. Is training of all equipment operators documented? Reference [15.1.1.6](#)

15.6.3. Are operators aware of special precautions to be used when mowing hills or slopes? Reference [15.2.2.2.3](#)

15.6.4. Are slow moving vehicle emblems used when tractors are operated on highways? Reference [15.2.4.5](#)



- 15.6.5. When using sickle-bar blades, do personnel always position them uphill? Reference [15.2.4.7](#)
- 15.6.6. Are riders prohibited on tractors, the draw bar or towed equipment except when specifically designed for such use? Reference [15.2.4.9](#)
- 15.6.7. Are tractors left on inclines braked and blocked? Reference [15.2.4.11](#)
- 15.6.8. Is the power take-off guard in place? Reference [15.2.4.12](#)
- 15.6.9. Are a minimum of two (2) workers and an on-site supervisor assigned during tree maintenance involving climbing, working from high reach lift and cutting down trees other than small, low trees? Reference [15.3.2](#)
- 15.6.10. Are all safety related fall protection and climbing devices inspected prior to use? Reference [15.3.3](#)
- 15.6.11. Does each climber have at least one lifeline and one handline? Reference [15.3.3](#)
- 15.6.12. Is required PPE provided and in use by all workers involved in tree maintenance? Reference [15.3.4](#)
- 15.6.13. Have supervisors performed a JSA and developed local OIs for tree maintenance operations? Reference [15.3.5](#)
- 15.6.14. Are herbicides applied per manufacturer's instructions and used only by certified personnel? Reference [15.4.3](#)
- 15.6.15. Is required PPE used by personnel applying herbicides? Reference [15.4.3](#)
- 15.6.16. Are oxygen and combustible gas levels tested prior to entry to an irrigation pit? Reference [15.5.2](#)

## Chapter 16

### MOBILE ELEVATING WORK PLATFORMS

**16.1. General Information.** This chapter applies to vehicle-mounted elevating and rotating platforms, including work platforms, fire fighting aerial devices and aircraft maintenance equipment used for elevating workers. It also applies to all manually-propelled and self-propelled mobile work platforms (including ladder stands) and rolling (mobile) scaffolds (towers). In some cases, the Air Force changes the design of commercially purchased mobile work platforms and scaffolds or builds this equipment; therefore, this chapter includes essential information on loads, rules and requirements for design, construction and use of mobile work platforms and scaffolds. Also refer to 29 CFR 1910.28., *Safety Requirements for Scaffolding*.

#### 16.2. Hazards.

16.2.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on the JSA and job safety lesson plan. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process. Examples are TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. Refer to AFI 91-202, Attachment 5, *Job Safety Training Outline (JSTO)*, for additional guidance and information.

16.2.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

16.2.3. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of industrial work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph **2.4** for additional information.

**16.3. General Requirements.** The potential for worker injury, death and property damage is reduced by proper platform and scaffold (tower) design, thorough operator training and inspections, good equipment maintenance and supervisor enforcement of safe work practices. Supervisors shall ensure workers are physically capable of work at high elevations. Workers, too, must be alert to signs or symptoms from co-workers such as decreased performance, change in attitude and/or physical changes, etc., which could lead to a mishap.

#### 16.4. Vehicle-Mounted Elevating and Rotating Work Platforms.

16.4.1. Procurement. Commercial aerial devices procured for Air Force fire fighting purposes shall conform to NFPA 1901, *Standard for Automotive Fire Apparatus*. All other aerial devices, either commercially procured or constructed by the Air Force for mission specific needs, shall conform to ANSI A92.2., *Vehicle Mounted Elevating and Rotating Aerial Devices*.

16.4.2. Modifications. Modifications shall conform to ANSI A92.2. and 29 CFR 1910.67., *Vehicle-Mounted Elevating and Rotating Work Platforms*, and shall be documented on the appropriate form. Authorized modifications include temporary removal of installed equipment not needed for a particular mission or modification to provide a new or improved

capability. **Warning:** Any modification which removes or defeats any safety device or feature on an aerial device is prohibited.

#### 16.4.3. Clearances.

16.4.3.1. Electrical. Maintain the following clearances when operating aerial lifts under, over, by or near electric power lines.

16.4.3.1.1. For lines rated 50 kilovolts (kV) or less, the minimum clearance between lines and any part of the aerial lift shall be at least 10 feet (305 centimeter [cm]).

16.4.3.1.2. For lines rated over 50 kV, the minimum clearance between lines and any part of the aerial lift shall be at least 10 feet (305 cm) plus 4 inches (10 cm) for each kilovolt over 50 kV, or twice the length of the line insulator, but never less than 10 feet (305 cm).

16.4.3.2. **Exceptions:** Requirements in paragraph **16.4.3** do not apply if:

16.4.3.2.1. The aerial device is insulated for the work and work is performed by trained communications outside plant workers, line clearance tree-trimming workers or exterior electric linemen.

16.4.3.2.2. Electric power transmission or distribution lines have been de-energized and visibly grounded at point of work or where insulating barriers (not part of or attached to the aerial lift) have been erected to prevent physical contact with the lines.

16.4.3.2.3. Insulating barriers (rated for the voltage of lines being guarded and not part of or attached to the vehicle or its raised structure) are installed to prevent contact with lines. In this instance, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier. Refer to UFC 3-560-01, *Electrical Safety, O & M*, for additional information.

16.4.3.2.4. Aerial lift is insulated for voltage involved and work is performed by a qualified person. In this instance, the clearance between non-insulated parts of the aerial lift and power line may be reduced to the distance in UFC 3-560-01, *Electrical Safety, O & M*, Table 10-9.

16.4.3.2.5. An aerial lift or equipment contacts an electrical conductor. In this instance, the vehicle, equipment and attachments shall be considered energized. Personnel standing on the ground shall not contact any part of the lift unless using protective equipment rated for the voltage. Refer to **Chapter 30**, *Communications Cable, Antenna and Communications Systems*, for additional information.

16.4.3.3. Aircraft. When operating aerial lifts under, over, by or near aircraft, ensure adequate clearance is maintained to allow for slight movement of both the aircraft and aerial equipment caused by light winds. See paragraph **16.4.6.9**.

16.4.4. Proximity Warning Devices. Proximity warning devices may be installed on aerial platforms but will not release the operator from assuring safe clearance IAW paragraph **16.4.3** Proximity warning devices are required on aerial platforms being used for aircraft maintenance.

16.4.5. Inspection and Test Procedures.

16.4.5.1. Aerial ladders shall be inspected and tested annually or immediately following any activity when it is known, or suspected, to have been loaded beyond its maximum load capacity, or immediately following any repair of any ladder assembly structural or mechanical component. Refer to NFPA 1914, *Standard for Testing Fire Department Aerial Devices*, for inspection requirements. Inspections are the joint responsibility of the principal operator and vehicle mechanic qualified to perform annual inspections. Document inspections and tests IAW AFI 23-302, *Vehicle Management*. **Note:** Aerial devices used for firefighting shall be inspected and tested at least annually IAW NFPA 1914. Qualified Fire Emergency Services (FES) Flight personnel may perform many of the tests and inspection actions; however, it is recommended they be performed by a third-party testing company or the aerial device manufacturer. A record of the inspection and tests shall be documented IAW AFI 23-302.

16.4.5.2. Articulating and extendible boom platforms shall be inspected and tested annually. Special inspections and tests shall be conducted immediately following any use where the work platform may have been loaded beyond the manufacturer's rated capacity, or immediately following any repair of a boom or work platform assembly structural or mechanical component. Refer to ANSI A92.2. for inspection requirements. Inspections shall be a joint effort by the principal operator and a vehicle mechanic qualified to perform annual inspections of the vehicle. The inspection and test shall be documented IAW AFI 23-302. When the personnel platform is attached to a telescoping derrick or crane with a rated capacity higher than that of the work platform, test procedures contained herein shall not apply and testing shall be accomplished IAW applicable technical orders (TOs) or manufacturer's maintenance manual.

16.4.5.3. Refer to 29 CFR 1926.1400., *Cranes and Derricks in Construction*, for information on use of cranes or derricks to hoist personnel work platforms.

#### 16.4.6. Operations.

16.4.6.1. ANSI A92.2. requires aerial device manufacturers provide manuals to dealers and direct sale purchasers. Air Force users shall ensure manuals are readily available (stored in weather resistant compartment provided by manufacturer) to workers. These manuals shall contain:

16.4.6.1.1. Description, specifications and ratings of the aerial device.

16.4.6.1.2. Operating instructions for aerial device and its auxiliary systems.

16.4.6.1.3. Precautions relating to multiple configurations such as performing aerial work from a moving vehicle.

16.4.6.1.4. Instructions regarding routine maintenance and frequency of recommended maintenance.

16.4.6.1.5. Replacement part information.

16.4.6.1.6. Instruction markings per paragraph **16.4.6.2**.

16.4.6.2. Each aerial device shall have a clearly visible plate or plates (located in a readily accessible area) stating:

- 16.4.6.2.1. Make, model and manufacturer's serial number.
- 16.4.6.2.2. Rated capacity.
- 16.4.6.2.3. Platform height.
- 16.4.6.2.4. Maximum recommended operating pressures of hydraulic and/or pneumatic systems.
- 16.4.6.2.5. Hazards inherent in operation of an aerial device.
- 16.4.6.2.6. Manufacturer's marking which describes the function of each control.
- 16.4.6.2.7. Insulated or non-insulated. **Note:** Insulating aerial devices do not protect personnel from phase to phase or phase to ground contacts at the platform end.
- 16.4.6.2.8. Qualification voltage and date of test, if applicable.
- 16.4.6.2.9. Year of manufacture.
- 16.4.6.2.10. Number of platforms.
- 16.4.6.2.11. Category of aerial device.
- 16.4.6.2.12. Manufacturer's rated line voltage. Where alternative configurations are possible, the plate will show by chart, schematic or scale the capacities of all combinations in their operating positions and cautions or restrictions, or both, for operation of all alternate or combinations of alternate configurations. These plates shall not be removed from the device, painted over or otherwise made unavailable for reference by the operator. **Note:** If an aerial device does not have a plate attached, contact the manufacturer and do not use the aerial lift until the plate is received. This plate shall not be removed or painted over.

16.4.6.3. Workers required to use vehicle-mounted elevating and rotating work platforms shall be thoroughly trained in all aspects of the job before using this equipment. This shall include "hands-on-training" prior to actual "on-the-job" training tasks. Completion of operator training and specific qualification shall be documented in individual's training records (MIMICs, MIS or other data retrieval system). Reference **Attachment 2, Minimum Mandatory Requirements for Aerial Lift Training and Training Plans**. **Note:** While these requirements relate to aerial lifts, a similar level of detail is required when developing training plans and training personnel on other powered or potentially hazardous equipment.

16.4.6.4. Before a mobile unit is moved for travel, the aerial device shall be secured in the specified lower traveling position (to prevent rotation) by the use of cradles or locking devices IAW manufacturer's instructions.

16.4.6.5. The unit shall be visually inspected and lift controls tested prior to each shift or day's work to determine the unit and controls are in safe working condition. The override feature explained in paragraph **16.4.6.6** shall be tested at this time. IAW ANSI A92.2., a record of this test shall only be documented if a discrepancy was found with the unit during the inspection.

16.4.6.6. Articulating and extendible boom platforms, primarily designed as personnel carriers, shall have both platform (upper) and lower controls. Upper controls shall be in

or beside the platform within easy reach of the operator. In order to prevent inadvertent actuation of the platform boom positioning controls, operation of an unlocking device shall precede use of the control itself and shall be maintained simultaneously during use of the controls. The unlocking device may be incorporated into each control. Lower controls shall override upper controls. Controls shall be plainly marked with their function. The override mode shall prevent boom movement with the lower control station unattended. Lower level controls shall not be operated without permission from the employee in the lift, except in an emergency. Whenever a worker is in or on an elevated work platform, at least one person qualified to operate the equipment shall be stationed near the lower level control panel.

16.4.6.6.1. Emergency Stop. The platform shall have an emergency stop control which will stop all platform movement. This control shall not require continuous operator actuation to stop movement.

16.4.6.6.2. Outrigger Controls. Aerial device outrigger controls shall be guarded to protect against inadvertent operation, and shall return to neutral when released by the operator. These controls shall be located so the operator can see the outrigger being operated.

16.4.6.7. Boom and basket load limits specified by the manufacturer shall not be exceeded.

16.4.6.8. Aerial lift trucks shall not be moved with the boom elevated and personnel in the basket unless the lift truck is specifically designed for such operation. In all cases, the manufacturer's operating instructions shall be followed.

16.4.6.9. Vehicle-mounted elevating and rotating work platforms shall not be used during high winds, thunderstorms or any other adverse or mission-limiting weather conditions which could endanger workers using the platform. Refer to the operator's manual or applicable TO for specified wind limits.

16.4.6.10. Platforms other than buckets or baskets shall include a guardrail system which shall:

16.4.6.10.1. Include a top rail, 42 inches high, and at least one rail midway between top rail and platform surface around its upper periphery. Both rails shall withstand 300 pounds of force applied in any direction. Refer to applicable ANSI standards for additional information.

16.4.6.10.2. Include toeboards on all sides of platforms. Where there is exposure to personnel or electrical wires below the platform, removable toeboards or the equivalent shall be provided. The minimum toeboard height shall be four (4) inches.

16.4.6.10.3. Include access for personnel entering the platform in the lowered position. Access steps or rungs shall have a slip-resistant surface.

16.4.6.11. A full body harness and lanyard (sized to limit free fall distance to six (6) feet or less, or the free fall distance permitted by the system, whichever is less) shall be worn by each bucket or platform occupant. Each lanyard shall be attached to a designated

anchor point on the boom or basket. Refer to 29 CFR 1910.66., *Personal Fall Arrest System, Appendix C (d)(1)(iv)*.

16.4.6.12. Belting off to an adjacent pole, structure or equipment while working from an aerial lift shall not be permitted.

16.4.6.13. Workers shall stand firmly on the basket floor, not sit or climb on edge of basket or use planks, ladders or other devices for a work position.

16.4.6.14. Climber's equipment shall not be worn while performing work from an aerial lift.

16.4.6.15. Aerial devices, including insulated aerial devices, shall not be brought into contact with energized or potentially energized conductors. Workers shall not rely on dielectric capabilities of aerial devices.

16.4.6.16. Consult BE prior to work near suspected sources of non-ionizing radiation, i.e., radar and microwave equipment. Refer to **Chapter 30** for additional guidance.

16.4.6.17. Before using an aerial device, the worksite shall be surveyed for hazards, such as un-tamped earth fills, ditches, drop-offs and floor obstructions, debris, overhead obstructions and electrical conductors, weather conditions and presence of unauthorized persons.

16.4.6.18. Before and during each use, the operator shall:

16.4.6.18.1. Check for overhead obstructions and electrical conductors.

16.4.6.18.2. Ensure load weight does not exceed manufacturer's rated capacity.

16.4.6.18.3. Ensure outriggers and stabilizers are used if required by manufacturer's instructions.

16.4.6.18.4. Ensure guardrails are properly installed, including bolts, pins or other locking devices on removable railings and attachments, and that gates are closed.

16.4.6.18.5. Use outrigger pads when necessary to provide firm footing.

16.4.6.18.6. Set brakes.

16.4.6.18.7. Chock wheels before using the lift on an incline.

16.4.7. Maintenance and Repair of Powered and/or Mobile Units:

16.4.7.1. If deficiencies affecting safe operation are discovered during the daily operator inspection (or during use), the equipment shall immediately be removed from service until repaired. The manufacturer's recommended maintenance procedures shall be followed and tests outlined in paragraph **16.4.5** shall be conducted prior to returning an aerial device to service following repairs to the ladder, boom or work platform.

16.4.7.2. All repairs shall be accomplished by qualified personnel.

## **16.5. Manually-Propelled and Self-Propelled Mobile Work Platform and Scaffolds (Towers).**

16.5.1. Work platforms with work levels four (4) feet or higher and accessed by a ladder or stairway at an angle over 60 degrees, shall have guardrails, midrails and toeboards IAW

paragraph **16.4.6.10** on all four (4) sides of the work platform, including work platform access opening.

#### 16.5.2. Working Loads:

16.5.2.1. Work platforms and scaffolds shall carry their designed load under all conditions of use. Aircraft maintenance work platforms shall support design loads listed in their TOs. Parts, additions or accessories for safe use of platforms and scaffolds shall be part of the design.

16.5.2.2. Specific design and construction requirements are not part of this standard due to the wide variety of materials and design possibilities. However, the design used shall produce a mobile ladder stand or scaffold that will safely hold specified loads. Materials selected shall be strong enough to meet test requirements and protected against corrosion and deterioration.

16.5.2.2.1. The design working load of ladder stands shall be calculated based on one or more 250-pound persons with 50 pounds of equipment each.

16.5.2.2.2. Scaffold design work loads shall be calculated based on:

16.5.2.2.2.1. Light - Designed and constructed for a work load of 25 pounds per square foot.

16.5.2.2.2.2. Medium - Designed and constructed for a work load of 50 pounds per square foot.

16.5.2.2.2.3. Heavy - Designed and constructed for a work load of 75 pounds per square foot.

**Note:** Ladder stands and scaffolds shall support at least four (4) times the design work load.

16.5.2.3. Mobile ladder stand and scaffold materials shall meet strength, dimension and weight specifications in this standard to safely support the design work load.

16.5.2.4. Bolts or other fasteners used to assemble ladders, scaffolds and towers shall be large enough and in sufficient quantity at each connection to develop designed strength.

16.5.2.5. The operator shall ensure there are no sharp edges, burrs or other hazards to personnel on exposed surfaces.

#### 16.5.3. Work Levels.

16.5.3.1. Maximum work level height shall not exceed four (4) times the minimum or least base dimension (width) of any mobile ladder stand or scaffold. Where the basic mobile unit does not meet this requirement, suitable outrigger frames shall be used to obtain this least base dimension or the unit shall be tied with guy wires or braced to keep the unit from tipping.

16.5.3.2. The minimum platform work level width for mobile scaffolds (towers) shall not be less than 20 inches. Ladder stands shall have a minimum step width of 16 inches.

16.5.3.3. The supporting structure for the work level shall be rigidly braced, using cross bracing or diagonal bracing with rigid platforms at each work level.



16.5.3.4. Ladder stand steps shall have slip-resistant treads or a slip-resistant coating.

16.5.3.5. The work level platform of scaffolds shall be wood, aluminum, plywood planking, steel or expanded metal, for the scaffold's full width, except for necessary openings. Work platforms shall be secured to the support structure. Planking shall be 2-inch (nominal) scaffold grade minimum 1,500 fiber (f) (stress grade) lumber or equivalent.

16.5.3.6. Scaffold work platforms four (4) feet or higher shall have guardrails, midrails and toeboards IAW paragraph [16.4.6.10](#).

16.5.3.7. Scaffolds shall have a climbing ladder or stairway (for access and egress) affixed or built into the scaffold. The ladder or stairway shall be located so it will not tip the scaffold. A landing platform shall be provided at intervals not exceeding 30 feet.

16.5.3.8. Self-propelled elevating work platforms shall be in the lowered position prior to being moved. Manually-propelled mobile work platforms shall not be moved with personnel on the working platform. Tools and equipment left on the work platform while the unit is moved shall rest securely on the floor of the platform and be protected by a rail and toeboard IAW paragraph [16.4.6.10](#).

16.5.3.9. Full-body harnesses shall be worn with lanyard attached to the structural anchor point when using self-propelled mobile work platforms (if guard rails will be removed) with manufacturer-installed structural anchor points and the platform elevated four (4) feet or more above the surface. Self-propelled work platforms manufactured without an approved structural anchor point shall have protective guardrails, midrails (when required) and toeboards installed on all open sides IAW paragraph [16.5.1](#). When within 14 inches of the work surface, i.e., aircraft and buildings, guardrails need not be in place on the side that is within 14 inches of a working surface. Bolts, pins or other locking devices shall be provided and used on all removable railings and attachments.

16.5.3.10. Personal fall arrest equipment anchorages shall be capable of supporting at least 5,000 pounds (22.2 kilonewton [kN]) per worker attached, or shall be designed, installed, and used as part of a complete personal fall arrest system which maintains a safety factor of two, under the supervision of a qualified person. (See [Chapter 13, Fall Protection](#), and OSHA Standard 29 CFR 1910.66., *Personal Fall Arrest System, Appendix C*.)

16.5.3.11. Lanyards, "D" rings, snap-hooks and all fall arrest system components shall sustain a minimum 5,000 pound tensile load IAW 29 CFR 1910.66., Appendix C.

#### 16.5.4. Operations.

16.5.4.1. Training requirements in paragraph [16.4.6.3](#) also apply to all manually-propelled elevating aerial platforms and self-propelled elevating work platforms.

16.5.4.2. Operators shall know the location of operating and safety manuals, including the manual defining dealer, owner, lessor, lessee, user and operator responsibilities on the aerial platform. Operators shall be familiar with and use these manuals when questions arise.

16.5.4.3. Aerial platforms shall be given a visual inspection and functional test before use each day or at the beginning of each shift including, but not limited to, the following:

- 16.5.4.3.1. Operating and emergency controls.
  - 16.5.4.3.2. Safety devices.
  - 16.5.4.3.3. Personal protective devices, including fall protection.
  - 16.5.4.3.4. Air, hydraulic and fuel system leaks.
  - 16.5.4.3.5. Cables and wiring harness.
  - 16.5.4.3.6. Loose or missing parts.
  - 16.5.4.3.7. Tires and wheels.
  - 16.5.4.3.8. Placards, warnings and control markings.
  - 16.5.4.3.9. Outriggers, stabilizers and other structures.
  - 16.5.4.3.10. Guardrail system, including bolts, pins or other locking devices on all removable railings and attachments.
  - 16.5.4.3.11. Any special items required by the manufacturer.
  - 16.5.4.3.12. Inspection deficiencies shall be documented IAW applicable TO or local procedure for stands not covered by a TO. A visible indicator, i.e., **AF Form 981**, *Out of Order*, or other means shall be affixed to stands removed from service until repaired and returned to service.
- 16.5.4.4. Refer to paragraph **16.4.6.17** for workplace inspection information.
- 16.5.4.5. The operator shall ensure the following before each elevation of the platform:
- 16.5.4.5.1. The aerial platform is operated on a surface within the manufacturer's limits.
  - 16.5.4.5.2. Outriggers, stabilizers, extendable axles or other stability enhancing means are used as required by the manufacturer.
  - 16.5.4.5.3. Guardrails are installed and access gates or openings are closed per manufacturer's instructions, including bolts, pins or other locking devices on all removable railings and attachments.
  - 16.5.4.5.4. The load and its distribution on the platform and any platform extensions do not exceed the manufacturer's rated capacity for the specific configuration.
  - 16.5.4.5.5. There is adequate clearance from overhead obstructions.
  - 16.5.4.5.6. Minimum safe approach distances to energized power lines and parts are maintained.
  - 16.5.4.5.7. The operator and all personnel on the platform wear fall protection devices and other safety gear, as required, at all times.
- 16.5.4.6. Users shall inspect and maintain aerial platforms to ensure proper operation. The frequency of inspection and maintenance shall be based on the manufacturer's recommendations and compatible with operating conditions and severity of the operating environment. Aerial platforms not in safe operating condition shall be immediately

removed from service until repaired. A qualified person shall make repairs IAW manufacturer's recommendations. This periodic inspection shall include those requirements in paragraphs [16.5.4.3](#) and [16.5.4.5](#).

16.5.4.7. Controls for manually elevated platforms shall be clearly marked for direction and function. Controls for platform elevating and lowering mechanisms shall be self-holding and readily accessible from the ground. Controls at the platform are optional.

16.5.4.8. Upper controls of power elevated platforms shall be:

16.5.4.8.1. Clearly marked as to direction and function;

16.5.4.8.2. A type that automatically returns to the off or neutral position when released;

16.5.4.8.3. Protected against inadvertent operation;

16.5.4.8.4. Readily accessible to the operator;

16.5.4.8.5. Designed to include a control that must be continuously activated for upper controls to function and that automatically returns to the off position when released.

16.5.4.9. Aerial platforms with a powered elevating assembly shall have a clearly marked emergency lowering means readily accessible from ground level.

16.5.4.10. The aerial platform shall have a readily identifiable emergency stop device at upper control and lower control stations that will stop powered functions and platform movement.

16.5.4.11. The control system shall be designed so a single control system malfunction will not cause unintended platform movement.

16.5.5. Wheels And Casters:

16.5.5.1. Wheel and casters shall be sized to support four times the design working load.

16.5.5.2. Scaffold casters shall have a positive wheel and (or) swivel lock to prevent movement. Two of the four casters on ladder stands shall swivel and be lockable.

16.5.5.3. Screwjacks or other means for adjusting height shall be provided where leveling of the elevated work platform is required.

16.5.5.4. At least two brakes, wheel locks or permanently installed jacks shall be operable on all mobile work platforms.

16.5.6. Mobile Tubular Welded Frame Scaffolds:

16.5.6.1. Scaffolds shall be designed to comply with paragraphs [16.4.1](#), [16.4.2](#) and [16.4.4](#).

16.5.6.2. Scaffold vertical members shall be properly braced by cross or diagonal braces. Braces shall automatically square and align vertical members so the erected scaffold is always plumb, square and rigid.

16.5.6.3. Spacing of panels or frames shall be consistent with loads imposed. Frames shall be placed one on top the other with coupling or stacking pins to provide vertical alignment of legs.

16.5.6.4. Panels shall be locked together vertically by pins or equivalent if uplift can occur.

16.5.6.5. Scaffold over 50 feet in height shall be erected IAW manufacturer's instructions and under the supervision of a qualified professional engineer. The installation civil engineering activity is the authorizing agency for scaffold erection.

#### 16.5.7. Mobile Tubular Welded Sectional Folding Scaffolds:

16.5.7.1. General. Scaffolds, including sectional stairway and sectional ladder scaffolds, shall be designed and erected IAW paragraphs [16.4.1](#), [16.4.2](#), [16.4.4](#) and [16.5.6.5](#).

16.5.7.2. Stairway. Each section of folding stairway scaffold shall include a stairway, detachable work platform and a set of pivoting and hinged folding diagonal and horizontal braces.

16.5.7.3. Sectional Folding Stairway Scaffolds. These are medium duty scaffolds (light duty when equipped with a "high clearance" base section). **Note:** High clearance bases have a greater open space so the scaffold may be placed over obstructions like machinery or shrubbery. When high clearance bases are used to support sectional folding stairway scaffolds, the entire scaffold's load capacity shall be reduced. Sectional folding stairway scaffolds shall not exceed 4 ½ feet in width and 6 feet in length.

16.5.7.4. Sectional Folding Ladder Scaffolds. Sectional folding ladder scaffolds are light duty scaffolds (includes special base [open end] sections designed for high clearance over obstructions). For special applications, 6-foot folding ladder scaffolds, except high clearance base sections, shall be designed as medium duty scaffolds. A sectional folding ladder scaffold shall not exceed 6 feet 6 inches in width for a 6-foot long unit, 8 feet 6 inches for an 8-foot unit, or 10 feet 6 inches for a 10-foot long unit. End frames of sectional ladder and stairway scaffolds shall be designed so horizontal bearers provide support for multiple planking levels.

#### 16.5.8. Mobile Tube and Coupler Scaffolds:

16.5.8.1. Design. Units shall be designed IAW paragraphs [16.4.1](#), [16.4.2](#) and [16.4.4](#).

16.5.8.2. Material. Couplers shall be made of structural type material, such as drop-forged steel, malleable iron or structural grade aluminum. Use of gray cast iron is prohibited.

16.5.8.3. Erection of Scaffold. Refer to paragraph [16.5.6.5](#).

#### 16.5.9. Mobile Work Platforms:

16.5.9.1. Design. Units shall be designed IAW paragraphs [16.4.1](#), [16.4.2](#) and [16.4.4](#).

16.5.9.2. Base Width. The minimum base width shall conform to paragraph [16.5.3.2](#).

16.5.9.3. Bracing. Rigid diagonal bracing to vertical members shall be provided.

16.5.10. Mobile Ladder Stands:

16.5.10.1. Design. Units shall comply with applicable requirements of paragraphs [16.4.1](#), [16.4.2](#) and [16.4.4](#).

16.5.10.2. Base Width. Minimum base width shall be IAW paragraph [16.5.3.2](#) Maximum base section length shall be the total length of combined steps and top assembly, measured horizontally, plus 5/8 inch per step of rise.

16.5.10.3. Steps. Steps shall be uniformly spaced, with a rise of 9 inches to 10 inches, and a depth of at least 7 inches. Slope of the steps section shall be 55 to 60 degrees, measured from the horizontal.

16.5.10.4. Handrails. Units with more than 4 steps or 60 inches vertical height to the top step shall be equipped with handrails. Handrails shall be at least 29 inches high and the same height all along the step, measured vertically from the center of the step.

16.5.10.5. Load design shall meet requirements of paragraph [16.5.2.2.1](#).

16.5.11. Mobile Work Platforms and Ladder Stands shall:

16.5.11.1. Meet criteria in paragraphs [16.5.9](#) and [16.5.10](#). If these mobile work platforms have steps, they shall meet mobile ladder stand criteria for step dimensions and handrails.

16.5.11.2. Be maintained free of grease, oil, ice, snow, mud or any other slippery substance or object which could cause slips and falls. Step treads and walking surfaces shall be in good repair. Repair worn surfaces with suitable materials or make safe using abrasive or non-slip materials.

16.5.11.3. Removable guardrails may be used on all open sides of aircraft maintenance platforms. Guardrails removed for material handling shall be replaced as soon as material handling is complete. Protective guardrails are not required at the platform entrance if there is a ramp or stairway (angle less than 60 degrees) IAW paragraph [16.5.1](#). Protective guardrails shall only be removed from the side(s) of the platform positioned as close as practical (less than 14 inches) and parallel to aircraft, building or other working surface. Guardrails shall be installed on all open sides if platform levels are four (4) feet or higher above ground or floor. Bolts, pins or other locking devices shall be provided and used on all removable railings and attachments. Only guardrails and toeboards meeting criteria in paragraph [16.4.6.10](#) shall be used.

16.5.11.4. Prior to any user ascending a raised mobile platform: all locking devices (i.e., pins, collars, etc.) shall be installed, hydraulic pressure shall be released, the platform shall be slowly lowered until locking devices are securely engaged and hydraulic pressure valve(s) shall be closed. If the raisable portion of the platform cannot be elevated from ground level, the user may ascend to that platform portion and adjust platform height. However, requirements for locking devices, pressure release and closing valves shall be met prior to starting any task or work.

16.5.11.4.1. Ascending/descending work platform. The climbing apparatus shall be considered a ladder if it does not meet step dimension criteria in paragraph [16.5.10.3](#) and/or the angle of the apparatus is greater than 60 degrees from horizontal. Personnel ascending/descending ladders shall face the ladder and maintain a firm hold on the

ladder. Personnel ascending/descending stairs (less than or equal to 60 degrees) shall face the direction of travel and use hand rails as depicted in [Figure 16.1](#).

16.5.11.4.2. Refer to [Chapter 7](#), *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Stairs, and Portable and Fixed Ladders*, for additional guidance on ladder safety.

16.5.11.5. Mark mobile work platforms with reflective materials to the maximum extent authorized by appropriate TOs, such as 35-1-3, *Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE)*. When not being transported, mobile work platforms shall be secured to prevent collision with aircraft, vehicles or other equipment. Designated flight line storage areas for mobile work platforms shall be approved by installation Ground Safety office. Refer to [Chapter 24](#), *Aircraft Flight Line -Ground Operations and Activities*, for further guidance.

16.5.11.6. Mobile work platforms shall be inspected by the user daily, before use. IAW ANSI A92.2., a record of this test shall only be documented if a discrepancy was found with the unit during the inspection. This inspection shall include: brakes, jacks, wheel locks, securing cables, locking pins, hydraulic systems, anchor connections, railings and removable attachments and overall equipment condition. Maintenance work stands shall have at least two operational brakes, locks or permanently installed jacks. At least two brakes shall be set and all wheel casters locked, before any maintenance is performed. Wheel chocks may be used in conjunction with these requirements. Vehicle chocks may be constructed IAW Commercial Item Specification A-A-52475 or locally manufactured IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, section 4.1.2. Platforms shall be locked when not in use to avoid rolling down slanted surfaces or being moved by wind.

16.5.11.7. When mobile work platforms are being moved:

16.5.11.7.1. Personnel and equipment may remain on self-propelled work platforms when moved if platforms are in a lowered position. Refer to paragraph [16.5.3.8](#).

16.5.11.7.2. Platforms to be towed shall be equipped with hitches designed for such purpose.

16.5.11.7.3. The following rules apply when platforms are towed by vehicles:

16.5.11.7.3.1. Maximum towing speed for one maintenance stand is 10 miles per hour and 5 miles per hour for two or more maintenance stands. However, when surfaces and terrain make it necessary, speed shall be reduced accordingly.

16.5.11.7.3.2. No more than four type B1, B4, B5 and similar small stands may be towed as follows: two sets of two in tandem on a double hitch or two in tandem on a single hitch. Type B3, J7 and similar large stands shall be towed singly on a center mounted hitch. Four-wheeled units shall not be towed behind two-wheeled units. Large pieces of AGE, when towed in tandem, shall not block the driver's vision of last item being towed.

16.5.11.7.3.3. Safety pins shall be used to secure pintle hooks and trailer hitches.

16.5.11.8. Mobile work platforms used where static electricity is hazardous to the work operation, such as fuel cell repair or refueling vehicle maintenance, shall be grounded and equipped with static discharge plates for personnel to dissipate accumulated static electricity.

16.5.11.9. Maintain mobile work platforms and ladder stands IAW appropriate 35-series TOs.

**Figure 16.1. Ascending/Descending Work Platform.**



**Note:** Angle less than or equal to 60°, personnel ascending/descending stairs shall face the direction of travel and use hand rails. If angle is greater than 60° the climbing device shall be considered a ladder and accessed like a ladder.

**16.6. Mobile Elevating Work Platforms Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

16.6.1. Do operators of aerial lifts near electric power lines maintain clearances required by paragraph [16.4.3](#)? Reference [16.4.3](#).

16.6.2. Are aerial ladders inspected and tested annually? Reference [16.4.5.1](#)

16.6.3. Are aerial ladders inspected immediately following any repair of a structural or mechanical component of the ladder assembly? Reference [16.4.5.1](#)

16.6.4. Is NFPA 1914, *Standard for Testing Fire Department Aerial Devices*, used as a guide by the principal operator and a qualified vehicle mechanic while performing tests or annual inspections of aerial ladders? Reference [16.4.5.1](#)

16.6.5. Are articulating and extendible boom platforms inspected and tested annually? Reference [16.4.5.2](#)

16.6.6. Is ANSI A92.2., *Vehicle Mounted Elevating and Rotating Work Platforms*, used as a guide by the principal vehicle operator and a qualified vehicle mechanic while performing tests or annual inspections of articulated and extendible boom platforms? Reference [16.4.5.2](#)

- 16.6.7. Are tests and inspections of platforms recorded IAW AFI 23-302? Reference [16.4.5.2](#)
- 16.6.8. Is the aerial device manufacturer's operator manual available for operator use? Reference [16.4.6.1](#)
- 16.6.9. Have operators of vehicle-mounted elevating and rotating work platforms been thoroughly trained and qualified in the use of the equipment? Reference [16.4.6.3](#)
- 16.6.10. Are work platforms equipped with guardrails, midrails and toeboards on all four (4) sides of the platform, including the access opening to the platform? Reference [16.5.1](#)
- 16.6.11. Is the maximum height of mobile ladder stands or scaffolds restricted to a level no greater than four times the least base dimension of the supporting frame? Reference [16.5.3.1](#)
- 16.6.12. Are supporting structures for work levels rigidly braced? Reference [16.5.3.3](#)
- 16.6.13. Are the steps of all ladder stands constructed of slip-resistant materials or covered with a slip-resistant coating? Reference [16.5.3.4](#)
- 16.6.14. Is the work level platform of scaffolds secured to the support structure? Reference [16.5.3.5](#)
- 16.6.15. Are guardrails, midrails and toeboards installed on all scaffolding with work levels four (4) feet or more above ground or floor level? Reference [16.5.3.6](#)
- 16.6.16. Do supervisors ensure personnel do not ride moving manually-propelled work platforms? Reference [16.5.3.8](#)
- 16.6.17. Are at least two (2) of four (4) casters on ladder stands or work platforms equipped with positive swivel locks or wheel locks to prevent movement? Reference [16.5.5.2](#)
- 16.6.18. Are screwjacks or other suitable means for adjusting height provided when leveling elevated work platform is required? Reference [16.5.5.3](#)
- 16.6.19. Are at least two (2) brakes, wheel locks or permanently installed jacks operational on all mobile work platforms? Reference [16.5.5.4](#)
- 16.6.20. Are structural type materials used for scaffold couplers (i.e., drop-forged steel, malleable iron, or structural grade aluminum)? Reference [16.5.8.2](#)
- 16.6.21. Are rigid diagonal bracings provided to the vertical members? Reference [16.5.9.3](#)
- 16.6.22. Are handrails provided on mobile ladder stands that have more than four steps or 60 inches vertical height? Reference [16.5.10.4](#)
- 16.6.23. Are protective guardrails and mid-rails (when required), installed and secured with bolts, pins or other locking devices on mobile work platforms and ladder stands for work four (4) feet or more above ground or floor? Reference [16.5.11.3](#)
- 16.6.24. Are reflective materials for marking mobile work platforms used to the maximum extent authorized by TOs? Reference [16.5.11.5](#)
- 16.6.25. Are work platforms secured against movement when not being transported? Reference [16.5.11.50](#)



16.6.26. Are mobile work platform and/or ladder stands inspected daily before use? Reference [16.5.11.6](#)

16.6.27. Are mobile platforms and ladders used for fuel cell repair or other hazardous areas equipped with bonding and (or) ground connections and static discharge plates for personnel to dissipate accumulated static electricity? Reference [16.5.11.8](#)

16.6.28. Is maintenance of mobile work platforms and ladder stands accomplished as required by applicable 35-series TOs? Reference [16.5.11.9](#)

## Chapter 17

### SCAFFOLDING

**17.1. General Information.** This chapter applies to all scaffolding used in the Air Force, except rolling scaffolds (mobile towers), which are covered in [Chapter 16](#), *Mobile Elevating Work Platforms*. It specifies criteria for assembly, erection, storage and safe use of scaffolding. Since the Air Force primarily uses pre-formed tubular scaffolding, construction requirements for wooden pole scaffolding are not part of this chapter. In the event an Air Force organization must construct a wood scaffold, the design and material specifications contained in 29 CFR 1910.28., *Safety Requirements for Scaffolding*, 29 CFR 1910 Subpart D, *Walking-Working Surfaces*, 29 CFR 1926 Subpart L, *Scaffolds*, and 29 CFR 1915.71., *Scaffolds, Ladders and Other Working Surfaces*, shall be followed. Refer to [Chapter 16](#) for information on manually-propelled mobile ladder stands, mobile work platforms or mobile towers.

17.1.1. Procurement. Scaffolds and support equipment for Air Force use will meet design and construction specifications of 29 CFR 1910.28.

**17.2. Hazards and Human Factors.** Elevated work platforms and scaffolds present hazards associated with falls or falling objects. These hazards are usually the result of poorly designed equipment or from workers erecting them improperly or using them incorrectly. Further, workers can create hazards by building makeshift platforms, removing guardrails and toeboards, or failing to secure tools and equipment. These hazards can be minimized by properly designing platforms and scaffolds, by training personnel and by supervisors enforcing safe work practices. Supervisors must also consider the physiological effects of high places on individual workers, such as dizziness or instability. Factors such as illness, fatigue and physical deficiencies can also contribute to mishaps.

### 17.3. General Requirements.

17.3.1. Scaffolds shall be provided when work cannot be done safely from the ground or from solid construction and shall be constructed and erected only by qualified, trained personnel. When ladders are used they will conform to requirements in [Chapter 7](#), *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*.

17.3.2. The footing or anchorage for scaffolds shall be designed to support the maximum intended load without settling or displacement. Unstable objects such as barrels, boxes, loose brick or concrete blocks shall not be used to support scaffolds or planks.

17.3.3. Guarding requirements.

17.3.3.1. Guardrails shall be installed on open sides and ends of platforms 4 feet or more (and toeboards, if 10 feet or more) above the ground or floor except:

17.3.3.1.1. Scaffolding wholly within the interior of a building and covering the entire floor area of any room providing no side is exposed to a hoistway, elevator shaft, stairwell or other floor openings.

17.3.3.1.2. Needle-beam scaffolds and floats used by structural iron workers.

17.3.3.2. Scaffold guarding will consist of:

17.3.3.2.1. A guardrail of 2- by 4-inch lumber or equivalent material installed at a height of 36 to 42 inches above the platform.

17.3.3.2.2. A midrail (when required in this standard) of 1- by 4-inch lumber or equivalent.

17.3.3.2.3. Vertical supports installed at intervals not exceeding 10 feet.

17.3.3.2.4. Toeboards a minimum of four (4) inches in height.

17.3.3.2.5. A wire mesh screen shall be installed between the toeboard and guardrail (extending the entire length of the opening) where persons work or pass beneath the scaffold. The wire mesh shall be number 18-gauge US Standard wire 1/2-inch mesh or equivalent.

17.3.3.3. No more than 2 workers shall be permitted on suspension scaffolds with an intended working load of 500 pounds. No more than 3 workers shall be permitted on suspension scaffolds with an intended working load of 750 pounds. Each worker shall be protected by a personal fall arrest system (PFAS) attached to a lifeline. The lifeline shall be securely attached to substantial members of the structure (not scaffold), or to securely rigged lines, which will safely suspend the worker in case of a fall.

17.3.4. Scaffolds and their components shall be capable of supporting at least four (4) times the maximum intended load.

17.3.5. Scaffolds shall not be altered or moved horizontally while in use or occupied.

17.3.6. Scaffolds, their accessories and other devices prescribed in this chapter shall be maintained in good condition. Scaffold parts shall be inspected prior to use. If any of the following deficiencies are found, the scaffold shall not be used until repaired or replaced:

17.3.6.1. Accessory or structural damage.

17.3.6.2. Missing parts or members. (For example, braces, toeboards, guardrails, anchors, etc.).

17.3.6.3. Broken, bent or rusted frames or accessories.

17.3.6.4. Altered parts or accessories. (For example, substitution of smaller planking, bolts or anchors for those required).

17.3.6.5. Broken or deteriorated lifelines or ropes and their attachments and/or anchorages.

17.3.6.6. Any other conditions which would jeopardize the safety of workers. Scaffolds found defective shall be removed from service and tagged with a danger tag.

17.3.7. Scaffolds shall not be loaded in excess of the designed working load.

17.3.8. Planking shall be Scaffold Grade as recognized by grading rules for the species of wood used. The maximum permissible spans of 1 ¼ x 9-inch or wider planks are shown in **Table 17.1**

17.3.9. Nails or bolts used in the construction of scaffolds shall be of adequate size and in sufficient numbers at each connection to develop the designed strength of the scaffold. Nails will not be subjected to a straight pull and shall be driven full length.

17.3.10. Planking or platforms shall be overlapped (minimum 12 inches) and secured from movement.

17.3.11. A ladder or equivalent safe access shall be provided.

17.3.12. Scaffold planks shall extend beyond their end supports by not less than 6 inches or more than 12 inches.

17.3.13. The poles, legs or uprights of scaffolds shall be plumb and securely and rigidly braced to prevent swaying and displacement.

17.3.14. Materials being hoisted onto a scaffold shall have a tag line.

17.3.15. Workers shall wear hard hats during erection, maintenance and teardown of overhead scaffolding. Protective gloves are also recommended.

17.3.16. The clearance between scaffolds and power lines shall be as follows:

17.3.16.1. Scaffolds shall not be erected, used, dismantled, altered or moved such that they or any conductive material handled on them might come close to exposed and energized power lines as listed in [Table 17.2](#) and [17.3](#) **Exception:** Scaffolds and materials may be closer to power lines than specified in [Tables 17.2](#) and [17.3](#) where such clearance is necessary for performance of work, and only after the utility company or electrical system operator has been notified of the need to work closer and the utility company or electrical system operator has de-energized or relocated the lines, or installed protective coverings to prevent accidental contact with the lines.

17.3.17. Adverse weather conditions such as ice, snow, rain and wind can create a hazardous working surface. A plan shall be established addressing adverse weather conditions and measures to be taken to protect workers performing work under adverse weather conditions. The following rules shall apply to work under adverse weather. Refer to [Chapter 11, Weather Safety](#), for additional information.

17.3.17.1. Personnel shall not work on scaffolds covered with ice or snow. If the work surface remains slippery after ice or snow removal, it shall be sanded or otherwise treated to prevent workers from slipping.

17.3.17.2. Personnel shall not work on scaffolds during storms or high winds. Due to the many types and uses of scaffolding, it is impractical to determine specific wind criteria for work stoppage. Supervisors are responsible for assessing unsafe environmental and climatic work conditions and will take necessary preventive measures to protect workers.

17.3.18. Tools, materials and debris shall not be allowed to accumulate in quantities that could cause a hazard. When possible, containers shall be provided on scaffolds for storage of loose materials. Supervisors shall ensure good housekeeping practices are followed to prevent tripping hazards.

17.3.19. Chemically-active environments can destroy fiber rope. Rope materials such as polyester, nylon and manila can be damaged when exposed to caustics and acids. When fiber

rope is used near corrosive substances or chemicals, the manufacturer shall be consulted for assistance in determining the proper type rope to use.

17.3.20. Wire or fiber rope used for scaffold suspension shall support at least six (6) times the intended load.

17.3.21. The use of shore scaffolds or lean-to scaffolds is prohibited.

17.3.22. Lumber sizes, when used in this standard, refer to nominal sizes except where otherwise stated.

17.3.23. Scaffolds shall be secured to permanent structures by anchor bolts, reveal bolts or other equivalent means. Window cleaners' anchor bolts shall not be used.

17.3.24. Special care shall be taken to protect scaffold members, including wire or fiber ropes, when using heat-producing processes.

17.3.25. A covered storage area is recommended to protect scaffolding from damage and deterioration.

17.3.26. Wooden parts of scaffolding shall not be painted as paint can hide defects. Clear varnish, lacquer, shellac or linseed oil shall be used when wood protection is needed.

17.3.27. Individual workers shall not attempt to manually lift or move scaffold members which are excessively heavy, or because of their shape or size, cannot be safely handled. In these cases, assistance shall be obtained from other workers or mechanical handling equipment shall be used.

17.3.28. Hand tools used to assemble scaffolding shall be in good condition. When powered hand tools are used, they shall be electrically grounded or of double insulated construction.

#### **17.4. Tube and Coupler Scaffolds.**

17.4.1. When structural metals other than those stated in paragraphs [17.4.2](#), [17.4.3](#), and [17.4.4](#) are used in scaffold construction, they must be designed to carry four (4) times the maximum intended load.

17.4.2. A light-duty tube and coupler scaffold shall have posts, bearers, runners and bracing of nominal 2-inch outside diameter (O.D.) steel tubing. The posts shall be spaced no more than 10 feet along the length of the scaffold and the scaffold shall be no wider than 6 feet. Refer to [Table 17.4](#) for additional guidance.

17.4.3. A medium-duty tube and coupler scaffold shall have posts, runners and bracing of nominal 2-inch O.D. steel tubing. Posts shall not be spaced more than eight (8) feet along the scaffold. If the scaffold is six (6) feet wide, the bearer diameter must be 2 ½-inches O.D. If the scaffold is five (5) feet wide, the bearer diameter may be two (2) inches O.D. Refer to [Table 17.5](#) for additional guidance.

17.4.4. A heavy-duty tube and coupler scaffold shall have all posts, runners and bracing of nominal 2-inch O.D. steel tubing, with the posts spaced not more than 6 feet 6 inches along the length of the scaffold. The scaffold shall be no wider than six (6) feet.

17.4.4.1. Tube and coupler scaffolds shall be limited in heights and working levels to those permitted in [Table 17.6](#) Drawings and specifications of tube and coupler scaffolds greater than the limitations in [Table 17.6](#) shall be designed by a structural or civil

engineer. Design drawings or copies shall be made available to the installation CE for inspection purposes.

17.4.4.2. Tube and coupler scaffolds shall be constructed and erected to support four (4) times the maximum intended loads as prescribed in **Table 17.6** or as set in the specifications established by a structural or civil engineer.

17.4.4.3. Posts shall be accurately spaced, as required above, erected on suitable bases and maintained plumb.

17.4.4.4. Runners shall be erected along the length of the scaffold. They shall be located on both the inside and the outside posts at an even height. Runners shall be interlocked to form continuous lengths and coupled to each post. The bottom runners shall be located as close to the base as possible. Runners shall be placed not more than 6 feet 6 inches on centers.

17.4.4.5. Bearers shall be installed transversely between posts. They shall be securely coupled to the posts bearing on the runner coupler. When coupled directly to the runners, the coupler must be kept as close to the posts as possible.

17.4.4.6. Bearers shall be at least 4 inches, but not more than 12 inches, longer than the post or runner spacing. Bearers may be cantilevered for use as brackets to carry not more than two planks.

17.4.4.7. Cross bracing shall be installed across the width of the scaffold at least every third set of posts horizontally and every fourth runner vertically. Bracing shall extend diagonally from the inner and outer runners upward to the next outer and inner runners.

17.4.4.8. Longitudinal diagonal bracing shall be installed at approximately a 45-degree angle from near the base of the first outer post upward to the extreme top of the scaffold. Where the longitudinal length of the scaffold permits, bracing shall be duplicated beginning at every fifth post. In a similar manner, longitudinal diagonal bracing shall also be installed from the last post extending back and upward toward the first post. Where conditions preclude the attachment of this bracing to the posts, bracing may be attached to the runners.

17.4.4.9. The entire scaffold shall be tied to and securely braced against the building at intervals not exceeding 30 feet horizontally and 26 feet vertically.

## **17.5. Tubular Welded Frame Scaffolds.**

17.5.1. Metal tubular frame scaffolds, including accessories such as braces, brackets, trusses, screw legs, ladders, etc., shall be designed and proved to safely support four (4) times the maximum intended load.

17.5.2. Spacing of panels or frames shall be consistent with loads imposed.

17.5.3. Scaffolds shall be braced by cross-bracing or diagonal braces, or both, for securing vertical members together laterally. The cross-braces shall be of a length which will automatically square and align vertical members. This will ensure the erected scaffold is always plumb, square and rigid. Brace connections shall be made secure.

17.5.4. Scaffold legs shall be set on adjustable bases or plain bases placed on mud sills or other foundations able to support the maximum intended load.

17.5.5. The frames shall be placed one on top of the other with coupling or stacking pins to provide proper vertical alignment of the legs.

17.5.6. Where uplift may occur, panels shall be locked together vertically by pins or other equal means.

17.5.7. To prevent movement, the scaffold shall be secured to the building or structure at intervals not to exceed 30 feet horizontally and 26 feet vertically.

17.5.8. Drawings and specifications for frame scaffolds over 125 feet in height above the base plates shall be designed by a structural or civil engineer. Copies of the drawings and specifications shall be maintained by the installation structural or civil engineer for as long as the scaffolding is in use.

17.5.9. Tubular welded frame scaffolds shall be erected by competent and experienced personnel.

17.5.10. Inspections shall be made of all welded frames and accessories and any maintenance, including painting or minor corrections authorized by the manufacturer, shall be made before use.

17.5.11. Outrigger Scaffold requirements.

17.5.11.1. Outrigger beams shall extend not more than six (6) feet beyond the face of the building. The inboard end of outrigger beams, measured from the fulcrum point to the extreme point of support, shall not be less than one and one-half times the outboard end in length. The beams shall rest on edge, with sides plumb, and the edges horizontal. The fulcrum point of the beam shall rest on a secure bearing at least six (6) inches in each horizontal dimension. The beam shall be secured in place against movement and braced at the fulcrum point against tipping.

17.5.11.2. The inboard ends of outrigger beams shall be securely supported either by (a) struts bearing against sills in contact with the overhead beams or ceiling, or (b) tension members secured to the floor joists underfoot, or (c) by both, if necessary. The inboard ends of outrigger beams shall be secured against tipping. The entire supporting structure shall be braced in both directions to prevent any horizontal movement.

17.5.11.3. Unless outrigger scaffolds are designed by a structural or civil engineer, they shall be constructed and erected IAW **Table 17.7** Outrigger scaffolds designed by a structural and/or civil engineer shall be constructed and erected according to such design. Design copies shall be maintained by the installation structural or civil engineer. In the event the job location is off the installation, the on-site supervisor shall have a copy of the drawings and specifications in their possession. Copies shall be retained as long as the scaffold is erected.

17.5.11.4. Planking shall be laid tight and extend to within three (3) inches of the building wall. Planking shall be nailed or bolted to outriggers.

17.5.11.5. Where additional working levels are supported by the outrigger method, the plans and specifications of the outrigger and scaffolding structure shall be designed by a structural or civil engineer.

### **17.6. Masons' Adjustable Multiple-point Suspension Scaffolds.**

17.6.1. The scaffold shall be capable of sustaining a working load of 50 pounds per square foot, and loads shall not exceed that figure.

17.6.2. The scaffold shall be provided with hoisting machines that meet requirements of Underwriters Laboratories or Factory Mutual Engineering Corp.

17.6.3. The platform shall be supported by wire ropes (to conform with requirements in paragraph [17.3.20](#)) suspended from overhead outrigger beams.

17.6.4. Scaffold outrigger beams shall consist of structural metal securely fastened or anchored to the frame or floor system of the building or structure. Each outrigger beam shall be equal in strength to at least a standard 7-inch, 15.3-pound steel I-beam, be at least 15 feet long and not project more than 6 feet 6 inches beyond the bearing point. Where the overhang exceeds 6 feet 6 inches, outrigger beams shall be composed of stronger beams or multiple beams. They shall be installed IAW approved designs and instructions. If channel iron outrigger beams are used in place of I-beams, they shall be fastened together with the flanges turned out.

17.6.5. Outrigger beams shall be set and maintained with their webs in a vertical position. A stop bolt shall be placed at each end of every outrigger beam. The outrigger beam will rest on suitable wood-bearing blocks.

17.6.6. Scaffold parts such as bolts, nuts, fittings, clamps, wire ropes, and outrigger beams and their fastenings shall be kept in good working condition and shall be inspected before each installation and daily thereafter while the scaffold is in use.

17.6.7. The free end of suspension wire ropes shall be equipped with proper size thimbles and be secured by splicing or other equivalent means. The running ends shall be attached to the hoisting drum and at least four (4) turns of rope will remain on the drum.

17.6.8. Where a single outrigger beam is used, the steel shackles or clevises, with which the wire rope are attached to the outrigger beams, shall be placed directly over the hoisting drums.

17.6.9. The scaffold platform shall be equal in strength to at least 2-inch planking. For maximum planking spans, see [Table 17.1](#)

17.6.10. When workers are working on the scaffold and an overhead hazard exists, overhead protection shall be provided not more than nine (9) feet above the platform. It shall consist of 2-inch planking or material of equivalent strength laid tight.

17.6.11. Scaffolds shall only be installed or moved under the control of the on-site job supervisor or a structural or civil engineer.

### **17.7. Two-Point Suspension Scaffolds (Swinging Scaffolds).**



17.7.1. Two-point suspension scaffold platforms shall not be less than 20 inches nor more than 36 inches wide. The platform shall be fastened to the hangers by U-bolts or by other equal means.

17.7.2. The hangers of two-point suspension scaffolds shall be made of wrought iron, mild steel or other material having a cross-sectional area capable of sustaining four (4) times the maximum intended load. They shall be designed with a support for the guardrail, intermediate rail and toeboard.

17.7.3. When hoisting machines are used on two-point suspension scaffolds, they shall be tested and approved by Underwriters Laboratories or Factory Mutual Engineering Corp.

17.7.4. Roof irons or hooks shall be of wrought iron, mild steel or other material of proper size and design, securely installed and anchored. Tiebacks of 3/4-inch manila rope or equivalent will serve as a secondary method of anchorage. Tiebacks shall be installed at right angles to the face of the building, whenever possible, and secured to a structurally sound portion of the building.

17.7.5. Two-point suspension scaffolds shall be suspended by wire, synthetic or fiber ropes. Wire and fiber ropes will conform to paragraphs [17.3.19](#) and [17.3.20](#).

17.7.6. Blocks for fiber ropes shall be of standard 6-inch size, consisting of at least one double and one single block. The sheaves of blocks shall fit the size of rope used.

17.7.7. Wire, synthetic and fiber ropes, slings, hangers, platforms and other supporting parts shall be inspected before every installation. Daily inspections shall be made while the scaffold is in use.

17.7.8. No more than 2 workers shall be permitted to work at one time on suspension scaffolds with an intended working load of 500 pounds. No more than 3 workers shall be permitted to work at one time on suspension scaffolds with an intended working load of 750 pounds. Each worker shall be protected by a PFAS. The system shall be attached to substantial members of the structure (not the scaffold), or to securely rigged lines, which will safely suspend the worker in case of a fall.

17.7.9. Two-point suspension scaffolds shall be lashed to the building or structure to prevent swaying. Window cleaners' anchors shall not be used for this purpose.

17.7.10. The platform of every two-point suspension scaffold shall be one of the following types:

17.7.10.1. The side stringer of ladder-type platforms shall be clear straight-grained spruce or material of equal strength and durability. Rungs shall be of straight-grained oak, ash or hickory, at least 1 – 1/8 inch in diameter, with 7/8 inch tenons mortised into the side stringers at least 7/8 inch. Stringers shall be tied together with tie rods not less than 1/4 inch in diameter, passing through the stringers and riveted up tight against washers on both ends. The flooring strips shall be spaced not more than 5/8 inch apart except at the side rails where the space may be one inch. Ladder-type platforms shall be constructed IAW [Table 17.8](#)

17.7.10.2. Plank-type platforms shall be made of not less than nominal 2- by 8-inch unspliced planks. They shall be cleated together on the underside starting six (6) inches from each end. The intervals in between cleats shall not exceed four (4) feet. The plank-

type platform shall not extend beyond the hangers more than 18 inches. A bar shall be fastened to the platform at each end to prevent its slipping off the hanger. The span between hangers for plank-type platforms shall not exceed 10 feet.

17.7.10.3. Beam platforms will have side stringers of lumber not less than 2- by 6-inches set on edge. The span between hangers shall not exceed 12 feet when beam platforms are used. Flooring shall be supported on 2- by 6-inch crossbeams, laid flat and set into the upper edge of the stringers with a snug fit, at intervals of not more than four (4) feet, nailed in place. Flooring shall be of 1- by 6-inch material properly nailed. Floorboards shall not be spaced more than 1/2 inch apart.

### **17.8. Stone Setters' Adjustable Multiple-Point Suspension Scaffolds.**

17.8.1. The scaffold shall support a working load of 25 pounds per square foot and shall not be overloaded. Scaffolds shall not be used for storage of stone or other heavy materials.

17.8.2. The hoisting machine and its supports shall be of a type tested and listed by Underwriters Laboratories or Factory Mutual Engineering Corp.

17.8.3. The platform shall be fastened to the hangers by U-bolts or other equal means.

17.8.4. The scaffold unit shall be suspended from metal outriggers, iron brackets, wire rope slings or iron hooks which will safely support the maximum intended load.

17.8.5. Outriggers, when used, shall be set with their webs in a vertical position, anchored to the building or structure and provided with stop bolts at each end.

17.8.6. The scaffold shall be supported by wire rope conforming with paragraph [17.3.20](#) and suspended from overhead supports. Free ends of suspension wire ropes shall be equipped with proper size thimbles, secured by splicing or other equal methods. Running ends shall be securely attached to the hoisting drum, and at least four (4) turns of rope shall remain on the drum at all times.

17.8.7. When two (2) or more scaffolds are used on a building or structure, they shall not be bridged one to the other, but shall be maintained at even height with platforms butting closely.

17.8.8. Scaffolds shall only be installed or moved under the control of the on-site supervisor IAW designs and instructions of the structural or civil engineer.

### **17.9. Single-Point Adjustable Suspension Scaffolds.**

17.9.1. Scaffolding, including power units or manually operated winches, shall be tested and listed by Underwriters Laboratories or Factory Mutual Engineering Corp.

17.9.2. Power units may be either electrically or air motor driven.

17.9.3. Power-operated gears and brakes shall be enclosed. In addition to the normal operating brake, power driven units must have an emergency brake which engages automatically when the normal speed of descent is exceeded.

17.9.4. Guards, midrails and toeboards will completely enclose the cage or basket. Guardrails shall be no less than 2 by 4 inches or the equivalent installed no less than 36 inches nor more than 42 inches above the platforms. Midrails shall be 1 by 6 inches or the

equivalent, installed equal distance between the guardrail and the platform. Toeboards shall be a minimum of four (4) inches in height. Each worker shall be protected by a PFAS. The system shall be attached to substantial members of the structure (not the scaffold), or to securely rigged lines, which will safely suspend the worker in case of a fall.

17.9.5. The hoisting machines, cables and equipment shall be regularly serviced and inspected after each installation and every 30 days thereafter.

17.9.6. The units may be combined to form a two-point suspension scaffold. This type scaffold shall comply with paragraph 17.7.

17.9.7. The supporting cable shall be straight for its entire length. The operator shall not sway the basket or fix the cable to any intermediate points to change the original path of travel.

17.9.8. Equipment shall be maintained and used IAW the manufacturer's instructions.

17.9.9. Suspension methods shall conform to applicable provisions of paragraphs 17.6 and 17.7.

**17.10. Boatswains' Chairs.** The chair seat shall not be less than 12 by 24 inches and of 1-inch thickness. The seat shall be reinforced on the underside to prevent the board from splitting.

17.10.1. The two (2) fiber rope seat slings shall be of 5/8-inch diameter, reeved through the four (4) each seat holes so as to cross each other on the underside of the seat. Seat slings shall be of at least 3/8-inch wire rope when a worker is conducting a heat-producing process such as gas- or arc-welding.

17.10.2. A PFAS shall be in place and used to protect the worker when using a boatswain's chair. The lifeline shall be attached to substantial members of the structure (not the scaffold), or to securely rigged lines, which will safely suspend the worker in case of a fall.

17.10.3. The tackle shall consist of correct size ball bearing or bushed blocks and properly spliced 5/8-inch diameter first-grade manila rope, or other rope which will satisfy the criteria, e.g., strength and durability of manila rope.

17.10.4. Roof irons, hooks or the object to which the tackle is anchored shall be securely installed. Tiebacks, when used, shall be installed at right angles to the face of the building and fastened to a chimney.

**17.11. Carpenters' Bracket Scaffolds.**

17.11.1. Brackets shall consist of a triangular wood frame not less than 2 by 3 inches in cross section or of metal or equal strength material. Each part shall be properly fitted and securely jointed. Each bracket shall be attached to the structure by one of the following methods:

17.11.1.1. A bolt no less than 5/8 inch in diameter shall extend through the inside of the building wall.

17.11.1.2. A metal stud attachment device.

17.11.1.3. Welding to steel tanks.

17.11.1.4. Hooking over a well-secured and strong supporting member. Brackets shall be spaced no more than 10 feet apart.

17.11.2. No more than two persons shall occupy any given 10 feet of a bracket scaffold at any one time. Tools and materials shall not exceed 75 pounds.

17.11.3. The platform shall consist of at least two 2- by 9-inch nominal size planks extending not more than 18 inches or less than 6 inches beyond each end support.

**17.12. Bricklayers' Square Scaffolds.** The squares shall not exceed five (5) feet in width and five (5) feet in height. Parts shall not be less than those specified in [Table 17.9](#)

17.12.1. The squares shall be reinforced on both sides of each corner with 1- by 6-inch gusset pieces. They shall also have braces 1 by 8 inches on both sides running from center to center of each part, or other methods to obtain equal strength and rigidity.

17.12.2. The squares shall be set not more than five (5) feet apart for medium duty scaffolds, and not more than eight (8) feet apart for light duty scaffolds. Bracing, 1 by 8 inches, extending from the bottom of each square to the top of the next square, shall be provided on both front and rear sides of the scaffold.

17.12.3. Platform planks shall be at least 2- by 9-inch nominal size. The ends of the planks shall overlap the bearers of the squares and each plank shall be supported by not less than three squares.

17.12.4. Bricklayers' square scaffolds shall not exceed three (3) tiers in height and shall be constructed and arranged so one square will rest directly above the other. The upper tiers will stand on a continuous row of planks laid across the next lower tier and be nailed down or otherwise secured to prevent displacement.

**17.13. Horse Scaffolds.** Horse scaffolds shall not be constructed or arranged more than two tiers and shall not exceed 10 feet in height. The parts of the horses shall not be less than those specified in [Table 17.10](#) Horses shall be spaced not more than five (5) feet apart for medium duty and not more than eight (8) feet apart for light duty.

17.13.1. When arranged in tiers, each horse shall be placed directly over the horse in the tier below.

17.13.2. On scaffolds arranged in tiers, the legs shall be nailed down to the planks to prevent movement and each tier shall be cross braced.

17.13.3. Horses or parts which have become weak or defective shall not be used.

**17.14. Needle Beam Scaffolds.**

17.14.1. Metal beams or equal material used in scaffolding shall conform to paragraph [17.3.4](#).

17.14.2. Ropes or hangers shall be provided for supports. The span between supports on the needle beam shall not exceed 10 feet for 4- by 6-inch timbers. Rope supports shall be equivalent in strength to 1-inch diameter first-grade manila rope.

17.14.3. Ropes shall be attached to the needle beams by a scaffold hitch or a properly made eye splice. The loose end of the rope shall be tied by a bowline knot or by a round turn and one-half-hitch.

17.14.4. The platform span between the needle beams shall not exceed eight (8) feet when using 2-inch scaffold plank. For spans greater than eight (8) feet, platforms shall be designed based on requirements for the special span. The overhang of each end of the platform planks shall not be less than 1 foot and not more than 18 inches.

17.14.5. When one needle beam is higher than the other, or when the platform is not level, the platform shall be secured against slipping.

17.14.6. Unattached tools, bolts and nuts used on needle beam scaffolds shall be kept in suitable containers.

17.14.7. One end of a needle beam scaffold may be supported by a permanent structural member conforming to paragraph [17.3.4](#).

17.14.8. Each person working on a needle beam scaffold 20 feet or more above the ground or floor and working with both hands shall be protected by a PFAS. The lifeline shall be securely attached to substantial members of the structure (not the scaffold), or to securely rigged lines, which will safely suspend the worker in case of a fall.

**17.15. Plasterers, Decorators and Large Area Scaffolds.** Plasterers, decorators, lathers and ceiling workers inside scaffolds shall be constructed IAW the general requirements set forth for independent wood pole scaffolds. Platform planks shall be laid with the edges close together. When independent pole scaffold platforms are erected in sections, the sections shall be provided with connecting runways equipped with guardrails. Refer to 29 CFR 1910.28. for additional information.

**17.16. Interior Hung Scaffolds.**

17.16.1. Interior hung scaffold shall be hung or suspended from the roof structure or substantial ceiling beams.

17.16.2. The suspended steel wire rope shall conform to paragraph [17.3.20](#).

17.16.3. For hanging wood scaffolds, the following minimum nominal size material is recommended:

17.16.3.1. Supporting bearers 2 by 9 inches on edge.

17.16.3.2. Planking 2 by 9 inches or 2 by 10 inches, with a minimum span of 7 feet for heavy duty and 10 feet for light or medium duty.

17.16.3.3. Steel tube and coupler parts may be used for hanging scaffolds providing both types of scaffold are designed to sustain a uniformly distributed working load equivalent to heavy duty scaffold loads with a safety factor of four (4).

17.16.3.4. When a hanging scaffold is supported by wire rope, the rope shall be wrapped at least twice around the supporting members and twice around the bearers of the scaffold. Each end of the wire rope shall be secured by at least three (3) standard wire rope clips.

17.16.3.5. Overhead supporting members shall be inspected and checked for condition and strength before the scaffold is erected.

**17.17. Ladder-Jack Scaffolds.** Ladder-jack scaffolds shall be limited to light duty and shall not exceed a height of 20 feet above the floor or ground. Scaffold loads shall not exceed ladder safe working load. They shall be designed and constructed as specified in **Chapter 7, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders.***

17.17.1. The ladder jack shall bear on the side rails in addition to the ladder rungs, or if bearing on rungs only, the bearing area shall be at least 10 inches on each rung.

17.17.2. Ladders used in conjunction with ladder jacks shall be placed, fastened, held or equipped with devices to prevent slipping.

17.17.3. Wood platform planks shall not be less than two (2) inches nominal in thickness. Both metal and wood platform planks shall overlap the bearing surface not less than 12 inches. The span between supports for wood shall not exceed eight (8) feet. Platform width shall not be less than 18 inches.

17.17.4. Not more than two (2) persons shall occupy any given eight (8) feet of any ladder jack scaffold at any time.

**17.18. Window-Jack Scaffolds.** Window-jack scaffolds shall be used only for working at the window opening through which the jack is placed. These scaffolds shall not be used to support planks placed between one window jack and another or for supporting other elements of scaffolding. Window-jack scaffolds shall be provided with guardrails unless a PFAS is provided for the worker. **Note:** Window-jack scaffolds shall be used by one person only.

**17.19. Roofing Brackets.** Roofing brackets shall fit the pitch of the roof. Brackets shall be secured in place by nailing in addition to the pointed metal projections. The nails shall be driven full length into the roof. When rope supports are used, they shall consist of first-grade manila of at least ¾-inch diameter, or equivalent. A catch platform shall be installed below the working area of roofs which are more than 20 feet from the ground to the eaves and have a slope greater than 3 inches in 12 inches without a parapet. The platform width shall extend two (2) feet beyond the projection of the eaves and shall be provided with a safety rail, midrail and toeboard, unless workers on such roofs are protected by PFASs.

**17.20. Crawling Boards or Chicken Ladders.** Crawling boards shall be at least 10 inches wide and 1 inch thick. Cleats shall be 1 by 1-1/2 inches, equal in length to the width of the board and spaced at equal intervals not to exceed 24 inches. Nails shall be driven through and clinched on the underside. The crawling board shall extend from the ridge pole to the eaves when used in connection with roof construction, repair or maintenance. A firmly fastened lifeline of at least ¾-inch rope shall be strung beside each crawling board for a handhold. Crawling boards shall be secured to the roof by ridge hooks or equally effective means.

**17.21. Float or Ship Scaffolds.** A float or ship scaffold is a suspension scaffold consisting of a braced platform resting on two (2) parallel bearers and hung from overhead supports by ropes of fixed length. Float or ship scaffolds shall be limited to no more than three (3) workers and a few light tools, such as those needed for riveting, bolting and welding. They shall be constructed

IAW sub-paragraphs below. Substitute design and materials are permitted, provided equal strength, stability and safety are ensured.

17.21.1. The platform shall not be less than 3 feet wide and 6 feet long, made of ¾-inch plywood, equivalent to American Plywood Association Grade B-B, Group 1, Exterior. Under the platform, there shall be 2 supporting bearers made from 2- by 4-inch or 1-by 10-inch rough, selected lumber, or better. They shall be free of knots or other flaws and project six (6) inches beyond the platform on both sides. The ends of the platform shall extend about six (6) inches beyond the outer edges of the bearer. Each bearer shall be fastened to the platform.

17.21.2. A wood edging not less than ¾ by 1½ inches, or equal, shall be placed around all sides of the platform to prevent tools from rolling off.

17.21.3. Supporting ropes shall be 1-inch diameter manila rope or equal, free from deterioration, chemical damage, flaws or other imperfections. Rope connections shall be such that the platform cannot shift or slip. If two ropes are used with each float, they shall be arranged to provide four (4) ends which are fastened to an overhead support. Each of the two (2) supporting ropes shall be hitched around one end of a bearer and pass under the platforms to the other end of the bearer where it is hitched again, leaving enough rope at each end for the supporting ties.

17.21.4. Each worker shall be protected by a PFAS. The lifeline shall be attached to substantial members of the structure (not the scaffold) or to securely rigged lines, which shall safely suspend the worker in case of a fall.

**Table 17.1. Scaffold Grade Planking.**

Scaffold Grade Planking					
Materials					
	Full Thickness Undresses Lumber			Nominal Thickness Lumber	
Working Load (p.s.f.)	25	50	75	25	50
Permissible Span (ft.)	10	8	6	8	9

**Note:** The maximum permissible span for 1 ¼ x 9-inch or wider plank of full thickness is 4 feet with medium loading of 50 p.s.f..

**Table 17.2. Insulated Lines.**

Insulated Lines		
Voltage	Minimum distance	Alternatives
Less than 300 volts	3 feet (0.9 m)	
300 volts to 50 kv	10 feet (3.1 m)	
More than 50 kv.....	10 feet (3.1 m) plus 0.4 inches (1.0 cm) for each 1 kv over 50 kv	2 times the length of the line insulator, but never less than 10 feet (3.1 m)

**Table 17.3. Uninsulated Lines.**

<b>Uninsulated Lines</b>		
<b>Voltage</b>	<b>Minimum distance</b>	<b>Alternatives</b>
Less than 50 kv.....	10 feet (3.1 m)	
More than 50 kv.....	10 feet (3.1 m) plus 0.4 inches (1.0 cm) for each 1 kv over 50 kv	2 times the length of the line insulator, but never less than 10 feet (3.1 m)

**Table 17.4. Tube and Coupler Scaffolds – Light Duty.**

<b>Tube and Coupler Scaffolds – Light Duty</b>		
Uniformly distributed load .....	Not to exceed 25 p.s.f.	
Post spacing (longitudinal) .....	10 ft.	0 in.
Post spacing (transverse) .....	6 ft.	0 on.
<b>Working levels</b>	<b>Additional planked levels</b>	<b>Maximum height</b>
1	8	125 ft.
2	4	125 ft.
3	0	91 ft. 0 in.

**Table 17.5. Tube and Coupler Scaffolds – Medium Duty.**

<b>Tube and Coupler Scaffolds – Medium Duty</b>		
Uniformly distributed load .....	Not to exceed 50 p.s.f.	
Post spacing (longitudinal) .....	8 ft. 0 in.	
Post spacing (transverse) .....	6 ft. 0 in.	
<b>Working levels</b>	<b>Additional planked levels</b>	<b>Maximum height</b>
1	6	125 ft.
2	0	78 ft. 0 in.

**Table 17.6. Tube and Coupler Scaffolds – Heavy Duty.**

<b>Tube and Coupler Scaffolds – Heavy Duty</b>	
Uniformly distributed load .....	Not to exceed 75 p.s.f.
Post spacing (longitudinal) .....	6 ft. 6 in.
Post spacing (transverse) .....	6 ft. 0 in.



**Table 17.7. Outrigger Scaffolds.**

<b>Outrigger Scaffolds</b>		
	<b>Light Duty</b>	<b>Medium Duty</b>
Maximum scaffold load	25 p.s.f.	50 p.s.f.
Outrigger size	2 x 10 in.	3 x 10 in.
Maximum outrigger spacing	10 ft. 0 in.	6 ft. 0 in.
Planking	2 x 9 in.	2 x 9 in.
Guardrail	2 x 4 in.	2 x 4 in.
Guardrail uprights	2 x 4 in.	2 x 4 in.
Toeboards (minimum)	4 in.	4 in.

**Table 17.8. Ladder-Type Platforms.**

<b>Ladder-Type Platforms</b>					
	<b>Length of platform (feet)</b>				
	12	14 & 16	18 & 20	22 & 24	28 & 30
Side stringers Minimum Cross Section (finished) Sizes:					
At ends (in.)	1 ¾ x 2 ¾	1 ¼ x 2 ¾	1 ¾ x 3	1 ¾ x 3	1 ¾ x 3 ½
At middle (in.)	1 ¾ x 3 ¾	1 ¾ x 3 ¾	1 ¼ x 4	1 ¾ x 4 ¼	1 ¾ x 5
Reinforcing strip (minimum) (1)	.....				
Rungs (2)	..... ..... .....				
Tie Rods:					
Number (minimum)	3	4	4	5	6
Diameter (minimum)	¼ in.	¼ in.	¼ in.	¼ in.	¼ in.
Flooring, Minimum Finished Size (in.)	½ x 2 ¾	½ x 2 ¾	½ x 2 ¾	½ x 2¾	½ x 2 ¾

**NOTES:**

1. A 1/8 x 7/8 in. steel reinforcing strip or its equivalent shall be attached to the side or underside full length.
2. Rungs shall be 1 1/8 in. minimum diameter with at least 7/8 in. diameter tenons, and the maximum spacing shall be 12 in. center to center.

**Table 17.9. Bricklayers' Square Scaffolds.**

<b>Bricklayers' Square Scaffolds</b>	
<b>Members</b>	<b>Dimensions (Inches)</b>
Bearers or horizontal members	2 by 6
Legs	2 by 6
Braces at corners	1 by 6
Braces diagonally from center frame	1 by 8

**Table 17.10. Horse Scaffolds.**

<b>Horse Scaffolds</b>	
<b>Members</b>	<b>Dimensions (Inches)</b>
Horizontal members or bearers	3 by 4
Legs	1 ¼ x 4 ½
Longitudinal brace between legs	1 by 6
Gusset brace at top of legs	1 by 8
Half diagonal braces	1 ¼ x 4 ½

**17.22. Scaffolding Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations. **Note:** Due to the numerous types and different requirements for each specific type of scaffolding only general requirements are included in this checklist. For specific safety and design requirements involving different types of scaffolding, contact your installation Ground Safety office or CE.

17.22.1. Are scaffolds constructed and erected only by qualified and trained personnel? Reference [17.3.1](#)

17.22.2. Are scaffold footings and anchorages designed to support the maximum intended load without settling or displacement? Reference [17.3.2](#)

17.22.3. Is the use of unstable objects such as barrels, boxes, loose brick or concrete blocks to support scaffolds or planks prohibited? Reference [17.3.2](#)

17.22.4. Are guardrails installed on open sides and ends of platforms 4 feet or more (and toeboards if 10 feet or more) above the working level? Reference [17.3.3.1](#)

17.22.5. Is a wire mesh screen installed between the toeboard and guardrail along the entire length of opening where persons work or pass beneath the scaffold? Reference [17.3.3.2.5](#)

17.22.6. Is the scaffolding designed to support at least four (4) times the intended load? Reference [17.3.4](#)

17.22.7. Is scaffolding maintained in good condition and are parts inspected prior to their use? Reference [17.3.6](#)

17.22.8. Are deficiencies such as missing parts or members; broken, bent or rusted parts; or any other condition that could affect the integrity of the scaffold, repaired or replaced immediately? Reference [17.3.6](#)

17.22.9. Are scaffold pole, legs or uprights plumb and securely and rigidly braced to prevent swaying and displacement? Reference [17.3.13](#)

17.22.10. Do personnel involved in erection, maintenance and teardown of overhead scaffolding wear hard hats? Reference [17.3.15](#)

17.22.11. Are measures taken to protect workers during adverse weather conditions? Reference [17.3.17](#)

17.22.12. Are tools, materials and debris that could create a hazard prohibited from accumulating on scaffolding? Reference [17.3.18](#)

17.22.13. Is the use of shore scaffolds or lean-to scaffolds prohibited? Reference [17.3.21](#)

17.22.14. When protection of wooden parts on a scaffold is required, is clear varnish, lacquer or shellac used, and the use of paint prohibited? Reference [17.3.26](#)

17.22.15. Is scaffolding that is excessively heavy, bulky or awkward moved with the assistance of other workers or mechanical handling equipment to prevent injury to workers? Reference [17.3.27](#)

## Chapter 18

### MACHINERY

**18.1. General Information.** Refer to 29 CFR 1910 Subpart O, *Machinery and Machine Guarding*, and the National Safety Council (NSC) *Accident Prevention Manual for Industrial Operations*, for additional definitions and Figures.

#### 18.2. Hazards.

18.2.1. All mechanical motion is potentially hazardous. Motion hazards, such as rotating devices, cutting or shearing blades, in-running nip points, reciprocating parts, linear moving belts and pulleys, meshing gears, and uncontrolled movement of failing parts, are examples of motion which may be peculiar to any one machine or job operation. Personnel exposed to machinery or equipment hazards must be aware of the potential hazards.

18.2.2. Machine operators and others exposed to moving parts can get clothing, hair or body parts caught in the machinery. The chance of these mishaps occurring is greater as fatigue increases or attention decreases. Pressure to get the job done may result in overlooking sound work practices or attempting to bypass guards. This is particularly true when the operation necessitates the removal of guards to make adjustments, etc.

18.2.3. The techniques and skills for setting up and operating equipment require effective training programs.

18.2.4. Injuries from working on or near moving machinery range from minor cuts and bruises to a severed limb. This hazard exists where shop machinery is operated and may exist at all job sites where vehicles, equipment or machinery are in use.

#### 18.3. General Requirements.

18.3.1. Acquisition. Machines and attachments may be locally and centrally procured. All newly acquired machines shall meet the design and construction requirements identified in Military Specifications (Mil Specs). OSHA standards in **Table 18.1** will be used when no Mil Specs exist. Supervisors needing access to OSHA standards should contact the installation Ground Safety office or go to website: <http://www.osha.gov>. If a machine is not specifically covered by this instruction, a Mil Spec or an OSHA standard, the installation Ground Safety office shall be contacted for assistance in identifying applicable criteria. When possible, machinery should be selected that minimizes worker exposure to noise, vibration and awkward ergonomic positions.

18.3.2. Installation. Machines designed for fixed locations or that may tip over shall be securely fastened to the floor or other suitable foundation to eliminate all movement or walking. Machines equipped with rubber feet, nonskid foot pads or similar vibration dampening materials shall be installed IAW the manufacturer's recommendations. Weight limitation of floors or foundations shall be considered prior to machinery installation. Refer to 29 CFR 1910.212., *General Requirements for all Machines*, for additional information.

18.3.2.1. Sufficient space shall be provided around each machine to allow materials to be handled with the least possible interference from and to other workers and to allow access

for maintenance and repair. For detailed information on shop layout, passageways and machine clear zones, refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*.

18.3.2.2. IAW AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, BE shall determine requirements for exhaust systems. Machines that develop fine dust and fumes that are hazardous to workers shall be equipped with effective hoods, connected to an exhaust system. An interlocking device shall be installed to link the machine's power supply and the exhaust system to prevent operation of the machine without the exhaust system operating. In shops where small numbers of machines are not continuously in operation, portable collection systems may be more cost effective. Hoods and exhaust systems shall be constructed and installed to meet requirements of the current version of the American Conference of Governmental Industrial Hygienists (ACGIH) ventilation design standards.

18.3.2.3. Consult the installation CE facility design section whenever specific guidance on lighting is required for specific locations. Fine work may require increased illumination. This can be obtained with a combination of increased general lighting plus supplementary lighting. If fluorescent lighting is used, it shall be installed so as to eliminate any stroboscopic effect with moving machinery. Submit an AF Form 332, *Base Civil Engineer Work Request*, when a lighting survey is required. If the safety or health of personnel is a factor, the work request shall be coordinated with the installation Ground Safety office and/or BE, who may assign a risk assessment code (RAC), if warranted.

18.3.2.4. Machine energy isolating devices shall be capable of being locked out by a designed hasp or other attachment or an integral part to which, or through which, a lock can be affixed or the energy isolated by simply disconnecting an electrical plug.

18.3.3. Training. Personnel shall be trained by the supervisor or a designated trainer on all machinery or equipment they are required to use prior to use. Only trained personnel or those undergoing supervised on-the-job training shall operate shop machinery or equipment. Training shall be documented in the worker's AF Form 623, *Individual Training Record Folder*, for military personnel, and the Standard Form (SF) 182, *Authorization, Agreement and Certification of Training*, for government civilian workers.

18.3.3.1. Operators shall be trained in the proper operation, safety procedures, cleaning, hazard recognition and emergency shutdown procedures for each machine or piece of equipment they use.

18.3.3.2. Operators shall also be trained on machine or equipment maintenance or repairs they are required to perform.

18.3.3.3. Services craft or hobby shop patrons shall be trained by the supervisor or a designated trainer on the proper operation, safety procedures, hazard recognition and emergency procedures for each piece of equipment they will use. An Arts and Crafts Equipment Qualification card shall be issued to identify the machinery the patron is authorized to operate. Personnel shall not operate machines or equipment if this card is not available.

18.3.3.4. Supervisors and operators shall receive training on lockout and tagout procedures contained in **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*,

to ensure the purpose of the program is understood, and that each person has the knowledge and skills required to apply and remove locks and tags. Operators shall be retrained when there is a change in energy control procedures or a change in job assignment, machines or equipment. Services patrons, i.e. base hobby shops, shall receive general awareness training IAW paragraph **21.5.1** to understand the lockout and tagout program, but shall not apply or remove locks or tags.

#### 18.3.4. Safe Operations.

##### 18.3.4.1. Supervisors will:

18.3.4.1.1. Maintain manufacturers' manuals for all machinery or equipment under their control. In the absence of these, supervisors shall develop local OIs, to include job safety, maintenance (including cleaning and sanitizing as required), lubrication and inspection. Such instructions shall identify operator and maintenance technician responsibilities. Refer to 29 CFR 1910.212., and 1910.263., *Bakery Equipment*, for additional information.

18.3.4.1.2. Ensure only authorized personnel operate and maintain shop equipment.

18.3.4.1.3. Periodically evaluate machinery or equipment operators to ensure they are following proper and safe operating procedures. See paragraph **18.3.3** for required training.

18.3.4.2. Machines shall be used only for work within the rated capacity specified by the machine manufacturer.

18.3.4.3. One or more methods of machine guarding shall be provided to protect the operator and other employees or patrons in the machine area from hazards such as those created by point of operation, in-running nip points, rotating parts, flying chips, power transmission apparatus and sparks. For additional guidance refer to OSHA Publication 3067, *Concepts and Techniques of Machine Safeguarding*. Refer to 29 CFR 1910.212. for additional guidance.

18.3.4.4. Machines shall not be operated unless all guards are securely in place and operational. Any time guards are removed, the power cord shall be disconnected or the machinery turned off, locked out and tagged out. Refer to 29 CFR 1910.212., 29 CFR 1910.147., *The Control of Hazardous Energy (Lockout/Tagout)*, **Chapter 21** and paragraph **18.3.5.4** for additional guidance.

18.3.4.5. Machines shall be maintained so, while running, they are free of excessive vibration. Refer to 29 CFR 1910.213., *Woodworking Machinery Requirements*, for additional information.

18.3.4.6. No blade, cutterhead or collar shall be placed or mounted on a machine arbor unless it has been accurately sized and shaped to fit the arbor. Refer to 29 CFR 1910.213. for additional information.

18.3.4.7. Arbors and mandrels shall have a firm and secure bearing and be free from excessive end play. Refer to 29 CFR 1910.213. for additional information.

18.3.4.8. Machines shall never be left unattended with the control switch in the ON position. The operator shall remain at the machine until all motion has ceased. In the event of a power failure, the operator shall immediately switch the machine to the OFF position.

18.3.4.9. Workers operating, helping or observing machine operations shall comply with PPE requirements for each particular machine and general PPE requirements for the work area. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional information.

18.3.4.10. Loose fitting clothing, neckties, rings, bracelets or other apparel that may become entangled in moving machinery, power transmission apparatus or moving parts shall not be worn by machine operators, their helpers or anyone in close proximity of this equipment.

18.3.4.11. Hair nets or caps shall be worn to keep long hair under control and safely away from moving machinery, power-transmission apparatus or moving parts. Refer to **Chapter 9**, *Jewelry*, and **Chapter 14** for additional information.

18.3.4.12. The operator shall allow all moving parts to come to a complete stop before any attempt is made to clean or clear jammed work or debris from any part of a machine. Chips or other particles shall be removed using brushes, tools designed for such a purpose or compressed air. If using compressed air for cleaning equipment, keep the air pressure as low as practical, but limit air pressure to less than 30 psi, unless a lower pressure is required by TO, manufacturer's data or local procedures. Also, ensure the nozzle discharge tip is a diffuser type. Compressed air shall not be used to blow chips or other debris from a worker's body or clothing. Effective chip guarding (nozzle discharge tip is a diffuser type) and PPE shall be used. Also, to prevent flying chips and particles from striking the eyes and skin of the operator and bystanders, screens, barriers or protective cones attached to air nozzles shall be used.

#### 18.3.5. Inspection and Maintenance.

18.3.5.1. Supervisors shall ensure all machines are inspected upon receipt to detect and correct defects. TO 34-1-3, *Inspection and Maintenance of Machinery and Shop Equipment*, shall be followed for periodic inspection requirements.

18.3.5.2. Operator's inspection shall be conducted prior to the start of each shift, following a new setup or when operators change. This inspection shall ensure operating components are in good working order, and guards, interlocks and other protective devices are activated or in place, operating properly and in proper adjustment. Necessary maintenance or repair shall be performed and completed before the machine is placed in operation.

18.3.5.3. Repairs beyond the operator's capability shall only be accomplished by a qualified technician.

18.3.5.4. When maintenance is needed, whether done by the supervisor, operator or specialized technician, machines shall be completely shut down and all energy isolating devices locked out in the OFF position. The appropriate warning tag shall be affixed to the machine or energy source. In cases where machine or equipment design prohibits the

lockout capability, the tagout procedure with the **AF Form 983, *Danger – Equipment Lockout Tag***, shall be used. When machines and equipment are overhauled or replaced, energy isolating devices or controls that can be locked out must be installed. Refer to **Chapter 21** for specific guidance on installation of locks and tags.

18.3.5.5. All guards, interlocks and safety devices shall be in place prior to restoring power, unless their removal is required by technical data for an operational check.

18.3.5.6. Services patrons shall not perform maintenance on shop equipment. Malfunctioning equipment shall be shut down immediately and reported to the supervisor.

18.3.5.7. Electrical powered equipment shall be unplugged at the outlet or turned off at the circuit breaker or disconnect switch before washing the equipment or the surrounding area when water could splash on the equipment. Electrical components shall be protected when there is danger of water or cleaning liquids entering them.

18.3.5.8. Records of supervisor inspections and any machine maintenance shall be maintained.

#### 18.3.6. Machine Layout Requirements.

18.3.6.1. Machines subject to movement because of vibration, rotation or other reasons shall be securely fastened to prevent their movement while operating. Exceptions are machines (for example, meat slicers) which have very little vibration or movement and can be satisfactorily held in position with rubber feet.

18.3.6.2. Sufficient space for material handling and maintenance shall be provided around each machine. The installation Ground Safety office staff and CE shall be contacted for assistance on layout problems. Refer to **Chapter 7** for additional information on shop layout.

### 18.4. Woodworking Machinery.

#### 18.4.1. Hazards and Human Factors.

18.4.1.1. Hazards. The primary hazard of woodworking equipment is high-speed, revolving cutting blades and knives. Contact with these parts can result in lacerations and amputation of body parts. Other job hazards that account for a wide variety of injuries and illnesses are jamming or kicking back of material and wood chips, flying objects (wood chips, broken saw blades, etc.), poor housekeeping, improper material handling, unsatisfactory maintenance of machinery, excessive equipment noise and inhalation of wood dust. **Note:** Work on copper arsenate treated wood and western red cedar should be assessed by BE to ensure proper protection.

18.4.1.2. Human Factors. Many injuries in woodworking jobs result from personnel failing to follow prescribed safe operating practices. These failures result from worker attitude, inadequate training and supervisory failure to enforce safe job procedures. The use of machine guards, environmental controls, good training and maintenance programs, coupled with supervisory enforcement of protective equipment use and safe job practices, can eliminate most mishap-producing factors.



## 18.4.2. Requirements.

### 18.4.2.1. Tilting-Arbor and Tilting-Table Saws (29 CFR 1910.213.).

18.4.2.1.1. Table saws shall be equipped with a hood that covers the blade and automatically adjusts itself to the thickness of the material upon which it rides. The hood shall cover the part of the saw blade exposed above the material and shall be adaptable to cover tilted blades.

18.4.2.1.2. Table saws shall be provided with a spreader to prevent the wood's internal stresses from clamping down on the saw blade.

18.4.2.1.3. Table throat openings shall be kept as small as possible to prevent material from dropping below the level of the table. Several size throat pieces shall be available to accommodate rabbeting, grooving and dadoing operations.

18.4.2.1.4. Devices such as anti-kickback dogs and fingers or safety hold-down wheels shall be installed when ripping material. Anti-kickback dogs and fingers shall be inspected before each use and kept sharp to maintain their holding power.

18.4.2.1.5. Saw operators shall not reach over a revolving saw blade for any reason. If this appears necessary, a helper shall be positioned at the output end of the saw.

18.4.2.1.6. Saw blades shall not be stopped after the power is off by thrusting a piece of wood against the cutting edge or side of the blade.

18.4.2.1.7. Saw tables shall extend far enough on either side to give full support to any length of board that may be cut.

18.4.2.1.8. The blade or cutting head shall be inspected to ensure it is in proper cutting condition, for example, teeth sharp and properly set, no cracks and free of foreign residue, before starting any job.

18.4.2.1.9. The correct blade shall be matched to the work being done, to aid in avoiding kickbacks and other hazards. The following precautions will be taken:

18.4.2.1.9.1. A crosscut blade shall not be used for rip sawing or a ripping blade for crosscutting. Use of the wrong blade requires additional force to feed material and increases the danger of a slip-of-the-hand mishap, as well as encouraging a kickback. Services hobby shop supervisors shall clearly label each saw with a sign or decal, stating which type blade is installed and its uses.

18.4.2.1.9.2. Special blades shall be used for such materials as plywood or lumber in which there might be nails or other metal. If warped, twisted-grain, knotty or frozen lumber must be ripped, a carbide-tipped, controlled-cut blade shall be used.

18.4.2.1.10. Operators shall not crowd the saw, that is, force the material faster than it can be easily cut. If the saw does not cut a clean, straight line, something is wrong with the saw or the running speed. These conditions are potential sources of mishaps and shall be checked and remedied.

18.4.2.1.11. The rip fence shall be adjusted only when the saw is turned off and blade rotation has stopped. To enable the operator to set the rip fence without lifting the saw

guard, a permanent line shall be marked on the table in front of and in line with the saw blade.

18.4.2.1.12. Hands shall be kept out of the line of cut when feeding saws. When there is not enough room (at least 12 inches) for hand movement between the rip fence and saw blade, material shall be moved forward with a push stick.

18.4.2.1.13. The hood shall not be removed when narrow material is being ripped. Clearance for the hood can be obtained by attaching a filler piece to the table between the rip fence and the saw blade.

18.4.2.1.14. Saw blades shall be set no higher than is necessary to cut through the material being worked. One of two acceptable practices shall be used: either no more than three (3) teeth shall protrude above the material being cut, or not more than 1/8 inch of saw blade shall protrude above the material being cut.

18.4.2.1.15. Feather boards shall be used as side guides and top hold-downs on operations, such as rabbeting, grooving and dadoing, when a blade hood cannot be used. Their comb-tooth or feathered edges provide the right kind of pressure to firmly guide the material and prevent it from kicking back. Also, they prevent the operator's hand from moving into the blade.

#### 18.4.2.2. Radial Arm Saws (29 CFR 1910.213.).

18.4.2.2.1. Radial saws shall be equipped with a hood that encloses the saw blade and the arbor ends. The lower section of the hood shall be hinged so it rises and falls, adjusting itself automatically to the thickness of the material as the saw passes through it.

18.4.2.2.2. An anti-kickback device or hold-down wheel shall be installed on saws used for ripping. The device shall be adaptable to any thickness of stock to be cut.

18.4.2.2.3. Manually-operated radial saws shall be installed so the front of the table is slightly higher than the rear, which should prevent the cutting head from moving forward when the motor is turned on (without touching the moveable saw head). If the saw cutting head moves forward, the operator should first check to make sure the saw blade is not touching the table top. If the saw blade is located correctly, the front of the table should be raised to a height that prevents this movement.

18.4.2.2.4. With the saw turned off, the operator should pull the saw cutting head all the way forward and with the operator's hand on the pull grip and exerting minimal or no force, follow the head back to its original non-cutting position. If the movement of the saw has a tendency to drag, is jerky, or requires excessive force, the operator shall check the rollers for wear.

18.4.2.2.5. The operator should turn the saw ON and observe that the saw cutting head does not move forward.

18.4.2.2.6. If a sluggish or hesitant movement of the saw is detected during operation, the unit shall be turned off and taken out of service until the cause of the malfunction is corrected.

18.4.2.2.7. If at any time the saw rolls or moves out on the arm away from the column unassisted as a result of vibration, the unit shall be taken out of service until the cause of the malfunction is corrected.

18.4.2.2.8. The saw shall have a positive limit-stop to prevent the saw from traveling beyond the front edge of the table. Since this limits the width of the material that can be cut, it may be necessary to increase the width of the table so the saw can be operated safely the full distance of the arm.

18.4.2.2.9. When the saw is being used to crosscut a board, the operator shall pull the saw cutting head forward by hand until the cut is completed, then push the cutting head back easily to its non-cutting position. At no time shall the operator release the cutting head and let it roll back to the non-cutting position by itself.

18.4.2.2.10. Material shall be measured by placing the material to be cut against a stop gauge (whenever repeat cuts are required). When it is necessary to measure with a ruler, material shall be kept well away from the saw until measuring is completed.

18.4.2.2.11. When ripping with a radial saw is necessary, ripping and ploughing shall be against the direction in which the saw turns. The direction of the saw rotation shall be conspicuously marked on the hood. In addition, a permanent label not less than 1 ½ inches by ¾ inches shall be affixed to the rear of the guard at approximately the level of the arbor reading as follows: "DANGER: DO NOT RIP OR PLOUGH FROM THIS END" or the nearest commercially available equivalent.

18.4.2.2.12. Stock shall not be removed from the table until the saw is returned to its stopped position.

18.4.2.2.13. When making angle cuts or miter cuts, the locking device on the saw head shall be securely fastened.

18.4.2.2.14. When crosscutting, the stock shall lie solidly on the table and against the back guide.

18.4.2.2.15. Ensure the blade being used is proper for the work being performed.

18.4.2.2.16. When removing short pieces from a table close to the saw blade, the operator shall ease the saw back to the idling position and make sure all bouncing has stopped before placing hands on the table. Cylindrical stock shall be cut on a radial saw only when securely clamped.

#### 18.4.2.3. Band Saws (29 CFR 1910.213.).

18.4.2.3.1. Both upper and lower wheels shall be completely enclosed on both sides. The enclosures should be capable of being removed easily to permit saw blade maintenance.

18.4.2.3.2. The working part of a saw blade, between the guide rolls and the upper wheel enclosure, shall be guarded to prevent accidental contact with the saw blade. The guard shall be self-adjusting and attached to the gauge so that, in any position of the gauge, the guard will completely cover the portion of the saw blade between the guide rolls and upper wheel enclosure.

- 18.4.2.3.3. Saw Blade Tension. Excessive tension can cause fatigue failure of the blade and blade breakage. A means shall be provided to adjust and indicate the proper tension for the range of band saw blades used. Preferably, band saws should have an automatic tension control to compensate for the contraction that takes place as the blade cools after a job is finished and to ensure proper tension of the saw blade. If tension is manually controlled (i.e., no automatic tension control), instructions/procedures for tension control shall be developed and operators shall be trained, and supervised, in proper tension adjustment(s). **Note:** Automatic tension control/device is not mandatory.
- 18.4.2.3.4. Feed rolls on self-fed band saws shall be guarded to prevent the operator's hands from coming into contact with the in-running rolls at any point.
- 18.4.2.3.5. The saw speed shall not exceed the safe limit recommended by the manufacturer.
- 18.4.2.3.6. If material binds or pinches on the blade, the operator shall not attempt to back the work away from the blade until the machine is turned off and blade motion has stopped.
- 18.4.2.3.7. If a saw blade should break, the operator shall shut off the power, lock the start switch in the OFF position, and not attempt to remove any part of the saw blade until the machine has completely stopped.
- 18.4.2.4. Jointers (29 CFR 1910.213.).
- 18.4.2.4.1. Each hand-fed planer and jointer with a horizontal or vertical head shall be equipped with a cylindrical cutting head, the knife projection of which will not exceed 1/8 inch beyond the cylindrical body of the head.
- 18.4.2.4.2. The opening in the table shall be kept as small as possible. The clearance between the edge of the rear table and the cutting head circle or knives shall not exceed 1/8 inch. The table throat opening shall not exceed two (2) inches when tables are set or aligned with each other for a zero cut.
- 18.4.2.4.3. Jointers with front-table-mounted fences shall be equipped with an adjustable device to prevent thin stock from slipping laterally under the portion of the fence at the rear of the table.
- 18.4.2.4.4. An automatic guard shall be provided to cover the section of the cutter head near the operator (on the working side of the fence) and to contact the wood to prevent any opening between the guard and wood during the operation. The guard shall cover the section of the cutter head on the nonworking side of the fence, especially when the fence is moved toward the automatic guard. Two types of automatic guards are commonly found on jointers. One type is pushed aside by the material and is referred to as a swing guard. The other type, found on some old machines, rises to the top of the stock and drops after the material passes beneath it. Each type has some advantages and disadvantages depending on the principal type of operation performed. The swing guard is the most common type. The swing guard is pushed aside by the stock passing over the cutting head and is returned against the

fence by a spring after the wood is removed. For surface jointing, the cutter head shall be momentarily exposed as the rear of the stock passes over it. A well-constructed push block will protect an operator's hand at this point. The overhead guard may rise above the material or in some designs will also move to the side of the stock. This guard does impede the use of push blocks.

18.4.2.4.5. The guard over the section of the cutting head on the rear side of the fence shall consist of a sliding metal shield that will automatically adjust to the exposed length of the cutter head.

18.4.2.4.6. Whenever power feeders are used, the feeding mechanism shall be guarded by a metal shield or hood.

18.4.2.4.7. Because knife blades on a revolving cutting head produce a thrust forceful enough to pull stock from an operator's hand, hold-down push blocks, jigs or fixtures shall be used.

#### 18.4.2.5. Power Feed Planers (29 CFR 1910.213.).

18.4.2.5.1. Guards shall be provided for feed rolls, cutting heads and hold-down rolls at the discharge end. Feed rolls shall be guarded by a metal strip in front of the rolls under which the material may pass, but will prevent an operator's fingers being drawn into the rolls while feeding the machine. Where the top roll is corrugated, the strip shall extend over the top of the roll. Cutting heads and discharge rolls shall be guarded by a solid metal enclosure of substantial construction. The hood of an exhaust system may form part or all of the enclosure.

18.4.2.5.2. When other than corrugated top-feed rolls are used, an anti-kickback device shall be installed.

18.4.2.5.3. The operator shall examine each planer before use to ensure that knives are not set to take too heavy a cut for one pass.

18.4.2.5.4. Helpers shall position themselves where they will not be pinned between the material and an immovable object.

18.4.2.5.5. Operators shall be especially careful of their fingers when surfacing a short length of material as the infeed rolls may tip the material up and then down quickly, causing fingers to become pinched between the table top and the material.

#### 18.4.2.6. Shapers (29 CFR 1910.213.).

18.4.2.6.1. Shapers shall be equipped with a braking device that will stop the cutting head within 10 seconds after power is shut off. A double-spindle machine shall be equipped with separate braking devices.

18.4.2.6.2. A fence shall have as small an opening for the knives as possible and shall extend at least 18 inches on either side of the spindle.

18.4.2.6.3. Cutting heads shall be enclosed by a guard. The guard shall not be less than the greatest diameter of the cutter. Attaching a warning device of leather or other such material to the spindle is not acceptable.

18.4.2.6.4. Whenever possible, hold-downs and jigs shall be used to limit exposure of hands to cutters.

18.4.2.6.5. When a blade is removed from a spindle for sharpening, or for some other purpose, all other blades shall be removed at the same time.

18.4.2.7. Lathes (29 CFR 1910.213.).

18.4.2.7.1. Rotating, cutter-type lathes shall be provided with a hinged metal shield or hood that completely covers the knives and material when the machine is in operation. Exhaust system hoods may be included as part of the guard if they comply with standard guard designs.

18.4.2.7.2. Automatic lathes shall be equipped with a brake that will bring rotating material to a quick, but not instantaneous, stop after the power is shut off.

18.4.2.7.3. Automatic lathes shall be placed with the back side against a wall or barrier to contain knives should they be thrown rearwards.

18.4.2.7.4. Tool rests shall be set parallel, as close as possible to the work and high enough so tools will butt into the wood slightly above the horizontal center of the piece being turned.

18.4.2.7.5. Faceplate type lathes shall be provided with a control stop so the operator cannot unintentionally throw the power directly from the normal running direction of rotation into reverse. This will avoid the possibility of the faceplate unscrewing and flying off.

18.4.2.7.6. Lathes used for turning long pieces of material shall be equipped with guards that will contain the work piece if it separates from its anchorage.

18.4.2.7.7. Operators will not stand directly in line with hand-turning tools.

18.4.2.7.8. When sanding, the sandpaper shall be held in the fingers and pressed lightly against a small area at the top of the rotating material. This will keep the sandpaper from catching and pulling the operator's hand around the material.

18.4.2.7.9. Poor quality wood shall not be used for wood turning.

18.4.2.8. Sanding Machines (29 CFR 1910.213.).

18.4.2.8.1. Feed rolls of self-feed sanding machines shall be protected with a guard to prevent hands from coming in contact with the in-running rolls at any point.

18.4.2.8.2. Belt sanding machines shall be provided with guards at each nip point. These guards shall effectively prevent hands or fingers from coming in contact with the nip points. The unused run of the sanding belt shall be guarded against accidental contact.

18.4.2.9. Boring and Mortising Machines (29 CFR 1910.213.).

18.4.2.9.1. Safety-bit chucks shall not have projecting set screws.

18.4.2.9.2. A guard shall be provided which will enclose all portions of the bit chuck above the material being worked.

18.4.2.9.3. The top of the driving mechanism shall be enclosed.

18.4.2.9.4. If there is a counterweight, one of the following or equivalent methods shall be used to prevent its dropping:

18.4.2.9.4.1. It shall be bolted to the bar by a bolt passing through both the bar and counterweight.

18.4.2.9.4.2. A bolt shall be put through the extreme end of the bar.

18.4.2.9.4.3. Where the counterweight does not encircle the bar, a safety chain shall be attached to it.

18.4.2.9.4.4. Other types of counterweights shall be suspended by chain or wire rope and will travel in a pipe or other suitable enclosure wherever they might fall and cause injury or damage.

18.4.2.9.4.5. Universal joints on spindles of boring machines shall be completely enclosed to prevent accidental contact by the operator.

18.4.2.9.4.6. Each table-type boring or mortising machine shall be equipped with hold-down devices to keep work securely in place.

18.4.2.10. Tenoning Machines (29 CFR 1910.213.).

18.4.2.10.1. Feed chains and sprockets of double-end tenoning machines shall be completely enclosed, except for that portion of chain used for conveying the stock.

18.4.2.10.2. Sprockets and chains shall be guarded at the sides by plates projecting beyond the periphery of sprockets and the ends of lugs at the rear ends of frames over which feed conveyors run.

18.4.2.10.3. Each tenoning machine shall have cutting heads and saws, if used, covered by metal guards. These guards shall cover at least the unused part of the periphery of the cutting head. Where an exhaust system is used, the guard may form part or all of the exhaust hood.

18.4.2.11. Electrical Requirements and Safeguards (29 CFR 1910.213. and 1910.147.).

18.4.2.11.1. The motor START switch shall be protected against accidental or inadvertent operation. Refer to 29 CFR 1910.217., *Mechanical Power Presses*, for additional information.

18.4.2.11.2. All machinery shall be installed IAW NFPA 70, *National Electrical Code*.

18.4.2.11.3. Control switches shall be available to workers at their operating positions so they will not need to reach over moving parts of machinery. The stop control switch shall be identified by a printed word or color coded red. Controls shall not be wedged for continuous operation.

18.4.2.11.4. Machines not adequately safeguarded to protect the worker during an under-voltage situation or a power failure shall have an under-voltage protective device installed. This device prevents the machine from starting up after a power interruption, exposing the worker to the hazards of moving parts. Qualified operators

shall follow the safe operating practices in paragraph [18.3.4](#). The installation Ground Safety office and work center supervisors are responsible for identifying those machines that require this protection.

18.4.2.11.5. Foot treadle controls shall be protected against unexpected or accidental tripping. These controls shall also have a non-slip surface.

18.4.2.11.6. Exposed non-current-carrying metal components that may become energized shall be grounded.

18.4.2.11.7. All machine energy sources or energy isolating devices shall be locked out and tagged out before performing maintenance or major adjustments to moving parts that require panels and guards to be removed. **AF Form 983, *Danger – Equipment Lockout Tag***, may be used temporarily until the lockout is accomplished or in conjunction with the lockout. Refer to [Chapter 21](#) for additional guidance on lockout procedures. When working with cord and plug connected electric equipment for which exposure to the hazards of unexpected energization or start up of the equipment is controlled by the unplugging of the equipment from the energy source and by the plug being under the exclusive control of the employee performing the servicing or maintenance, then lockout/tagout is not required.

18.4.2.12. Safeguarding by Location or Distance. To safeguard by location, the machine or its dangerous moving parts must be positioned so hazardous areas are not accessible or do not present a hazard to a worker during the normal operation of the machine. This may be accomplished by locating a machine where a building design feature, such as a wall, protects the worker and other personnel. Additionally, enclosure walls or fences can restrict access to machines. Another possible solution is to have dangerous parts located high enough to be out of the normal reach of any worker.

18.4.2.12.1. Before attempting safeguarding by location or distance, a thorough hazard analysis of each machine and particular situation shall be performed by the supervisor and installation Ground Safety office. The analysis must clearly identify that workers are protected from dangerous moving parts and one of the restrictions in paragraph [18.4.2.12](#) is met.

18.4.2.12.2. Moving parts of machines shall be at least eight (8) feet above the work level, e.g., floor, platform or passageway.

18.4.2.12.3. Machines shall be in an enclosed area with a locked entrance. The enclosure (wall or fence) shall be at least eight (8) feet high. The main source of power shall be disconnected and locked in the OFF position when maintenance, service or major adjustments are made to moving parts with guards and panels removed. The **AF Form 983** will be used in conjunction with the lockout, or in place of the lock if lockout is not possible.

18.4.2.13. Safeguarding Devices.

18.4.2.13.1. A safeguarding device that performs one of several functions can be used to replace a guard. It must:

18.4.2.13.1.1. Stop the machine if a body part is inadvertently placed in the



danger area.

18.4.2.13.1.2. Restrain or withdraw the operator's hands from the danger area during operation.

18.4.2.13.1.3. Require the operator to use both hands on machine controls, thus keeping both hands and body out of danger.

18.4.2.13.1.4. Provide a barrier that is synchronized with the operating cycle of the machine to prevent entry to the danger area during a hazardous part of the cycle.

18.4.2.13.2. These devices shall be installed, adjusted and used IAW manufacturer's operating and maintenance instructions. Refer to 29 CFR 1910.212., *General Requirements for all Machines*, 1910.213, *Woodworking Machinery Requirements*, and 1910.217., *Mechanical Power Presses*, for additional safe distance and maximum opening requirements.

18.4.2.13.3. All hazardous parts not protected by the device must be guarded IAW paragraph [18.4.2.14](#).

18.4.2.14. Safeguarding by Barrier or Enclosure. These guarding techniques primarily apply to three areas: power transmission apparatus, feeding and ejection areas, and points of operation. Barriers may be fixed, adjustable or self-adjusting. Enclosure guards are normally fixed. Both types can be equipped with an interlock that prevents the machine from cycling or starting if the guard is opened or removed. Because the type of operation, size or shape of material, and method of handling vary between machines, the type of barrier or enclosure selected may also vary.

18.4.2.14.1. Every guard must, by design, construction, application and adjustment:

18.4.2.14.1.1. Prevent hands, fingers or other body parts from entering into the hazardous areas by reaching through, over, under or around the guard. Refer to 29 CFR 1910.217., Table O-10, for additional information.

18.4.2.14.1.2. Create no pinch point between the guard and moving machine parts.

18.4.2.14.1.3. Not be easily removable by the worker.

18.4.2.14.1.4. Offer maximum visibility of the point of operation consistent with operational and maintenance requirements.

18.4.2.14.1.5. Be affixed to the machine. Where possible, they shall be hinged to enhance maintenance or adjustments.

18.4.2.14.2. When a point-of-operation guard cannot be used because of unusual shapes or cuts, jigs or fixtures that provide equal safety for the operator shall be used. Upon completion of an unusual operation, the guard shall be immediately replaced.

18.4.2.14.3. Whenever a guard is removed for other than an operational requirement, the machine shall be shut down and the control switches locked and tagged in the OFF position.

18.4.2.14.4. Whenever possible, enclosure and barrier guards shall be interlocked with the machine control so the machine cannot be activated unless the guards, or the hinged or movable sections of the guard, are in position. Refer to 29 CFR 1910.217. for additional safe distance requirements.

18.4.2.14.4.1. The guard shall prevent the operator opening the interlocked section and reaching into the point of operation.

18.4.2.14.4.2. Only personnel authorized by the shop supervisor shall make adjustments.

18.4.2.14.4.3. Guards interlocked with the machine cycle shall, when opened, stop the related component, interrupt the machine cycle, or shut down the machine. Closing the guard shall not restart the machine cycle except when the guard is designed for that purpose.

18.4.2.14.5. When the periphery of the blades of a fan are less than seven (7) feet above the floor or working level, the blades shall be guarded. The guard will have openings no larger than 1/2 inch in width and depth. The use of concentric rings, with spacing between them not exceeding 1/2 inch, is acceptable providing that radial spokes and firm mountings are used to make the guard rigid enough to prevent it being pushed into the fan blade. The use of nylon mesh or similar materials with holes not exceeding 1/2 inch to modify a substandard fan guard is acceptable providing the combination of the two provides protection from contact with the blade. The mesh must not be able to be pushed into the fan blade during normal use.

18.4.2.14.6. An enclosure guard provides the greatest degree of protection against moving parts of transmission apparatus. Any enclosure is satisfactory provided it is strong enough to withstand the bumps and pressure imposed on it without collapsing against the mechanism it covers. Refer to 29 CFR 1910.212. and 1910.219., *Mechanical Power-Transmission Apparatus*, for additional guidance.

18.4.2.14.6.1. The guard shall be designed and installed so no part of the body can be inadvertently placed in, on, under or over the edges of the guard where it might contact a moving part. Refer to 29 CFR 1910.212. for additional guidance.

18.4.2.14.6.2. Guards shall be made of expanded metal; perforated or solid sheet metal; or wire mesh, plastic or other material of equal or greater strength. Material used shall be free from burrs or sharp edges. Guards shall be fastened to the framework of the machinery. In certain environments where chemical or corrosive operations are performed, the installation CE or the Ground Safety office may need to determine the best material for guard construction.

18.4.2.14.6.3. The enclosure guard and its supports shall be designed and installed so an adult person leaning on or falling against the enclosure will not be injured by the moving part.

18.4.2.14.6.4. Where there is a reasonable possibility of the moving part failing and causing injury, the enclosure shall be capable of containing the broken parts. Broken chains, belts, gears and couplings may throw objects when fracture

occurs. Part failure commonly occurs in operations involving frequent starting, stopping, reversing and cyclic shock or peak loads that exceed normal operational loads. Parts that run at high revolutions per minute (rpm) are potential projectile hazards. When part failure is considered a hazard, the guard filler material shall be a solid metallic sheet, plate stock or casting. Sheet or molded plastics or other non-metallics shall not be used unless impact-tested to resist penetration of a specific failing part.

18.4.2.14.6.5. Openings to permit lubrication, adjustment or inspection shall have hinged, sliding or bolted cover plates that shall be closed prior to starting the machine.

18.4.2.14.6.6. Horizontal belts and ropes above floors or platforms shall be guarded for their entire length if located over passageways or workplaces, and if center-to-center distance between pulleys is 10 feet or more.

18.4.2.14.6.7. Vertical belts running over a lower pulley above the floor or platform shall be guarded at the bottom in the same manner as overhead belts.

18.4.2.14.6.8. Where loose pulleys or idlers are not practical, belt perches in the form of brackets, rollers, etc., shall be used to keep idler belts away from the shafts. Perches shall be of strong materials and designed for safe shifting of belts.

18.4.2.14.6.9. Belt dressing shall not be applied when the belt or rope is in motion. However, if necessary, it shall be applied where belts leave the pulleys, not where they approach them.

18.4.2.14.6.10. Unless the distance to the nearest fixed pulley, clutch or hanger exceeds the width of the belt used, a guard shall be provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists. Where there are overhanging pulleys on a line, jack or countershaft, with no bearing between the pulley and the outer end of the shaft, a guard to prevent the belt from running off the pulley shall be installed.

18.4.2.14.6.11. Pulleys with cracks or pieces broken out of rims shall be taken out of service.

18.4.2.14.6.12. Pulleys used in areas where they would be exposed to corrosion shall be made of corrosion-resistant material. Pulleys located in corrosive environments shall be inspected semiannually to ensure they are in satisfactory condition.

18.4.2.14.6.13. Vibration is a recognized hazard potential, and in installations where components frequently pass through high-vibration levels, there is danger of rotating shafts fracturing. Guards that vibrate at high frequencies can become dislodged from their mountings. Operators and maintenance personnel must pay close attention to the integrity of guards. Workers who experience any musculoskeletal disorder symptoms shall report them to their supervisor as soon as possible so an ergonomic evaluation may be conducted.

18.4.2.14.6.14. Exhaust hoods may serve as guards for the top, bottom, backside and underside of table saws and wheels of bandsaws, provided they meet

construction criteria for guards.

18.4.2.15. Related Equipment (Shield and Holding Tools). While these aids do not give complete protection from machine hazards, they could provide the operator an extra margin of safety. Since these aids are not used instead of the safeguards, sound judgment is needed in their application.

18.4.2.15.1. Shields may be used to provide protection from flying particles.

18.4.2.15.2. Holding tools designed to aid material placement in and out of machinery shall be used to prevent placing hands in the danger zone. These tools are not a substitute for guarding required by this or any other machine standard. They shall only be used to supplement guard protection provided.

## **18.5. Metal Working Machinery.**

18.5.1. Hazards. The primary hazard associated with metalworking machinery is at the point of operation where cutting tools, other machine components, or stock are rotating or cycling at high rates of speed. Lacerations to fingers from being caught in, on or between the points of operation are the most common injuries. Other hazards include injuries, amputations, fractures, punctures, burns and eye and ear damage from:

18.5.1.1. Slippery floor surfaces from oil and grease leakage and coolant splashing.

18.5.1.2. Flying particles and objects, such as hot and sharp chips, coolant and dislodged machine and auxiliary parts.

18.5.1.3. Excessive noise levels.

18.5.1.4. Exposed gears, belt drives and clutch mechanisms.

18.5.1.5. Heavy material and auxiliary device movements, e.g., power press dies and lathe chucks.

18.5.1.6. Handling of extremely hot or cold materials.

18.5.1.7. Loose clothing, jewelry, hair, etc.

18.5.1.8. Inadequate lighting.

18.5.2. Requirements:

18.5.2.1. Power Presses. Mechanical power presses come in many different sizes and types, but all perform the same basic functions, e.g., forming, punching and shearing, or assembling metal or other material. They accomplish these functions by dies or tools mounted to a slide. The slide travels toward and away from a stationary anvil upon which the material is placed. The frame of the press guides the slide's path of travel. The slide's motion is provided through a crankshaft-clutch-motorized flywheel apparatus. When the clutch engages, energy is transmitted from the flywheel to the crankshaft, which in turn moves the slide. Power presses are divided into two (2) categories based on the type of clutches they use: full revolution or part revolution. The full revolution type, once activated, makes one complete revolution of the crankshaft that causes a full cycle of the slide before the clutch can be disengaged. The part revolution type can be disengaged at any point before the crankshaft has a full revolution and full stroke of the slide. Although

direct drive presses have no clutch, they can be stopped at any point by de-energizing the drive motor, so are considered a part revolution-type press.

18.5.2.1.1. Supervisors shall ensure either a fixed barrier guard, safeguard device or combination of both is installed and used on every operation when the opening between the die (tool) and base (anvil) is more than 1/4 inch. The functional manager and installation Ground Safety office must approve guarding by location. The use of hand-feeding tools, regardless of size, does not replace a guard or device. Refer to 29 CFR 1910.212. and 1910.217. for additional safe distance and maximum opening requirements. **Note:** The functional manager and installation Ground Safety office must approve guarding by location.

18.5.2.1.2. A guard is the most effective form of protection, if properly designed and constructed to prevent entry of hands or fingers into the point of operation. It shall not permit a worker to reach through, over, under or around the guard. If a guard is installed and functions correctly, no other device is required. Following are four (4) of the most common types of guards used on power presses.

18.5.2.1.2.1. A die enclosure guard is a barrier attached to the die shoe.

18.5.2.1.2.2. A fixed barrier guard is a guard attached to the press frame or base (anvil).

18.5.2.1.2.3. An interlocked barrier guard is attached to the press frame and base and has hinged or movable sections. The guard itself or the hinged or movable sections are locked in the closed position. The interlock also prevents opening the guard or the movable sections as long as the slide is in motion. The hinged or movable sections of the guard are intended for infrequent use such as setup or adjustment and not for manual feeding.

18.5.2.1.2.4. An adjustable barrier guard is attached to the press bed, base or die shoe, and requires adjustment for each job or die setup. Only personnel authorized by the shop supervisor will perform adjustments.

18.5.2.1.3. Since fixed guarding is not always possible due to the nature of an operation, certain devices are acceptable as a means of protection against point-of-operation hazards. When the following devices are properly installed and function properly, no other point-of-operation guarding is required unless the operation is such that a combination of guards or devices is necessary. Refer to 29 CFR 1910.212. and 1910.217. for additional safe distance and maximum opening requirements.

18.5.2.1.3.1. A movable barrier or gate device resembles an interlocked barrier guard in appearance since it is interlocked into the press clutch so slide motion cannot be initiated unless the gate is closed. There are two types of gates.

18.5.2.1.3.1.1. Type A gate must enclose the point of operation before a stroke can be initiated and remain closed as long as the slide is moving.

18.5.2.1.3.1.2. Type B gate prevents entry only during the down stroke and must prevent access prior to the start of the motion or die closure.

18.5.2.1.3.2. Pull-out devices consist of operator wristbands connected by cords and linkage to the slide or upper die so, when the die descends, the operator's

hands shall be automatically withdrawn from the point of operation if the worker has not already withdrawn them. Close supervision is required to ensure their use and proper alignment.

18.5.2.1.3.3. Holdout or restraint devices consist of attachments for each of the operator's hands. These devices are securely anchored and adjusted to prevent the operator from reaching into the point of operation at any time.

18.5.2.1.3.4. Presence-sensing devices are permitted only on part revolution clutch presses. A presence-sensing device is a light curtain or other type sensing field between the operator and the point of operation. It is interlocked into the control system so slide motion is prevented or stopped prior to die closure if the operator's hands or any part of the body is within the sensing field. Areas not protected by the presence-sensing devices must be guarded. **Note:** Presence-sensing devices shall not be used on machines using full revolution clutches, e.g., power presses, or used as a tripping means to initiate motion.

18.5.2.1.3.5. Sweep-type devices cannot be used as a single safeguard for point-of-operation guarding. These devices consist of single or double arms or rods attached to the slide of the presses to push the operator's hands away from the point of operation as the slide descends.

18.5.2.1.4. Two-hand control devices are normally used on presses with a part revolution clutch. The operator must depress two (2) buttons concurrently to initiate slide motion. These buttons must be depressed continuously (holding time) on the downstroke or the clutch is disengaged, the brake applied, and the slide stops. Refer to 29 CFR 1910.217. for additional safe distance requirements.

18.5.2.1.4.1. Two-hand trip devices, once pressed, do not have to be held during the downstroke, and the slide will stop only after it has completed a full cycle. The device is generally applicable to full revolution clutch presses.

18.5.2.1.4.2. In addition to proper design, installation and correct operation, two-hand trips and presence-sensing devices shall be located far enough away from the point of operation (depending on the stopping time of the press) that when operators release the control buttons or disturb the presence-sensing field, they do not have time to reach into the point of operation before the die closes or slide stops.

18.5.2.1.4.3. A control reliability system detects a failure within the controls and prevents initiation of a successive stroke until the failure is corrected.

18.5.2.1.4.4. A brake monitor system monitors the performance of the brake on each stroke and automatically prevents the activation of a successive stroke if the stopping time or braking distance has deteriorated beyond the predetermined safe stopping distance.

18.5.2.1.4.5. Safeguarding devices such as two-hand controls, presence-sensing devices, type B gates or movable barriers allow the operator to feed or remove parts by placing one or both hands in the point of operation. Therefore, when

these devices are used on part revolution clutch presses, the control reliability system and brake monitor system are required to ensure operator safety.

18.5.2.1.4.6. The energy controls shall be isolated by a lockout device and safety blocks installed during machine repairs or alterations of the die area.

18.5.2.1.4.7. Single or dual hand-lever-operated power presses shall be equipped with a spring latch on the operating lever to prevent premature or accidental tripping.

18.5.2.1.4.8. Operating levers on hand-tripped machinery with more than one operating station shall be interlocked so the machine can only be tripped when all levers are actuated concurrently.

18.5.2.1.4.9. A means of selecting **OFF, INCH, SINGLE STROKE** or **CONTINUOUS** modes of operation (as applicable) shall be integrated with the clutch and/or brake control to govern the operating mode of the presses.

18.5.2.1.4.10. During the inch operating mode, workers shall be protected by one of the following:

18.5.2.1.4.10.1. Requiring concurrent use of both hands to actuate the clutch.

18.5.2.1.4.10.2. A single control protected against accidental actuation. **Note:** The control shall be located so the worker cannot reach into the point of operation while actuating the control.

18.5.2.1.4.11. Two-handed controls for single-stroke press machines shall ensure safe operation by design, construction and/or separation so:

18.5.2.1.4.11.1. Concurrent use of both hands is required to trip the press.

18.5.2.1.4.11.2. Machine adjustment can be made, but concurrent use of both hands is required during the die closing portion of the stroke.

18.5.2.1.4.11.3. Repetitive operation is not possible unless controls are activated in proper sequence. The control systems shall require all operator hand controls are released before an interrupted stroke can be resumed.

18.5.2.1.4.12. Individual operator two-hand trip controls shall be designed and constructed to require use of both hands to protect against unintentional operation. A control arrangement requiring concurrent operation of both operator hand controls shall be used. Bypass of control interlocks is prohibited.

18.5.2.1.4.13. Two-hand trip systems on full-revolution-clutch machines shall provide anti-repeat protection for operators. When two-hand trip systems are used on multiple operator machines, each operator shall have a separate set of controls.

18.5.2.1.4.14. Picks, pliers, tongs and other hand-feeding tools required for the safe handling of stock, dies or materials shall be provided to operators to supplement other guards. These tools shall not eliminate the need for required protective clothing, equipment or machine guarding. Additionally, a die setter's safety bar shall be used for turning the flywheel when the power is off.

18.5.2.1.4.15. As an alternative or supplement to other guarding methods,

individual die guards shall be attached to the die shoe, stripper or die block in a fixed position. They shall be designed so the operator cannot reach over, under or around the guard into the danger zone.

18.5.2.1.4.15.1. Attachment points shall be provided on dies requiring mechanical handling.

18.5.2.1.4.15.2. Die stops or other means shall be used on inclined presses to prevent inadvertent movement of the die while setting or removing them.

18.5.2.2. Hydraulic Press. Hydraulic power presses shall be safeguarded to prevent the operator's hands being placed between the dies during press cycling. Safeguards used include safeguarding by location or distance (paragraph [18.4.2.13](#)), safeguarding by device (paragraph [18.4.2.13](#)) and safeguarding by barrier or enclosure (paragraph [18.4.2.14](#)). Supervisors shall ensure:

18.5.2.2.1. Controls meet requirements of paragraphs [18.5.2.15](#) and [18.5.2.16](#). The following additional features apply to hydraulic press controls.

18.5.2.2.1.1. Two-hand control systems, when installed, shall incorporate an anti-repeat feature.

18.5.2.2.1.2. A Stop and Auto Return switch, when provided, shall be color-coded yellow. Since it does not deactivate power or other controls, a power disconnect or Stop switch, capable of being locked, shall be provided.

18.5.2.2.2. Control of energy sources as referenced in paragraph [18.4.2.11](#).

18.5.2.2.2.1. Ensure pneumatic and hydraulic systems meet requirements of paragraph [18.5.2.19](#).

18.5.2.2.2.2. Refer to paragraph [18.5.2.22](#) for requirements on safeguarding hydraulic presses equipped with automatic material clamping equipment.

18.5.2.3. Press Brakes. The design and construction of a press brake are different from other ram function metalworking machines. The bed and ram, which are longer than other machines, are located in front of and extend beyond the machine's frame. This permits a much larger working area. Press brakes can be hydraulic or mechanical and are classified as either general purpose or special purpose. The operator controls the speed of the ram.

18.5.2.3.1. Controls shall meet the requirements of paragraphs [18.5.2.15](#) and [18.5.2.16](#).

18.5.2.3.2. Energy sources shall be controlled as referenced in paragraph [18.4.2.11](#).

18.5.2.3.3. Pneumatic and hydraulic systems shall meet requirements of paragraph [18.5.2.19](#).

18.5.2.3.4. Safeguarding the point of operation depends on the operation being performed. Proper safeguarding must be planned and installed by someone knowledgeable of both press brakes, in general, and the specific operation. A point-of-operation device (paragraph [18.4.2.13](#)) or a point-of-operation barrier or enclosure



(paragraph [18.4.2.14](#)) will guard the point of operation. Guarding by a safe distance (for example, maintaining a safe distance between the point of operation and a worker's hand and fingers while supporting stock) can only be used when barriers, enclosures or devices are not possible. The functional manager must approve guarding by safe distance. The supervisor shall ensure a proper guarding system is used for the material and work being performed. The following requirements shall be based upon the type of safeguard available and installed for the operation:

18.5.2.3.4.1. Safeguarding by Distance or Location—paragraph [18.4.2.12](#).

18.5.2.3.4.2. Safeguarding by Device—paragraph [18.4.2.13](#).

18.5.2.3.4.3. Related Tools—paragraph [18.5.2.20](#).

18.5.2.3.4.4. Safeguarding of Power Transmission Equipment—paragraph [18.5.2.21](#).

18.5.2.3.4.5. Powered Clamping, Working Holding Devices—paragraph [18.5.2.22](#).

#### 18.5.2.4. Shapers, Forming Rolls, Calenders and Cold Headers.

18.5.2.4.1. Controls shall meet the requirements of paragraphs [18.5.2.15](#) and [18.5.2.16](#).

18.5.2.4.2. Energy sources shall be controlled as referenced in paragraph [18.4.2.11](#).

18.5.2.4.3. All pneumatic and hydraulic components shall be designed and maintained to meet paragraph [18.5.2.19](#) requirements.

18.5.2.4.4. The primary function of safeguards on these machines is to protect the operator's hands, fingers and other body parts from contacting the point of operation and slide mechanisms. Adjustable barrier or enclosure safeguards shall be used to the maximum extent possible. Safeguarding by location or distance should not be considered for these machines because of the frequent need for the worker to hold the work-piece. Regardless of the type selected, the requirements of paragraphs [18.4.2.13](#) and [18.4.2.14](#) will be used in evaluating the safeguard.

18.5.2.4.4.1. The rear of the reciprocating ram shall be guarded to protect other employees. Additional barrier guards shall be provided at refuse drop areas.

18.5.2.4.4.2. A chip guard shall be provided to prevent flying chips from striking the operator or other workers. **Note:** All material shall be securely clamped in position on the machine table.

18.5.2.5. Shears. There are two types of shears used in metalworking shops: powered and mechanical. Since both types perform the same basic function, safeguarding requirements for point of operation, movable parts, pinch points, and scrap deposit areas are also the same. Safeguarding shall be provided to protect the operators from the hazardous areas.

18.5.2.5.1. Controls shall meet the requirements of paragraphs [18.5.2.15](#) and [18.5.2.16](#).

18.5.2.5.2. Energy sources shall be controlled as referenced in paragraph [18.4.2.11](#).

18.5.2.5.3. Pneumatic and hydraulic systems shall meet the standards of paragraph [18.5.2.19](#).

18.5.2.5.4. Barrier or enclosure guarding shall be considered the primary means of safeguarding shearing machines. Location or distance safeguarding may be considered but is normally not applicable due to the varying operations performed on shearing machines—paragraphs [18.4.2.13](#), [18.4.2.14](#), and [18.5.2.20](#) through [18.5.2.22](#) shall be used to evaluate the adequacy of installed guards or devices. The area where sheared or punched refuse drops shall be barricaded to prevent injuries to operators and helpers. All shears shall be equipped with an emergency stop control. Refer to paragraph [18.5.2.18](#) for emergency stop control requirements.

18.5.2.6. Lathes, Screw/Bar and Chucking Machines. Multiple-spindle machines are normally equipped with enclosures that isolate the point of operation from the operator. Additional hazard areas of all machines and operations that require safeguarding include powered work-holding devices, powered turrets and controls and operations where work pieces extend beyond the confines of the workspace.

18.5.2.6.1. Controls shall meet the requirements of paragraphs [18.5.2.15](#) and [18.5.2.16](#).

18.5.2.6.2. Energy sources shall be controlled as referenced in paragraph [18.4.2.11](#).

18.5.2.6.3. Pneumatic and hydraulic systems, when installed, shall meet the paragraph [18.5.2.19](#) standards.

18.5.2.6.4. A fixed or movable barrier device or awareness device shall be installed when a lathe operates in the automatic or semi-automatic mode and a tool trapping space is created by the automatic advancing of rotating and non-rotating components.

18.5.2.6.5. Power-indexed turrets containing an exceptionally long tool or tool-holding device that extends in the operator's workspace shall have a barrier guard, rigid awareness barrier (protective railing) or awareness device installed during machine operation. One of these safeguards shall also be installed when a rotating work-piece extends beyond the normal confines of the machine. Guards or devices are not required when tracing is being performed and the operator must initiate each cycle.

18.5.2.6.6. All lathes procured after 6 October 1983, shall be equipped with a spindle braking device, if the operator must stop the spindle to manually unload a work piece.

18.5.2.6.7. Chucks shall always be started on the lathe spindle by hand.

18.5.2.6.8. The tail stock end of the work shall be countersunk deeply enough so there is minimal chance of the work being torn loose.

18.5.2.6.9. Tools shall be adjusted in the tool rest so they are slightly above the center to keep the work from climbing. An exception is thread-cutting, where the tool should be at center.

18.5.2.6.10. Chips in the process of being generated, such as long stringy chips, shall not be removed by hand. A tool, puller, brush or shovel shall be used.

18.5.2.6.11. Operators shall not attempt to brake the lathe by grasping the chuck, work or any other machine component.

18.5.2.7. Drilling, Milling and Boring Machines. A barrier guard or guarding device shall be installed and used when machines are operated in an automatic or semi-automatic mode, cutting devices are exposed or any part of the operator's body is within one (1) foot of the cutting device. Awareness barriers can also be used; however, only in situations when a guard or guarding device would, of itself, present a hazard. The type of guarding shall depend on the machine, location and operation. Additionally, shields may be required to protect workers from chips and splashing coolant. The requirements identified in paragraph [18.5.2.20](#) shall apply to the design and installation of shields. Additionally, the following requirements for guards, machine components and operations apply.

18.5.2.7.1. Operators shall not hand-hold stock while using these machines. When the cutting tool contacts the stock or work piece, it can catch or twist the material from the operator's grasp. The resulting uncontrolled rotation of the stock will cause injury to the operator. A hold-down fixture or stock vise shall be used to prevent these injuries.

18.5.2.7.2. Drill chucks shall not have protruding set screws.

18.5.2.7.3. Auxiliary devices, e.g., index heads, vises, drill or boring bits and extra tools, shall be properly stored.

18.5.2.7.4. Drill presses shall not be operated at a speed greater than specified by the press or drill manufacturer for the particular material to be drilled.

18.5.2.7.5. Automatic and high production drilling machines shall be equipped with barricades or enclosures to separate operators and other personnel from drilling operations. When steps or stairs are necessary for making adjustments to the machine or work, they shall be well constructed, provided with non-slip treads and in good repair.

18.5.2.7.6. Controls shall meet the criteria of paragraphs [18.5.2.15](#) and [18.5.2.16](#).

18.5.2.7.7. Energy sources shall be controlled as referenced in paragraph [18.4.2.11](#).

18.5.2.7.8. When provided, pneumatic and hydraulic systems shall conform to paragraph [18.5.2.19](#).

18.5.2.8. Planers. The reciprocating work and table shall be barricaded or enclosed to prevent personnel from being struck by material that is turning against the cutter.

18.5.2.8.1. A chip shield shall be provided to prevent chips from flying and striking the operator or other workers.

18.5.2.8.2. Safety dogs shall be placed at each end of the planer table to prevent the table from running off the gear rack.

18.5.2.8.3. All material shall be securely clamped in position on the planer table.

18.5.2.9. Saws. Safeguarding of metalworking saws varies depending on the type of machine and material being processed. The general requirements of paragraphs [18.5.2.15](#)

through **18.5.2.18.4** apply to all saws. The following paragraphs address the three (3) most common types of saws used in Air Force shops. For saws not covered, the supervisor and installation Ground Safety office shall develop requirements on machine safeguards. Refer to ANSI Standard B11.10, *Safety Requirements for Metal Sawing Machines*, for additional information.

#### 18.5.2.10. Bandsaws.

18.5.2.10.1. Both upper and lower wheels shall be completely enclosed on both sides. The enclosures should be easily removed to permit saw blade maintenance.

18.5.2.10.2. The working part of a saw blade, between the guide rolls and the upper wheel enclosure, shall be guarded to prevent accidental contact with the saw blade. The guard shall be self-adjusting and attached to the gauge so that, in any position of the gauge, the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure.

18.5.2.10.3. Saws equipped with an automatic tension control to compensate for the contraction that takes place in the cooling of the blade after a job is finished and to ensure proper tension of the saw blade.

18.5.2.10.4. Saws equipped with manual control (i.e., no automatic tension control), instructions/procedures for tension control shall be developed and operators shall be trained, and supervised, in proper tension adjustment(s).

18.5.2.10.5. Feed rolls on self-fed bandsaws shall be guarded to prevent the operator's hands coming in contact with the in-running rolls at any point.

18.5.2.10.6. Saw speed shall not exceed the safe limit recommended by the manufacturer.

#### 18.5.2.11. Hacksaws.

18.5.2.11.1. Loss of coolant and lubricants from a power hacksaw shall be minimized by proper maintenance of the coolant system and installation of splash shields.

18.5.2.11.2. Vises, fixtures and other work-holding equipment shall be used to hold the work piece securely.

18.5.2.11.3. Stock being cut by a power hacksaw shall not be hand-held.

#### 18.5.2.12. Circular Metal Saws.

18.5.2.12.1. The safeguard shall be of sufficient strength to protect the operator from a broken saw blade or teeth.

18.5.2.12.2. It shall enclose the spindle end and nut.

18.5.2.12.3. It shall be provided with an opening or means of removing chips that, in itself, shall not create a hazard to the operator.

18.5.2.12.4. It shall enclose all unused portions of the exposed saw blade. The part of the blade used for cutting shall be protected by a barrier. The barrier shall be positioned to prevent the operator contacting the blade.

18.5.2.12.5. Loss of coolant and lubricants from the machine shall be minimized by proper maintenance of the coolant system and the installation of splash shields.

18.5.2.12.6. Vises, fixtures and other work-holding equipment shall be used to hold the work piece securely.

18.5.2.12.7. All circular sawing machines shall be equipped with a pair of flanges or blotter where required.

#### 18.5.2.13. Cut-Off and Contour Saws.

18.5.2.13.1. Both the upper and lower wheels on both sides of saws shall be enclosed. The enclosure shall be hinged to permit easy access to the saw blade.

18.5.2.13.2. The working part of the saw blade, between the guide rolls and upper wheel enclosure, shall be guarded to prevent accidental contact with the saw blade. The guard shall be self-adjusting and attached to the gauge so that, in any position of the gauge, the guard shall completely cover the saw blade between the guide rolls and upper wheel enclosure.

18.5.2.13.3. Abrasive cut-off saws shall be connected to an exhaust system.

18.5.2.13.4. Stock being cut by a cut-off or contour saw shall not be hand-held.

18.5.2.14. Riveting Machines. A guard shall be provided to prevent operators from placing their hands between dies.

#### 18.5.2.15. Operator Controls.

18.5.2.15.1. Controls shall be within easy reach of the machine operator and placed so the operator does not have to reach past moving parts that may cause injury.

18.5.2.15.2. Controls shall be positioned or protected against accidental or inadvertent operation. Refer to 29 CFR 1910.217., *Mechanical Power Presses*, for additional information.

18.5.2.15.3. Controls shall not be wedged for continuous operation.

18.5.2.15.4. Controls shall be clearly identified when their function is not self-evident. They shall not initiate any motion unrelated to its designation.

18.5.2.15.5. Jog circuits, if used, shall be designed to prevent continuous run or automatic operation.

18.5.2.15.6. Foot (treadle) controls shall have a non-slip surface and be protected against unexpected and accidental tripping.

18.5.2.15.7. Energy sources shall be controlled IAW paragraph [18.4.2.11](#).

#### 18.5.2.16. Mechanical Controls.

18.5.2.16.1. Handwheels that turn in a clockwise rotation shall produce for the controlled component a linear movement to the right, away or upward. If rotary motion is produced by the handwheel, clockwise rotation shall cause clockwise movement of the controlled component.

18.5.2.16.2. Control levers shall move in the same direction as the controlled component when both motions are parallel.

18.5.2.16.3. Crank and handwheel controls (with protrusions) that rotate at more than 50 surface feet per minute shall have an adjustable barrier guard installed.

18.5.2.17. Multiple Control Stations.

18.5.2.17.1. When a setup control station is provided in addition to the normal operator's control station, selection of the setup station shall render the operator's station inoperative, except for emergency stop. Switching from one control station to another shall not create a hazard.

18.5.2.17.2. When more than one operator is required to operate the machine from different control stations, each station shall be provided with a cycle start button that must be depressed concurrently in order to initiate the cycle.

18.5.2.17.3. When one operator can operate the machine from more than one station, all cycle start buttons other than the one being used shall be made inoperative.

18.5.2.17.4. Where parts are manually loaded and the operator may be exposed to a hazard due to cutter or machine table movements, the rapid traverse from one part or position to the other shall be initiated by the operator.

18.5.2.18. Emergency Stop Control.

18.5.2.18.1. All machines shall incorporate one or more emergency stop controls that, upon momentary operation, shall de-energize all machine motions. These emergency stops shall be located at each operator control station and, if inherent hazards are present at other operating positions, an emergency stop should be provided.

18.5.2.18.2. The emergency stop shall be color coded red.

18.5.2.18.3. The emergency stop control shall override all other controls and, when actuated, not create other hazards.

18.5.2.18.4. All machine motions stopped by the emergency or master switch shall be restartable only by deliberate action by the operator.

18.5.2.19. Pneumatic and Hydraulic Systems.

18.5.2.19.1. Circuits shall be designed and components selected, applied and adjusted so loss of control media (fluid, air, etc.) shall not cause a hazard.

18.5.2.19.2. Circuits shall be designed and components applied so pressure variations will not cause a hazard.

18.5.2.19.3. Components shall be used that cannot be adjusted outside the safe working range of the circuit.

18.5.2.19.4. Means shall be provided to prevent operation when loss of working pressure could cause a hazard.

18.5.2.19.5. Circuits employing accumulator tanks shall automatically vent the accumulator pressure or isolate the accumulator when the machine is shut off.

18.5.2.19.6. Non-vented accumulators shall be identified with a sign that says "WARNING: PRESSURIZED VESSEL" or the nearest commercially available equivalent. Charging and discharging information for proper servicing of non-vented accumulators shall be given on or near the accumulator (in a visible location) and in the maintenance manual.

18.5.2.19.7. Gas-charged accumulators operating above 200 pounds per square inch, gauge (psig) charging pressure, shall be charged with inert gas.

18.5.2.19.8. Flexible hoses shall be arranged so they will not create a tripping hazard. Where failure of flexible hoses may constitute a whipping hazard, they shall be restrained or contained.

18.5.2.19.9. Whenever pressure is maintained after power is off, such as in counterbalance or accumulator circuits, a warning plate shall be used and procedures for depressurizing the circuit shall be documented in the maintenance manual.

18.5.2.20. Related Equipment. While these aids do not give complete protection from machine hazards, they could provide the operator an extra margin of safety. Since these aids are not used in place of safeguards, sound judgment is needed in their application.

18.5.2.20.1. Shields may be used to provide protection from flying particles. When chips or coolant fluids are splashed on the operator or on the work area and passageway floor, a splash shield shall be installed.

18.5.2.20.2. Holding tools designed to aid material placement in and out of machinery shall be used when it would otherwise be necessary to place hands in the danger zone. These tools are not considered a substitute for guarding, but will be used to supplement guard protection provided.

18.5.2.20.3. Awareness barriers do not provide physical protection, but are only to remind a person that he or she is approaching the danger area. Generally, awareness barriers are not considered adequate where continual exposure to the hazard exists.

18.5.2.21. Transmission Belts and Pulleys.

18.5.2.21.1. Horizontal belts and ropes above floors or platforms shall be guarded for their entire length if located over passageways or workplaces, if center-to-center distance between pulleys is 10 feet or more, or if the belt is 8 inches or more in width.

18.5.2.21.2. Vertical belts running over a lower pulley above the floor or platform shall be guarded at the bottom in the same manner as overhead belts.

18.5.2.21.3. Where loose pulleys or idlers are not practical, belt perches in the form of brackets, rollers, etc., shall be used to keep idler belts away from the shafts. Perches shall be of strong materials and designed for safe shifting of belts.

18.5.2.21.4. Belt dressing shall not be applied when the belt or rope is in motion. However, if necessary, it shall be applied where belts leave the pulleys, not where they approach them.

- 18.5.2.21.5. Unless the distance to the nearest fixed pulley, clutch or hanger exceeds the width of the belt used, a guard shall be provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists. Where there are overhanging pulleys on a line, jack or countershaft, with no bearing between the pulley and the outer end of the shaft, a guard to prevent the belt from running off the pulley shall be installed.
- 18.5.2.21.6. Pulleys with cracks or pieces broken out of rims shall be taken out of service.
- 18.5.2.21.7. Pulleys used in areas where they would be exposed to corrosion shall be made of corrosion-resistant material. Pulleys located in corrosive environments shall be inspected semiannually to ensure they are in satisfactory condition.
- 18.5.2.22. Powered Clamping, Work Holding Devices. These shall be provided with a safeguard to warn the operator or contain the work piece when there is a lack of clamping pressure. An electrical interlock can be installed which shuts down power to a lathe when hydraulic pressure drops or electrical interruption occurs. A retaining cover or barrier guard can also be used. Another method for protecting personnel is an audible or visual warning device that shall be visible or audible to the operator at his normal work position.

## **18.6. Permanently Installed Grinding Machines.**

### **18.6.1. Hazards and Human Factors.**

18.6.1.1. Hazards. Personnel injuries and property damage can result from improper use, care or storage of abrasive wheels and associated equipment. Material failure hazards include:

18.6.1.1.1. Improper mounting of wheels to machinery, excess pressure on work surface causing heat and vibration that leads to abrasive wheel deterioration or destruction, use of wheel speeds greater than manufacturer's ratings, improper storage practices causing damage to wheels, wires expelled from brush wheels, particles ejected or thrown from the material being worked and vibration that may burst wheels or disks.

18.6.1.1.2. Procedural hazards include holding the work incorrectly; using the wrong type wheel; grinding on the side of a wheel not designed for side wheel grinding; taking too heavy a cut; applying work too quickly to a cold wheel or disk; grinding too high above the center of a wheel; failing to use wheel washers (blotters); incorrectly adjusting or lacking a work rest; using spindles of incorrect diameter or with the threads cut so the nut loosens as the spindle revolves; installing flanges of the wrong size, with unequal diameters or unrelieved centers; or dressing of wheels incorrectly, resulting in off-center conditions or fracture strains.

18.6.1.2. Human Factors. Worker and supervisor attitudes and attentiveness are important factors in working safely with abrasive wheel machinery. Monotony and fatigue interact when repetitive work is performed over a long period of time. Exposure to noise, heat, dust and vibration is frequently present. Constant operator attention is



essential. Some human factors-related situations and mishaps associated with abrasive wheel operations are:

18.6.1.2.1. Eye and face injuries when face shields or goggles are not used in addition to the shield mounted on the grinder.

18.6.1.2.2. Injury to body parts from contact with revolving wheels or unguarded moving parts, with monotony and fatigue as contributing factors.

18.6.1.2.3. Respiratory problems caused by inhalation of abrasive wheel dust and failure to use face respirators where required.

18.6.1.2.4. Hearing loss caused by exposure to noise in excess of threshold limit values and failure to use hearing protection devices supplied for this purpose.

#### 18.6.2. Requirements.

18.6.2.1. Exhaust Ventilation. Wherever dry grinding, polishing or buffing is performed and worker exposure (without regard to the use of respirators) exceeds occupational and environmental exposure limits (OELs), a local exhaust ventilation system shall be provided and used to reduce employee exposures. BE shall determine if exhaust ventilation is needed. When required, exhaust systems shall conform to criteria in the most current version of the ACGIH's ventilation design standards. Also refer to 29 CFR 1910.94., *Ventilation*, for additional information.

#### 18.6.2.2. Wheel and Spindle Speeds.

18.6.2.2.1. The spindle rpm of grinders shall be shown on the machine in a location readily visible to the operator. It is the supervisor's and worker's responsibility to verify the speed of the wheel spindle to ensure the speed is correct for the size and type of wheel used. Refer to ANSI Standard B11.9., *Safety Requirements for the Construction, Care, and Use of Grinding Machines*, for additional information.

18.6.2.2.2. All grinding wheels shall have the operating speed affixed to the wheel. Those without a rating shall be tagged and removed from service until the rpm rating is validated.

#### 18.6.2.3. Safe Operating Procedures.

18.6.2.3.1. Abrasive wheel machines shall not be operated unless safety guards are installed as outlined in paragraph **18.5.2.6** except wheels used for internal work where the work offers protection. See **Figure 18.3** for types 16, 17, 18, 18R and 19 cones, plugs and threaded hole pot balls as examples of those not requiring guards while used for internal work. Refer to 29 CFR 1910.215, *Abrasive Wheel Machinery*, for additional information.

18.6.2.3.2. Peripheral protectors, commonly referred to as tongue guards, shall be positioned so the opening between the wheel and the guard is no more than 1/4 inch. Refer to paragraph **18.5.2.6** for additional information on tongue guards and 29 CFR 1910.215. for additional information.

18.6.2.3.3. Work rests shall be used during all off-hand grinding operations. They shall be of rigid construction and designed to be adjustable to compensate for wheel wear. Refer to 29 CFR 1910.215. for additional information.

18.6.2.3.3.1. Adjust these devices closely to the wheel with a maximum opening of 1/8 inch to prevent the work being jammed between the wheel and rest. Jamming the work piece could break the wheel and cause personnel injury. Work rests shall be securely clamped after each adjustment and the adjustment shall not be made with the wheel in motion. In those instances where jamming or contact with a grinding wheel is precluded by the size of the work piece, a side guard offers sufficient protection to the operator. Accordingly, in such situations, the requisite to have a work rest adjusted to a maximum opening of 1/8 inch is not required. However, work rest clearance shall not exceed the width of the work piece. Refer to 29 CFR 1910.215. for additional information.

18.6.2.3.3.2. Do not grind stock that is thin enough to be pulled between the work rest and the wheel.

18.6.2.3.4. Machines shall be operated within rated speeds at all times. Refer to 29 CFR 1910.215. for additional information.

18.6.2.3.5. Wheels found defective, cracked or out of balance shall be taken out of service until repaired or discarded. Wheels shall be removed from service when they are worn to a size that would allow the flange assembly to contact the piece being ground or the work rest.

18.6.2.3.6. The operator shall stand to one side whenever grinding machines are initially turned on, until the wheel has reached its operating speed and when going from operating speed to the stopped position.

18.6.2.3.7. The machine will be stopped and inspected to determine the cause of chattering or vibration.

18.6.2.3.8. Abrasive grinding wheels shall not be used to grind aluminum, brass, copper or other soft metals unless the wheel is specifically designed for that purpose. Soft metal wheels shall be used to grind soft metals only.

18.6.2.3.9. Side wheel grinding shall be accomplished only on wheels designed for that purpose.

18.6.2.3.10. Operators shall ensure that grinders, buffers and wire brush machines are turned off when work is completed or before leaving the vicinity of the machine.

18.6.2.3.11. Machine operators shall not wear loose-fitting clothing that may become entangled in moving parts or power transmission apparatus.

18.6.2.3.12. PPE required for abrasive grinding operations is dependent on the material being processed. As a minimum, operators shall wear the proper eye and face protection (e.g., face shield, goggles or spectacles) identified in [Chapter 14, Personal Protective Equipment \(PPE\)](#). Shop aprons of heavy construction shall be worn when operations are performed on a continuing or prolonged basis. Gloves shall be worn when burrs or rough edges present a hazard to the worker's hands.

18.6.2.3.13. Holding tools designed to aid material placement in and out of machinery shall be used when it would otherwise be necessary to place hands in the danger zone.

18.6.2.3.14. Wire brush wheel operators shall wear protective aprons of heavy construction and a face shield. Care must be exercised when gloves are used to ensure they are not snagged by the rotating brushes and pulled into the wheel.

18.6.2.3.15. Polishing and buffing wheel operators shall wear face shields.

18.6.2.4. Inspections. Grinding machines shall be inspected prior to use. The following minimum items shall be checked unless manufacturer's instructions require more stringent inspection criteria.

18.6.2.4.1. Work rest, for security and proper adjustment, e.g., 1/8 inch maximum opening.

18.6.2.4.2. Wheels, for security and condition, e.g., cracks, gouges, chipped edges or uneven wear.

18.6.2.4.3. Wheels, for evidence of side grinding or grinding of soft metals when the wheels are not designed for these purposes.

18.6.2.4.4. Shatter-resistant transparent shields, for cleanliness, scoring and proper placement.

18.6.2.4.5. Machine guards and power transmission guards, for condition, security and proper alignment.

18.6.2.4.6. Periphery (tongue) guards for security and proper adjustment, e.g., 1/4 inch maximum opening.

18.6.2.4.7. Proper lighting at point of operation.

18.6.2.5. Maintenance and Lubrication. Maintenance on grinding equipment shall not be accomplished until the machine power source is turned off and locked out or the power cord is unplugged.

18.6.2.5.1. Wheel Mounting. Incorrect mounting of an abrasive wheel is responsible for much wheel breakage. Compression forces, radial forces and grinding heat cause stresses around the central hole of the wheel. It is most important that manufacturer's recommendations concerning size and design of mounting flanges and mounting techniques be followed prior to any maintenance. Refer to 29 CFR 1910.215., *Abrasive Wheel Machinery*, on additional information on wheel mounting and the following subsets of wheel mounting.

18.6.2.5.1.1. Operating Speed. Before mounting the wheel, check the spindle speed of the machine to ensure it does not exceed the maximum operating speed marked on the wheel.

18.6.2.5.1.2. Shelf Life. Check that the shelf life requirements of the wheel have not been exceeded (if applicable).

18.6.2.5.1.3. Inspection. Visually inspect and perform a ring test on wheels. Defects such as broken, chipped or gouged wheels can be easily detected, but cracks are frequently not visible to the naked eye. Tap wheels gently with a light nonmetallic implement such as the handle of a screwdriver for light wheels, or with a wooden mallet for heavier wheels. See [Figure 18.1](#). If they sound dead, a

crack exists. Do not use them. This procedure is known as a ring test and is performed as follows:

18.6.2.5.1.3.1. Ensure wheels are dry and free from sawdust when performing the ring test; otherwise they do not ring clear. Organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

18.6.2.5.1.3.2. Tap wheels about 45 degrees at each side of the vertical centerline and about 1 or 2 inches from the periphery. See [Figure 18.1](#). Then rotate 45 degrees and repeat the test. A sound and undamaged wheel will give a clear ring. If cracked, there will be a dead sound.

18.6.2.5.1.4. Arbor Size. Ensure grinding wheels fit freely on the spindle and remain free under all grinding conditions. Proper clearance between the wheel arbor hole and the machine spindle is essential to avoid excessive pressure due to mounting and spindle heat expansion.

18.6.2.5.1.5. Surface Condition. Ensure all contact surfaces of wheels, blotters and flanges are flat and free of foreign matter. Uneven mounting pressure against the side of a wheel causes stress that could lead to wheel failure.

18.6.2.5.1.6. Reducing Bushing. If a bushing is used in the wheel hole, ensure it does not exceed the width of the wheel and does not contact the flange.

18.6.2.5.1.7. Flanges. Mount all abrasive wheels between flanges that are not less than 1/3 the diameter of the wheel. Exceptions include mounted wheels, threaded wheels (plug and core), plate mounted wheels and cylinder, cup or segmental wheels mounted in chucks. Refer to 29 CFR 1910.215 for detailed information on exceptions.

18.6.2.5.1.7.1. Flanges shall be dimensionally accurate and in good balance. There shall be no rough surfaces or sharp edges.

18.6.2.5.1.7.2. Both flanges shall be the same diameter and have equal bearing surface. Exceptions to this are type 27 and type 28 wheels. Refer to [Figure 18.2](#).

18.6.2.5.1.7.3. The driving flange shall be securely fastened to the spindle and the bearing surface shall run true. When more than one wheel is mounted between a single set of flanges, wheels may be cemented together or separated by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. Blotters shall not be used as spacers; normally soft copper or brass shall be used. If wheels are to be cemented together, the wheel manufacturer's recommendation shall be followed.

18.6.2.5.1.7.4. All flanges shall be maintained in good condition. When bearing surfaces become worn, warped, sprung or damaged, they shall be trued and resurfaced. When resurfacing or truing, material shall not be removed from the flange to the point that it loses its rigidity.

18.6.2.5.1.8. Blotters. Use blotters between flanges and abrasive wheel surfaces

to ensure uniform distribution of flange pressure (See [Figure 18.2](#)). Exceptions include mounted wheels, threaded wheels (plug and core), plate mounted wheels and cylinder, cup or segmental wheels mounted in chucks. When blotters are required, ensure they cover the entire contact area of wheel flanges. The proper thickness of blotters depends upon the type of material used. OSHA addresses only blotting paper (.025 thickness), but rubber, leather and felt are all acceptable. Follow the manufacturer's recommendation.

18.6.2.5.1.9. Multiple Wheel Mounting. When more than one wheel is mounted between a single set of flanges, cement wheels together or separate them by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. When mounting wheels that have not been cemented together, or ones that do not utilize separating spacers, care must be exercised to use wheels specially manufactured for that purpose.

18.6.2.5.1.10. Start Up Procedures. Do not operate machines until the safety guards are in place. After the guards are reinstalled, rotate the wheel several revolutions by hand to ensure it clears both the work rest and the safety guards. Defective wheels are most likely to break when first started; therefore, run newly installed wheels at full operating speed for at least one (1) minute before work is applied. During this time, ensure operator and other personnel stand clear of the machine.

18.6.2.5.2. Wheel Dressing. Damaged or out-of-balance abrasive wheels produce poor work and may injure the operator. To restore a rutted, excessively rough or unbalanced wheel, it is necessary to dress it by removing part of the face. Wheel dressing tools shall be equipped with hood guards over the tops of cutters to protect the operator from flying wheel particles or pieces of broken cutters. The dresser shall be supported on the work rest and the work rest shall be adjusted away from the wheel so the heel of the dresser may hook over the work rest and be guided by it as the dresser is moved evenly back and forth across the wheel face. Dressing shall be done only by personnel trained in this task. Operators performing dressing operations will:

18.6.2.5.2.1. Wear a face shield over safety glasses for face protection and a respirator, if conditions warrant.

18.6.2.5.2.2. Use a dressing tool with a cutting head equal in width to the width of the grinding wheel. A dresser containing self-traversing star wheels in the cutting head requiring the operator to simply place the dresser against the wheel and apply pressure is preferred. The work rest is not required as a guide in order to properly dress the wheel utilizing this dressing tool.

18.6.2.5.2.3. Inspect star dressers for loose shaft and worn discs prior to use.

18.6.2.5.2.4. Round off wheel edges with a hand stone before and after dressing to prevent the edges from chipping.

18.6.2.5.2.5. Use a work rest to support and guide the tool. Use a tool holder if one is available.

18.6.2.5.2.6. Apply moderate pressure slowly and evenly.

18.6.2.5.2.7. Always apply diamond dressers at the center or slightly below the center of the wheel.

18.6.2.5.3. Lubrication. Grinding machine spindle bearings shall be properly lubricated to prevent overheating or other conditions that might damage the abrasive wheel. Lubrication intervals shall be established based on the manufacturer's recommendations, or more stringent criteria may be adopted if usage experience requires. Improperly lubricated spindle bearings will cause the mounting spindle to expand because of heat generated, thus exerting a stress in the arbor hole area. Other adverse conditions related to improper lubrication can cause vibration that may result in a broken wheel.

18.6.2.6. Guarding. Guards shall be used on grinding machines except wheels used for internal work where the work offers protection. Types 16, 17, 18, 18R and 19 cones, plugs and threaded hole pot balls are examples of wheels not requiring guards while used for internal work (See [Figure 18.3](#)). On other wheels, the guard shall cover the spindle end, nut and flange projections, and be mounted to maintain proper alignment with the wheel. Fasteners used to mount the guard shall equal or exceed the strength of the guard. An exception to this is where the work itself provides adequate protection. The maximum exposure angles specified below shall not be exceeded. Visors or other accessory equipment shall not be included as part of the guard when measuring guard opening, unless such equipment offers the same protection as the guard and unless the accessory equipment is fastened as securely as the guard. For this and the following sub-paragraphs, refer to 29 CFR 1910.215. for additional information.

18.6.2.6.1. Bench and Floor Stand (Pedestal) Grinders. The angular exposure of the grinding wheel periphery and sides for safety guards on these machines shall not exceed 90 degrees or 1/4 the periphery. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure shall not exceed 125 degrees (See [Figures 18.4](#) and [18.5](#)). Where the operator stands in front of the opening, these units shall be equipped with a peripheral protector (tongue guard) that can be adjusted to the decreasing diameter of the wheel. The opening shall be maintained at no more than 1/4 inch.

18.6.2.6.2. Cylindrical Grinders. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on cylindrical grinding machines shall not exceed 180 degrees. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle (See [Figure 18.6](#)). Tongue guard protective requirements of paragraph [18.5.2.6](#) also apply to cylindrical grinders.

18.6.2.6.3. Top Grinding Operations. Where the work is applied to the wheel above the horizontal centerline, the exposure of the grinding wheel periphery shall be as small as possible and shall not exceed 60 degrees (See [Figure 18.7](#)).

18.6.2.6.4. Additional Types of Grinders. Equipment in the following paragraphs has minimal use at most Air Force installations. Organizations using this equipment shall develop guard criteria using 29 CFR 1910.215.

18.6.2.6.4.1. Cup wheels.

18.6.2.6.4.2. Surface grinders and cutting-off machines.

18.6.2.6.4.3. Swing frame grinders.

18.6.2.6.4.4. Automatic snagging machines.

18.6.2.6.4.5. Band-type guards.

18.6.2.6.5. Guard Material and Design. Locally manufactured guards shall meet requirements of 29 CFR 1910.215.

18.6.2.6.6. Shields. Shatter-resistant transparent shields shall be provided as an added margin of safety on grinding machines.

18.6.2.6.7. Power Transmission. When power transmission apparatus is separate from the grinding machine, refer to paragraph [18.5.2.21](#) for guarding requirements.

18.6.2.7. Wet Grinding. Machines shall meet the same criteria for guarding, work rests and machine set up as for other abrasive wheel machinery. The following also apply:

18.6.2.7.1. When shutting down a wet grinding operation, the coolant shall be shut off first and the wheel allowed to rotate until the coolant has been spun out.

18.6.2.7.2. Wet process grinding wheels shall not be left partially submerged in water because this may cause an unbalanced wheel that may break when rotated.

18.6.2.7.3. The concentration and alkalinity of coolant affects organic bonded wheels. To avoid damage to these wheels, it is important to follow the manufacturer's instructions.

18.6.2.7.4. Floor surfaces around wet processes shall be of rough concrete or shall have nonskid materials or mats applied to reduce slipping hazards.

18.6.2.8. Wheel Storage. Abrasive wheels are easily broken; therefore, care shall be exercised in handling and storage to prevent damage.

18.6.2.8.1. Wheels shall be stored in a dry area not subject to extreme temperature changes or below freezing temperatures. Wet wheels may crack or break if stored below 32 degrees Fahrenheit. Breakage may also occur if a wheel or disk is taken from a cold storage room and work is applied to it before it is warmed to room temperature.

18.6.2.8.2. Storage shall be arranged to allow wheel selection and removal without damaging other wheels.

18.6.2.8.3. Thin organic bonded cutting wheels shall be laid on a flat horizontal surface away from heat.

18.6.2.8.4. Straight or tapered wheels are best stored when supported on edge in racks.

18.6.2.8.5. Wheels shall be dated when placed in storage so they can be issued oldest first. Manufacturer's instructions shall be checked to see if wheels or discs have a shelf life requirement and to see if they have special handling or storage requirements that could affect their safe use.

18.6.2.8.6. Wheels that cannot be hand carried shall be moved by hand trucks or powered trucks. Wheels shall not be rolled on the floor. When moving wheels by truck, workers shall avoid bumps and irregular surfaces.

18.6.2.8.7. Wheel storage areas should be as close to the grinding operation as practical.

18.6.2.8.8. Wheels that are bumped, dropped or show evidence of abuse shall be inspected using procedures in paragraph [18.6.2.5.1.3](#) prior to being placed in storage. Those found unsatisfactory shall be tagged and discarded unless repairs can be performed.

#### 18.6.2.9. Polishing and Buffing Wheels.

18.6.2.9.1. The softness of these wheels is controlled by the size of the flange. The larger the flange, the harder the surface. Special wheel dressing tools may also be used to soften the surface.

18.6.2.9.2. When polishing and buffing wheels are driven by variable speed motors, speed controls shall be safeguarded from accidental change.

18.6.2.9.3. When rouge or tripoli is applied to a rotating wheel, the side of the cake shall be held lightly against the wheel's periphery. If a stick is used, the side of the stick shall be applied so that it will fly away from the wheel.

18.6.2.9.4. Tool rests are not required for wire buffers and polishers.

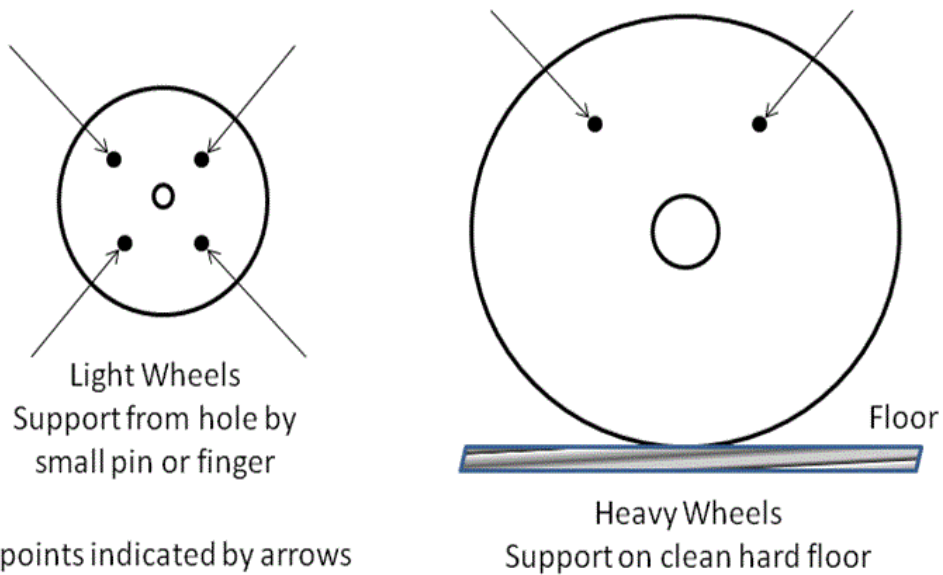
18.6.2.10. Special Grinding Operations. Grinding materials such as magnesium, titanium, thorium and beryllium present fire and health hazards. Supervisors of these operations shall contact the installation Ground Safety office, Fire Emergency Services (FES) Flight and BE for assistance in determining safe work practices and protective equipment needs.

**Table 18.1. OSHA Standards.**

<b>OSHA Standards</b>	
<b>Subject</b>	<b>OSHA Standard</b>
The Control of Hazardous Energy (Lockout/Tagout)	29 CFR 1910.147
Machinery & Machine Guarding	29 CFR 1910 Subpart O
Machinery & Machine Guarding (Definitions)	29 CFR 1910.211
General Requirements for all Machines	29 CFR 1910.212
Woodworking Machinery Requirements	29 CFR 1910.213
Abrasive Wheel Machinery	29 CFR 1910.215
Mechanical Power Presses	29 CFR 1910.217
Mechanical Power Transmission Apparatus	29 CFR 1910.219



**Figure 18.1. Tapping Locations on Ring Test.**



**Figure 18.2. Flange Installation.**

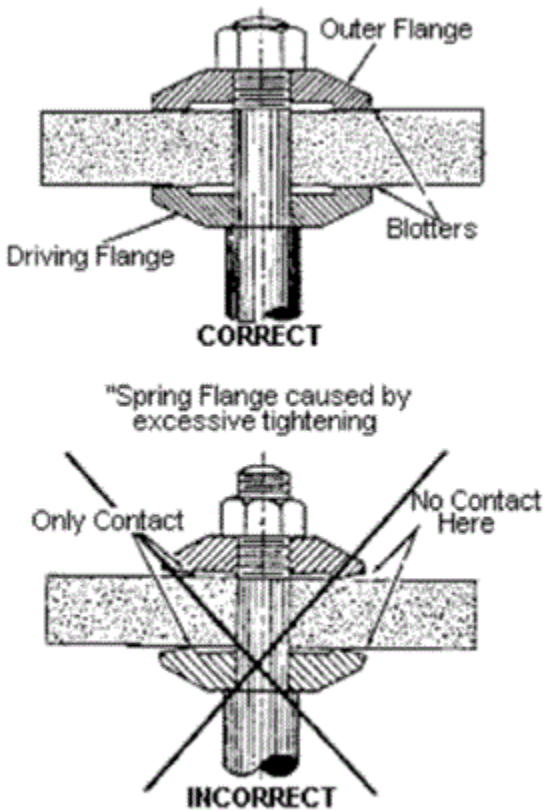


Figure 18.3. Types 16, 17, 18, 18R and 19 Cone and Plug Wheels.

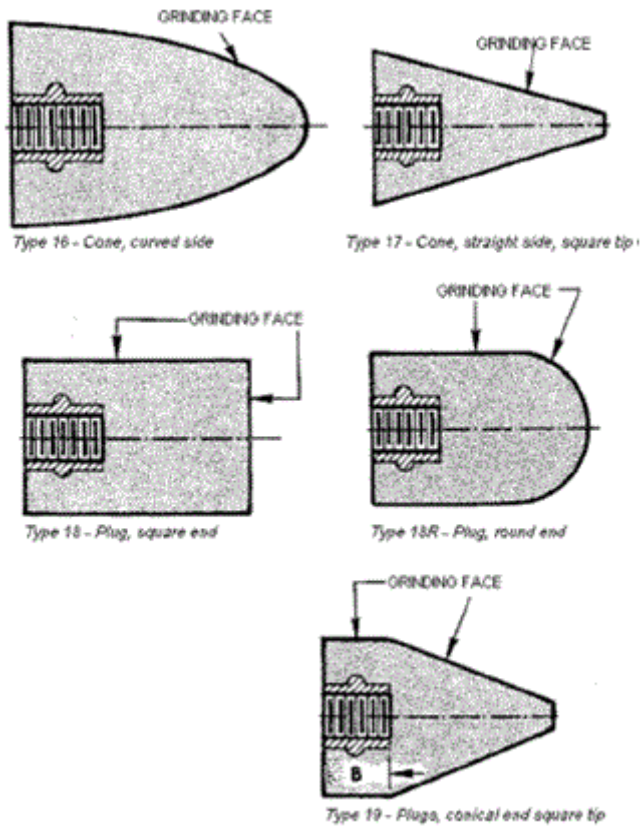


Figure 18.4. Bench and Floor Stand Grinder Guard Exposure Angles.

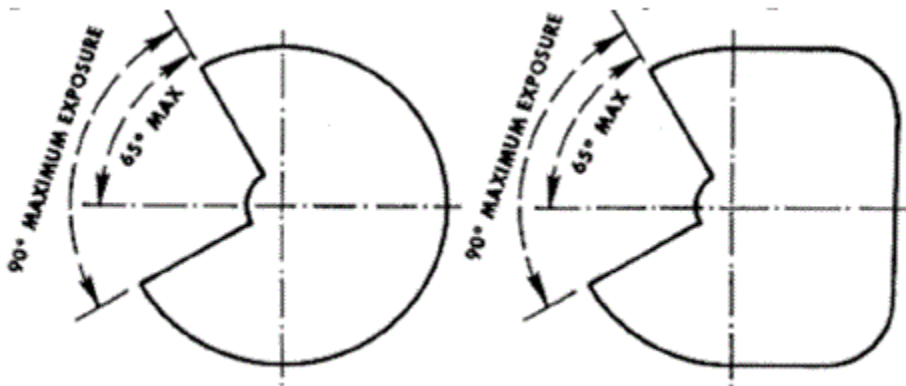


Figure 18.5. Bench and Floor Stand Grinder Guard Exposure Angles When Contact Below the Horizontal Plane of the Spindle is Required.

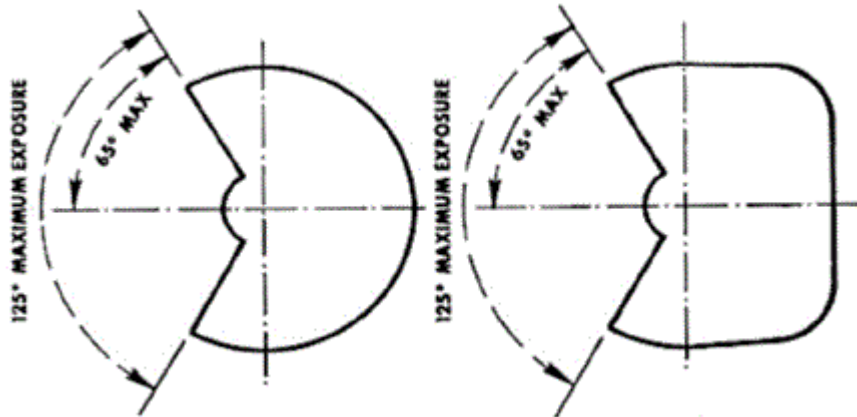


Figure 18.6. Cylindrical Grinder Guard Exposure Angles.

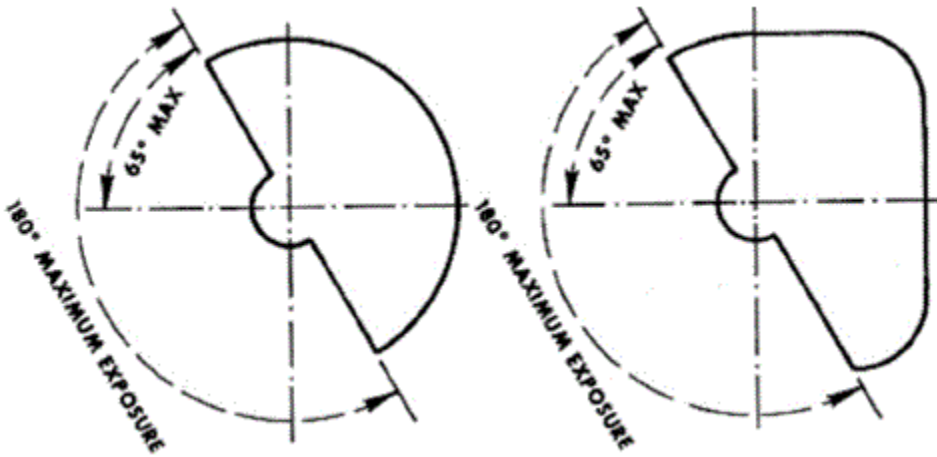
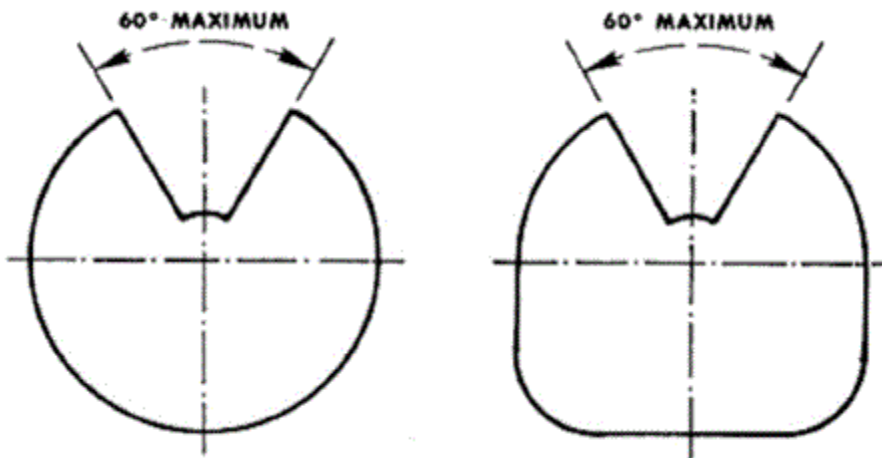


Figure 18.7. Top Grinding Guard Exposure Angles.



**18.7. Machinery Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

18.7.1. Does the hood cover the part of the saw blade exposed above the material? Reference [18.4.2.1.1](#)

18.7.2. Is a spreader provided at the table saw to prevent the wood from clamping down on the saw blade? Reference [18.4.2.1.2](#)

18.7.3. Are table throat openings kept as small as possible to prevent material from dropping below the level of the table? Reference [18.4.2.1.3](#)

18.7.4. Are anti-kickback dogs and fingers or safety hold-down wheels installed when material is being ripped? Reference [18.4.2.1.4](#)

18.7.5. Are anti-kickback dogs and fingers inspected before each use? Reference [18.4.2.1.4](#)

18.7.6. Is the blade or cutting head inspected for proper cutting condition (e.g., teeth sharp and properly set, no cracks, free of foreign residue) before a job is started? Reference [18.4.2.1.8](#)

18.7.7. Do Services hobby shop supervisors label each saw with a sign or decal that states which type blade is installed and what it is used for? Reference [18.4.2.1.9.1](#)

18.7.8. Do operators take care not to crowd the saw (force material faster than it can be cut)? Reference [18.4.2.1.10](#)

18.7.9. Is a permanent line marked on the table in front of and in line with the saw blade to enable the operator to set the rip fence without lifting the saw guard? Reference [18.4.2.1.11](#)

18.7.10. Are hands kept out of the line of cut when feeding saws? Reference [18.4.2.1.12](#)

18.7.11. Are feather boards used as side guides and top hold-downs on operations (rabbeting, grooving and dadoing) when a saw blade hood cannot be used? Reference [18.4.2.1.15](#)

18.7.12. Are radial saws equipped with a hood that encloses the saw blade and arbor ends? Reference [18.4.2.2.1](#)

18.7.13. Is the lower section of the hood hinged so it rises and falls, adjusting itself automatically to the thickness of the material as the saw passes through it? Reference [18.4.2.2.1](#)

18.7.14. Does the saw have a positive limit-stop to prevent the saw from traveling beyond the front edge of the table? Reference [18.4.2.2.8](#)

18.7.15. Is the direction of saw rotation conspicuously marked on the hood? Reference [18.4.2.2.11](#)

18.7.16. Is a permanent decal that reads “DANGER: DO NOT RIP OR PLOUGH FROM THIS END” affixed to the rear of the saw guard at approximately arbor level? Reference [18.4.2.2.11](#)

18.7.17. Is the locking device on the saw head securely fastened when angle or miter cuts are made? Reference [18.4.2.2.13](#)

18.7.18. When removing short pieces from a table close to a saw blade, does the operator ease the saw back to the idling position and make sure all bouncing has stopped before placing hands on the table? Reference [18.4.2.2.16](#)

18.7.19. Are both upper and lower wheels completely enclosed on both sides of band saws? Reference [18.4.2.3.1](#)

18.7.20. Is the band saw guard self-adjusting, and does it completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure? Reference [18.4.2.3.2](#)

18.7.21. If material binds or pinches on the blade, is the saw turned off and blade motion allowed to stop before the operator attempts to back the work away from the blade? Reference [18.4.2.3.6](#)

18.7.22. Are jointers with front-table-mounted fences equipped with an adjustable device to prevent thin stock from slipping laterally under the portion of the fence at the rear of the table? Reference [18.4.2.4.3](#)

18.7.23. Is an automatic guard provided to cover the working and nonworking side sections of the planer/jointer cutter head and prevent any opening between the guard and wood during the operation? Reference [18.4.2.4.4](#)

18.7.24. Do planer/jointer operators use hold-down push blocks, jigs or fixtures? Reference [18.4.2.4.7](#)

18.7.25. Are guards provided for feed rolls, cutting heads and hold-down rolls at the discharge end of power feed planers? Reference [18.4.2.5.1](#)

18.7.26. Are feed rolls guarded by a metal strip in front of the rolls that will prevent an operator’s fingers being drawn into the planer/jointer? Reference [18.4.2.5.1](#)

18.7.27. When other than corrugated top feeders are used, is an anti-kickback device installed on the planer? Reference [18.4.2.5.2](#)

18.7.28. Are shapers equipped with a braking device that will stop the cutting head within 10 seconds after power is shut off? Reference [18.4.2.6.1](#)

18.7.29. Is a double-spindle shaper machine equipped with separate braking devices? Reference [18.4.2.6.1](#).

18.7.30. Does the shaper fence extend at least 18 inches on either side of the spindle? Reference [18.4.2.6.2](#).

18.7.31. Is a hinged metal shield or hood provided on rotating, cutter-type lathes? Reference [18.4.2.7.1](#).

18.7.32. Is a brake installed on automatic lathes? Reference [18.4.2.7.2](#).

- 18.7.33. Are guards that will contain the workpiece if it separates from its anchorage installed on lathes used for turning long pieces of material? Reference [18.4.2.7.6](#).
- 18.7.34. Is a guard installed on the feed rolls of self-feed sanding machines? Reference [18.4.2.8.1](#).
- 18.7.35. Are guards installed at each nip point on a belt sanding machine? Reference [18.4.2.8.2](#).
- 18.7.36. Are hold-down devices installed on table-type boring or mortising machines? Reference [18.4.2.9.4.6](#).
- 18.7.37. Are feed chains and sprockets of double end tenoning machines completely enclosed? Reference [18.4.2.10.1](#).
- 18.7.38. Is the motor **START** switch on the machine protected against accidental or inadvertent operation? Reference [18.4.2.11.1](#)
- 18.7.39. Is machinery installed IAW the NEC? Reference [18.4.2.11.2](#)
- 18.7.40. Are control switches available to workers at their operating positions so they do not need to reach over moving parts of machinery? Reference [18.4.2.11.3](#)
- 18.7.41. Is the stop control switch identified by a printed word or color coded red? Reference [18.4.2.11.3](#)
- 18.7.42. Are under-voltage protective devices installed on machines that are not safeguarded to protect the worker during under-voltage situations? Reference [18.4.2.11.4](#)
- 18.7.43. Have installation safety offices and shop supervisors identified those machines that require under-voltage protection? Reference [18.4.2.11.4](#)
- 18.7.44. Are foot treadle controls protected against unexpected or accidental tripping? Reference [18.4.2.11.5](#)
- 18.7.45. Are exposed non-current-carrying metal components of machines grounded? Reference [18.4.2.11.6](#)
- 18.7.46. Are all machine energy sources or energy isolating devices, such as disconnect switches or circuit breakers, locked out or tagged out before maintenance is performed or major adjustments are made with guards and panels removed? Reference [18.4.2.11.7](#)
- 18.7.47. Are proper lockout/tagout procedures followed? Reference [18.4.2.11.7](#)
- 18.7.48. Are machines or their dangerous moving parts positioned so hazardous areas are not accessible or do not present a hazard to workers during normal operation? Reference [18.4.2.12](#)
- 18.7.49. Before use of any safeguarding techniques, is a thorough hazard analysis made of each machine and particular situation? Reference [18.4.2.12.1](#)
- 18.7.50. Is the main source of power disconnected and locked in the **OFF** position when maintenance, service or machine adjustments are made? Reference [18.4.2.12.3](#)
- 18.7.51. Are safeguarding devices installed, adjusted, and used according to manufacturer's operating and maintenance instructions? Reference [18.4.2.13.2](#)

- 18.7.52. Are hazardous parts that are not protected by a safeguarding device, guarded IAW [18.4.2.14](#)? Reference [18.4.2.13.3](#)
- 18.7.53. Whenever a guard is removed for other than an operational requirement, is the machine shut down and the control switch(s) locked and tagged in the **OFF** position? Reference [18.4.2.14.3](#)
- 18.7.54. Are enclosure and barrier guards interlocked with the machine control so the machine cannot be activated unless the guard or the hinged or movable sections of the guard are in position? Reference [18.4.2.14.4](#)
- 18.7.55. Are fan blades guarded when the blades are less than seven (7) feet above the floor or working level? Reference [18.4.2.14.5](#)
- 18.7.56. Are all guards designed and installed so no part of the body can be inadvertently placed in, on, under or over the edges of the guard where it might contact a moving part? Reference [18.4.2.14.6.1](#)
- 18.7.57. Does the installation CE or Ground Safety office determine the best material for guard construction in environments where chemical or corrosive operations are performed? Reference [18.4.2.14.6.2](#)
- 18.7.58. Are pulleys with cracks or pieces broken out of the rims taken out of service? Reference [18.4.2.14.6.11](#)
- 18.7.59. Do operators and maintenance personnel inspect guards prior to use and after maintenance? Reference [18.4.2.14.6.13](#)
- 18.7.60. Are holding tools used only to supplement guard protection when it would otherwise be necessary to place hands in the danger zone? Reference [18.4.2.15.2](#)
- 18.7.61. Are presence-sensing devices used only on part-revolution clutch presses? Reference [18.5.2.1.3.4](#)
- 18.7.62. Are press areas not protected by presence-sensing devices guarded? Reference [18.5.2.1.3.4](#)
- 18.7.63. Do buttons on two-hand control devices operate only when the buttons are depressed concurrently and continuously (holding time) on the press downstroke or else is the clutch disengaged, the brake applied and the slide stopped? Reference [18.5.2.1.4](#)
- 18.7.64. Are energy controls isolated by a lockout device and safety blocks during press repairs or alterations of the die area? Reference [18.5.2.1.4.6](#)
- 18.7.65. Are operating levers on hand-tripped machinery with more than one operating station interlocked? Reference [18.5.2.1.4.8](#)
- 18.7.66. Is a means provided to select **OFF**, **INCH**, **SINGLE STROKE** or **CONTINUOUS** modes of operation integrated with the clutch brake control to govern the operation mode of the press? Reference [18.5.2.1.4.9](#)
- 18.7.67. During the inch operating mode, is concurrent use of both hands required to actuate the press clutch? Reference [18.5.2.1.4.10.1](#)

- 18.7.68. For presses with a single control, is it protected against accidental actuation and located so the worker cannot reach into the point of operation while actuating the control? Reference [18.5.2.1.4.10.2](#)
- 18.7.69. Are individual operator's two-hand trip controls designed and constructed so use of both hands is required to protect against unintentional press operations? Reference [18.5.2.1.4.12](#)
- 18.7.70. Do two-hand trip systems on full-revolution-clutch presses provide anti-repeat protection for operators? Reference [18.5.2.1.4.13](#)
- 18.7.71. When two-hand trip systems are used on multiple operator press machines, does each operator have a separate set of controls? Reference [18.5.2.1.4.13](#).
- 18.7.72. Are operators provided picks, pliers, tongs and other hand-feeding tools required for the safe handling of stock, dies or materials? Reference [18.5.2.1.4.14](#).
- 18.7.73. Is a die setter's safety bar used for turning the flywheel when the power is off? Reference [18.5.2.1.4.14](#).
- 18.7.74. Are power presses safeguarded to prevent the operator's hands entering the area between the dies during press cycling? Reference [18.5.2.2](#).
- 18.7.75. Is a power disconnect or Stop switch (capable of being locked) provided on hydraulic presses? Reference [18.5.2.2.1.2](#).
- 18.7.76. When using shears, is the area where sheared or punched refuse drops barricaded to prevent injuries to operators and helpers? Reference [18.5.2.5.4](#).
- 18.7.77. Are shears equipped with an emergency stop control? Reference [18.5.2.5.4](#)
- 18.7.78. Are tools adjusted in lathe tool rests so they are slightly above the center? Reference [18.5.2.6.9](#)
- 18.7.79. When chips are generated during lathe use, is a tool, puller, brush or shovel used to remove them? Reference [18.5.2.6.10](#)
- 18.7.80. Is a chip shield provided on planers to prevent chips from flying and striking personnel? Reference [18.5.2.8.1](#)
- 18.7.81. Do the supervisor and installation Ground Safety office develop requirements on machine safe-guards for saws not covered in this standard? Reference [18.5.2.9](#)
- 18.7.82. Are both upper and lower wheels of bandsaws completely enclosed on both sides? Reference [18.5.2.10.1](#)
- 18.7.83. Is there a self-adjusting guard on the bandsaw that will completely cover the saw blade between the guide rolls and the upper wheel enclosure? Reference [18.5.2.10.2](#)
- 18.7.84. Are vises, fixtures and other work-holding equipment used on hacksaws to hold the workpiece securely? Reference [18.5.2.11.2](#)
- 18.7.85. Are riveting machines guarded to prevent operators placing their hands between dies? Reference [18.5.2.14](#)



- 18.7.86. When more than one operator is required to operate a machine from different control stations, is each station provided with a cycle start button? Reference [18.5.2.17.2](#)
- 18.7.87. Are all cycle start buttons other than the one being used made inoperative (when one operator can operate the machine from more than one station)? Reference [18.5.2.17.3](#)
- 18.7.88. Are the emergency stops color coded red and located at each operator control station? Reference [18.5.2.18.1](#)
- 18.7.89. Can machine motions that are stopped by the emergency or master switch only be restarted by deliberate action by the operator? Reference [18.5.2.18.4](#)
- 18.7.90. Do circuits employing accumulator tanks automatically vent the accumulator pressure or isolate the accumulator when the machine is shut off? Reference [18.5.2.19.5](#)
- 18.7.91. Are non-vented accumulators identified with a sign saying “WARNING: PRESSURIZED VESSEL” or the nearest commercially available equivalent? Reference [18.5.2.19.6](#)
- 18.7.92. Are flexible pneumatic and hydraulic hoses arranged so they do not create a tripping hazard? Reference [18.5.2.19.8](#)
- 18.7.93. Whenever pressure is maintained after power is off, is a warning plate used? Reference [18.5.2.19.9](#)
- 18.7.94. Are local exhaust ventilation systems provided and used when dry grinding, polishing or buffing is performed to maintain employee exposures within permissible exposure limits? Reference [18.6.2.1](#)
- 18.7.95. Are abrasive wheel machines only operated with safety guards installed? Reference [18.6.2.3.1](#)
- 18.7.96. Are work rests used during all off-hand grinding operations? Reference [18.6.2.3.3](#)
- 18.7.97. Are work rests adjusted closely to the wheel with a maximum opening of 1/8 inch to prevent work being jammed between the wheel and rest? Reference [18.6.2.3.3.1](#)
- 18.7.98. Are operators prevented from using abrasive grinding wheels to grind aluminum, brass, copper or other soft metals (unless the wheel is specifically designed for that purpose)? Reference [18.6.2.3.8](#)
- 18.7.99. Are operators prevented from using the side of the wheel for grinding (other than wheels designed for that purpose)? Reference [18.6.2.3.9](#)
- 18.7.100. Do all operators ensure that the grinders, buffers and wire brush machines are turned off when work is completed or prior to leaving the vicinity of the machine? Reference [18.6.2.3.10](#)
- 18.7.101. Do the operators wear safety glasses or goggles for protection of the eyes, and a face shield for protection from wheel breakage, sparks and other grinding debris? Reference [18.6.2.3.12](#)
- 18.7.102. Are safety guards in place prior to starting a grinder? Reference [18.6.2.5.1.10](#)
- 18.7.103. Do personnel wear face shields over safety glasses for face protection when dressing grinder wheels? Reference [18.6.2.5.2.1](#)

18.7.104. On grinding wheels requiring guards, does the guard cover the spindle end, nut and flange projections? Reference [18.6.2.6](#)

18.7.105. Where the work is applied to the grinding wheel above the horizontal center line, is the exposure of the grinding wheel periphery as small as possible and not over 60 degrees? Reference [18.6.2.6.3](#)

18.7.106. Do supervisors of operations that use materials such as magnesium, titanium, thorium, and beryllium contact installation Ground Safety office, FES Flight and BE for assistance to determine safe work practices and protective equipment needs? Reference [18.6.2.10](#)

## Chapter 19

### EMERGENCY SHOWER AND EYEWASH UNITS

**19.1. General Information.** This chapter addresses selection, acquisition, location, installation, maintenance, testing and use of emergency shower and eyewash units. Also included are performance specifications for both permanently-installed and self-contained units. Types of equipment covered are emergency showers, eyewash units, eye and face units, combination units, hand-held drench hoses and eyewash bottles. Specific OSHA requirements are listed in paragraphs 19.2.2, 19.2.3 and 19.2.4. Information in this instruction is derived from ANSI Z358.1, *Emergency Eyewash and Shower Equipment*, and includes regulatory OSHA requirements. Different makes, styles and combinations are available and must be chosen carefully.

19.1.1. The best means of worker protection is to engineer hazards out of the job so the worker is not exposed. If this is not possible, personal protective equipment (PPE) may be required. Eyewash units, eye and face units, deluge showers and other similar devices are emergency equipment and not a substitute or alternative for personal protective equipment. Injuries may be caused by exposure to chemicals or by materials thrown from equipment or machinery. Other injuries, particularly to the face and eyes, may occur when harmful liquids are sprayed, squirted, splashed, splattered, dropped or dripped.

19.1.2. Installed units that do not meet the criteria of this instruction shall be evaluated by the installation Ground Safety office and prioritized for replacement or upgrade.

19.1.3. Acquisition. Emergency shower and eyewash equipment may be both locally and centrally procured. The procuring document shall include a requirement for the equipment to meet or exceed ANSI Z358.1 (2004) specifications.

### 19.2. OSHA Requirements.

19.2.1. 29 CFR 1910.111, *Storage and Handling of Anhydrous Ammonia*.

19.2.1.1. Paragraph (b)(10)(iii): Stationary ammonia storage installations shall have an easily accessible shower or a 50-gallon drum of water.

19.2.1.2. Paragraph (b)(10)(iv): Each vehicle transporting ammonia in bulk (except farm applicator vehicles) shall carry a container of at least five (5) gallons of water and shall be equipped with a full-face mask (approved by BE).

19.2.2. 29 CFR 1910.151(c), *Medical Services and First Aid*: Where the eyes or body of any worker may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of eyes and body shall be provided in the work area for immediate emergency use.

19.2.3. 29 CFR 1910.268(b)(2)(i), *Telecommunications*: Supervisors will ensure eye protection devices, with side as well as frontal eye protection, are used when measuring storage battery specific gravity or handling electrolyte. Acid resistant gloves and aprons shall be worn for protection against splattering. Facilities for quick drenching or flushing of the eyes and body shall be provided unless the storage batteries are of the enclosed type and equipped with explosion proof vents, in which case sealed water rinse or neutralizing packs

may be substituted for the quick drenching or flushing facilities. Employees assigned to work with storage batteries shall be instructed in emergency procedures, such as dealing with accidental acid spills.

19.2.4. 29 CFR 1926.441(a)(6), *Batteries and Battery Charging (Subpart K, Electrical)*: “Facilities for quick drenching of eyes and body shall be provided within 25 feet (7.62 m) of battery handling areas.”

**19.3. Responsibilities.** Each supervisor is responsible for ensuring emergency showers and eyewashes are provided, inspected, tested and maintained IAW this instruction. Evaluations for each request for emergency showers and/or eyewashes shall be made by the installation Ground Safety office to determine the need for the installation of units. Rationale for decisions shall be documented and maintained in respective facility case files. The type of material used, its properties, how the material is dispensed, probability of injury, extent of potential injury and PPE available and used shall be considered in determining the need for the units. Emergency showers and eyewashes are NOT a substitute for PPE and personnel shall use proper PPE when required. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance on PPE and the wear of contact lenses in the workplace.

#### **19.4. Equipment.**

19.4.1. Permanently-installed shower and eyewash units (**Figure 19.1**) provide the best emergency protection for personnel. Self-contained units (**Figure 19.2**) and eyewash bottles (**Figure 19.3**) offer minimum protection and use shall be IAW paragraphs **19.4.3** through **19.4.5**.

19.4.2. Hand-held drench hoses (**Figure 19.4**) can supplement shower and eyewash units but do not replace them. They can be used where the worker is in an awkward position physically or to reach parts of the face or body inaccessible to the fixed stream of the shower or eyewash. Eyes are usually washed with a spent stream which is accomplished by holding the hose up and washing the eye at the point where the stream has minimum pressure.

19.4.3. Self-contained units provide minimum worker protection and shall only be used in the following situations:

19.4.3.1. As an interim fix, pending installation or repair of a permanently-installed unit.

19.4.3.2. For workers exposed to irritants rather than substances that could damage the eye.

19.4.3.3. In temporary locations where a permanent installation would not be economically feasible or may not be possible.

19.4.3.4. In field operations, such as remote missile or communications sites, where a source of potable water is not available.

19.4.4. Eyewash bottles are not a replacement for other type units. An eyewash bottle may be kept in the immediate vicinity where employees are working on extremely hazardous operations. These units supply immediate flushing after which the individual may then proceed or be helped to a permanently-installed or self-contained unit to flush the eyes more thoroughly.

19.4.5. Personnel working in remote areas where eyewash facilities are not readily available could be exposed to dust, fuels, solvents and other materials that if blown or splashed into the eyes would irritate the eyes. Immediate, continuous thorough flushing of the eyes with water or normal saline is usually very beneficial prior to definitive medical treatment and vehicles supporting such operations should be equipped with unexpired large eyewash bottles or other means of flushing the eyes.

**19.5. Location.** Emergency showers and eyewash units shall be installed as required and maintained in an operable condition. They shall be in conspicuously identified and accessible locations that require no more than 10 seconds to reach and free of obstructions that may inhibit immediate use of the equipment. The unit shall be located as close to the hazard as possible without physically causing a hazard itself and shall not be located where the water spray will contact electrical circuits. Energized circuits located within two (2) feet of emergency eyewash stations and within five (5) feet of emergency shower stations shall be protected by ground fault circuit interrupters (GFCI). Some corrosive substances have a very fast reaction time and worker exposure to them requires the emergency shower and eyewash unit be located immediately adjacent to the hazard.

**19.6. Installation.** Permanently-installed units shall be assembled, installed and tested by qualified personnel IAW manufacturer's instructions and the applicable portion of paragraph 19.12. Facility design requirements shall be considered prior to installation. Installed units shall meet requirements of OSHA, ANSI Z358.1 and the manufacturer of the unit. Travel distances to eyewash stations shall not exceed 100 feet and shall not take more than 10 seconds to reach. Workers should not have to open any doors or use any stairs to reach the station. Placement of the unit shall be in a central location where the need is the greatest. Work situations may require that more than one station be available. Units shall be connected to a supply of water free from contamination and equal in purity to potable water. Water pressure must be capable of producing the required columns and sprays IAW manufacturer's instructions.

19.6.1. Water shall not be delivered at an extreme temperature (hot or cold) that could discourage the unit's use. Water temperature shall be between 60° F and 100° F. Lukewarm water (90° F to 95° F) is ideal. BE will be consulted for guidance in circumstances where chemical reaction is accelerated by contact with water or increased water temperature. Self-contained units and the supply lines of permanently-installed units shall be protected from freezing and from sunlight or other heat sources that could cause extremes in water temperature.

19.6.2. Permanently-installed units and self-contained units installed in fixed locations shall be identified with a highly visible sign. The area around or behind the unit, or both, may be painted with green and white stripes if needed to increase visibility for easy identification by the user. Emergency shower and eyewash units shall be well lighted. Consult the local CE facility design section whenever specific guidance on lighting is required.

19.6.3. If shutoff valves are installed in the water line for maintenance purposes, provisions shall be made to prevent accidental shutoff by placing a tag at the valve indicating the water supply is for emergency use. The affected supervisor(s) shall be notified prior to shutting off the water supply.

**19.7. Control Valve and Actuating Mechanism.**

19.7.1. The control valve shall be designed so, once activated, the water flow continues without requiring the use of the operator's hands. It shall remain on until intentionally shut off, shall be simple to operate (push-pull), and go from "off" to "on" in one second or less. Malfunctioning valves shall be replaced or repaired immediately.

19.7.2. The control valve will be operated by an easily located and readily accessible actuating device, such as a ring and chain attached to the lever or rocking arm of the valve, a walk-on treadle or a push handle (**Figure 19.5**).

**19.8. Alarms and Lights.** Audible alarms or blinking lights may be used to indicate the unit is in operation. Units in remote areas or where an individual is working alone may be equipped with activating valves electrically connected to warning lights or buzzers positioned in occupied areas (dispatch offices, work areas, etc.) to alert personnel when the unit is activated so aid may be sent. In remote areas such as missile sites, the buddy system may be used in lieu of an alarm system. Supervisors of operations where the buddy system is used shall indicate clearly what actions each person is to perform. When in doubt as to the type of buddy system to use, the supervisor shall consult with the installation Ground Safety office. Buddies shall know the hazards involved in any operation, their duties as buddies, how to use prescribed rescue equipment and emergency procedures.

**19.9. Maintenance and Testing.**

19.9.1. Permanently-installed shower and eyewash units shall be activated by the supervisor or worker weekly to verify proper operation. The unit only needs activated long enough to ensure adequate pressure and volume of water is available and all orifices are free of obstructions. If a build-up of scale, rust, etc., is noted, spray heads or nozzles shall be removed and cleaned or replaced. The source of contamination shall be eliminated if possible. Units installed in unoccupied or infrequently used areas are exempt from this testing requirement, but shall be tested prior to commencing operations that could expose personnel to hazardous operations.

19.9.2. The supervisor or worker shall inspect permanently-installed unit(s) monthly and document the inspection IAW paragraph **19.12**. Documentation shall be maintained to show date of inspection and name of individual performing the test. This documentation may be kept in a log, computerized or affixed to the equipment by tag or label. **Exception:** Units installed at missile sites shall be tested and documented by the team chief during the most frequently performed periodic inspection established for that system.

19.9.3. Self-contained units shall be tested and inspected IAW the manufacturer's instructions. Where tap water is used, fluid shall be replaced at least monthly. Less frequent intervals of fluid change, as recommended by the manufacturer, are acceptable where a solution or water additive is used. Fluid level shall be checked monthly. Tags or labels shall be attached to the unit or adjacent to it, indicating the fluid change schedule. Missile sites are given the same exception as in paragraph **19.9.2**.

19.9.4. Eyewash bottles shall have instructions and expiration dates, if applicable, permanently affixed to the unit. They shall be tested, refilled, maintained and disposed of IAW the manufacturer's instructions.

19.9.5. All units shall be inspected by the installation Ground Safety office during scheduled surveys for proper placement, installation and documentation of supervisory testing and operation. Inspection personnel shall also randomly check employees to determine if they have been adequately trained on the use of emergency equipment.

**19.10. Training.** All workers exposed to conditions that may use this emergency equipment shall be instructed in its use as a part of their job safety training. The initial treatment for a hazardous substance splash shall be to wash the affected areas for a minimum of 15 minutes prior to seeking medical treatment. Depending on the chemicals involved, clothing may need to be removed during the showering period. When eyes are affected, it is important to hold the eyelids open and roll the eyeballs so water will flow on all surfaces, including the folds surrounding the eyeballs. This is best accomplished by placing the thumb and forefinger of each hand on the eyebrow and below the eye to provide an open surface for flushing. A worker can be temporarily blinded by a chemical splash and may be in extreme pain. It is a natural tendency to keep the eyes shut, preventing the benefits of running water. Medical attention shall be sought immediately after using an emergency eyewash and shower.

**19.11. Water Supply.** When any maintenance is performed that would render an emergency shower or eyewash inoperative, the responsible supervisor shall be notified in advance of the outage and again when service is restored. During the outage the supervisor will assure self-contained units or eyewash bottles are available for emergency use.

**19.12. Performance Specifications and Installation Requirements for Permanently-Installed Units.**

19.12.1. Emergency Showers.

19.12.1.1. The face of the emergency shower head shall be installed no less than 82 inches nor more than 96 inches in height from the surface on which the user stands. The spray pattern shall have a minimum diameter of 20 inches at 60 inches above the surface on which the user stands, and the center of the spray pattern shall be located at least 16 inches from any obstruction. In a combination unit, the eyewash is not considered an obstruction for the purpose of determining the distance of the center of the spray pattern. Multiple-spray emergency shower units (**Figure 19.6**) are exempt from these requirements and shall be installed IAW the manufacturer's specifications.

19.12.1.2. Enclosures, if used, shall provide a minimum unobstructed area 34 inches in diameter to accommodate movement necessary in an emergency situation.

19.12.1.3. Shower actuating devices shall be easy to locate and readily accessible to the user:

19.12.1.3.1. Hand pull devices shall be located not more than 69 inches nor less than 55 inches above the surface on which the user stands.

19.12.1.3.2. Push handles and/or paddles shall be approximately 40 inches above the surface on which the user stands.

19.12.1.3.3. Foot treadles shall not be more than six (6) inches above the walking surface.

19.12.1.4. The shower shall be tested IAW the following procedures:

19.12.1.4.1. With water pressure on and the valves closed, check visible plumbing connections for leaks.

19.12.1.4.2. Move the valve to the full open position. The valve shall move smoothly and freely and remain open without requiring further attention from the operator.

#### 19.12.2. Eyewash Equipment.

##### 19.12.2.1. Eyewash units:

19.12.2.1.1. Shall provide a controlled flow of potable water (or its equivalent) to both eyes simultaneously at a pressure low enough not to be injurious. Normally, this can be accomplished by a water stream that rises between 6 and 12 inches from the nozzle.

19.12.2.1.2. Nozzles shall be protected from contamination. If protective covers are used, their removal shall not require a separate motion by the operator when activating the unit.

19.12.2.1.3. Units shall be positioned with water nozzles 33 inches to 45 inches from the surface on which the user stands. Eyewash-actuating devices shall be easy to locate and readily accessible. If a foot treadle is used, it shall not be more than six (6) inches above the floor (**Figure 19.5**).

19.12.2.2. Eye and Face Wash Units. Units (**Figure 19.7**) shall meet the same criteria as an eyewash unit IAW paragraph **19.12.2.1**, except they shall be capable of delivering a greater volume of water. This additional flow is required to ensure the entire surface of the face is irrigated.

19.12.3. Hand-Held Drench Hoses. Drench hoses (**Figure 19.4**) supplement shower and eyewash units but do not replace them. They may be used where the user is in an awkward position physically to reach parts of the face or body inaccessible to the fixed stream of the shower or eyewash. Eyes are usually washed with a spent stream accomplished by holding the hose up and washing the eye at the point where the stream has minimum pressure.

19.12.4. Combination Units. These units (**Figure 19.1**) shall be installed so all components can be operated individually from a common water supply line and shall meet the previously stated performance and installation criteria for each component. It is not necessary for all components to operate simultaneously (individual conditions may dictate this requirement).

19.12.5. Self-contained Units. These units (**Figure 19.2**) shall be constructed of non-corrosive materials and provide a minimum of 15 minutes continuous flow. The stored fluid shall be protected against contaminants and temperature extremes. These units may be filled with potable water or a solution approved by either the manufacturer or the installation medical services. Instructions and expiration dates shall be permanently affixed to the unit.

19.12.6. Eyewash Bottles. Eyewash bottles (**Figure 19.3**) shall provide an immediate flushing to the eyes. Eyewash bottles are not a replacement for other types of emergency equipment. These bottles may be filled with potable water or an eye-flushing solution, either approved by the manufacturer or by the installation medical services. Local procedures shall be developed to prevent these units from being exposed to extreme temperatures. Instructions and expiration dates shall be permanently affixed to the unit, if applicable.



Figure 19.1. Permanent Combination Emergency Shower and Face and Eyewash Unit.

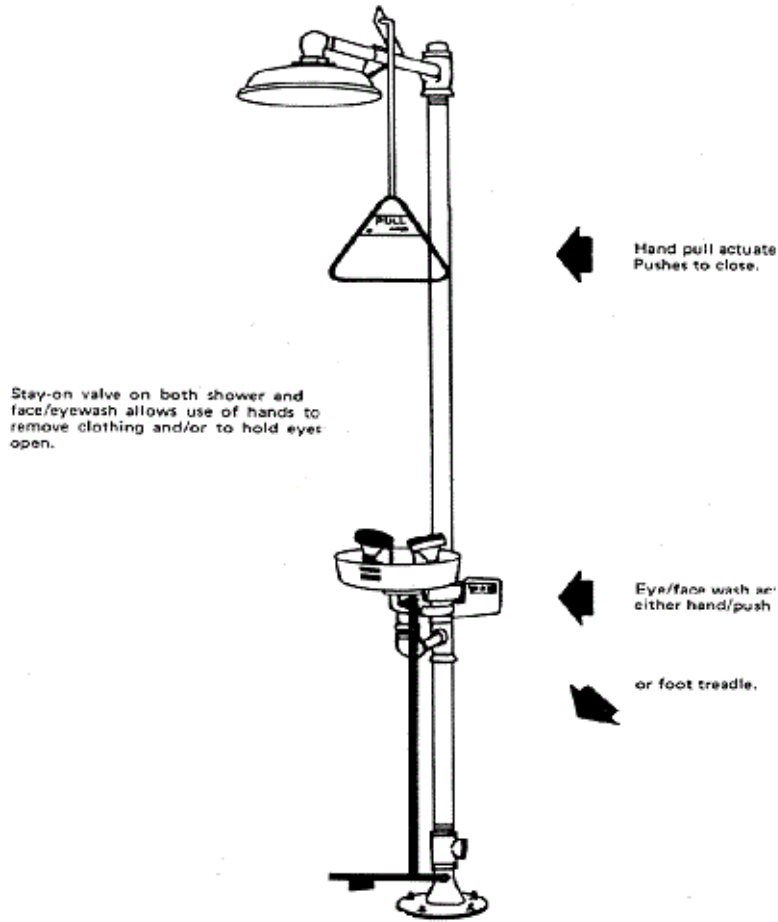
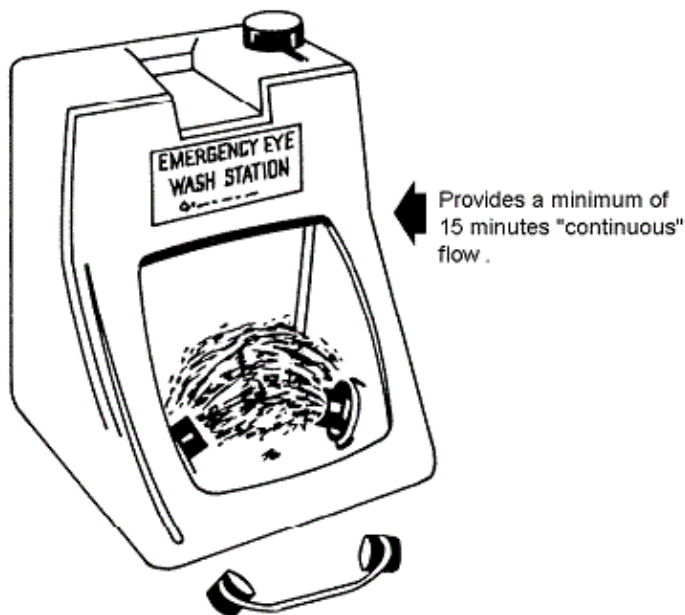


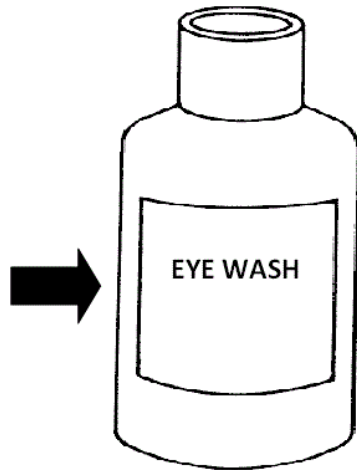
Figure 19.2. Self-Contained Non-Pressurized Eye Wash Unit.



**Figure 19.3. Eyewash Bottle.**

If working with materials that require IMMEDIATE flushing of eyes, eyewash bottles may be used in conjunction with plumbed or self-contained units.

SUPPLEMENTS PERMANENT AND SELF-CONTAINED UNITS BUT DOES NOT REPLACE THEM.



**Figure 19.4. Hand-Held Drench Hose (Permanent).**

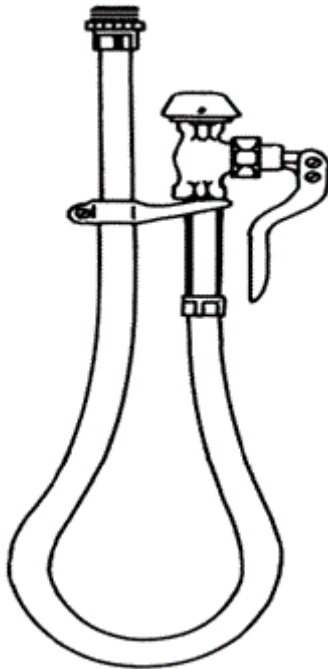


Figure 19.5. Activating Mechanisms.

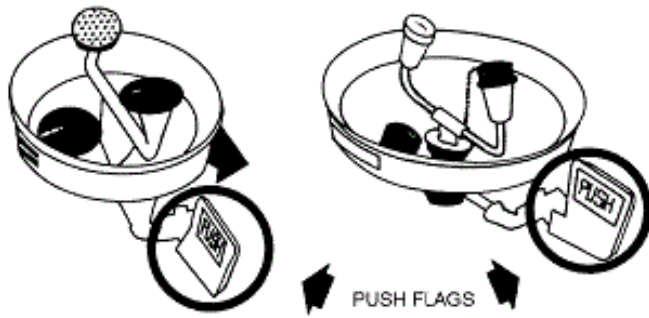
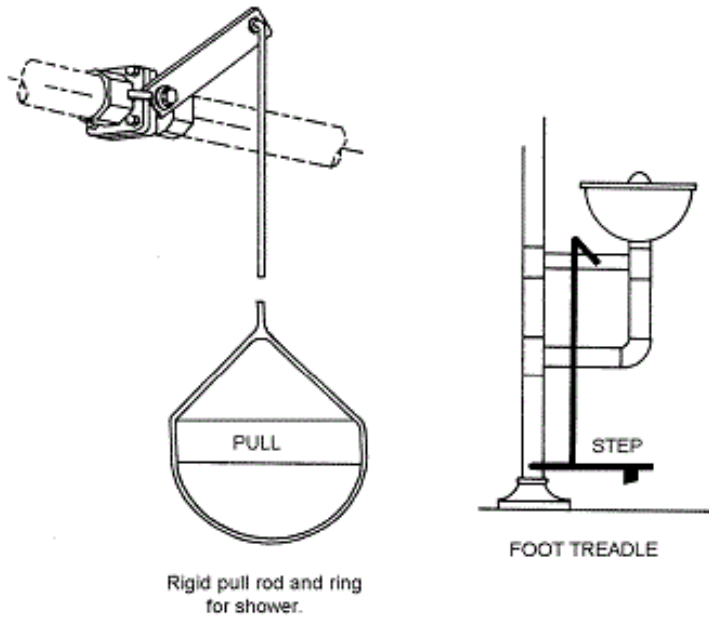
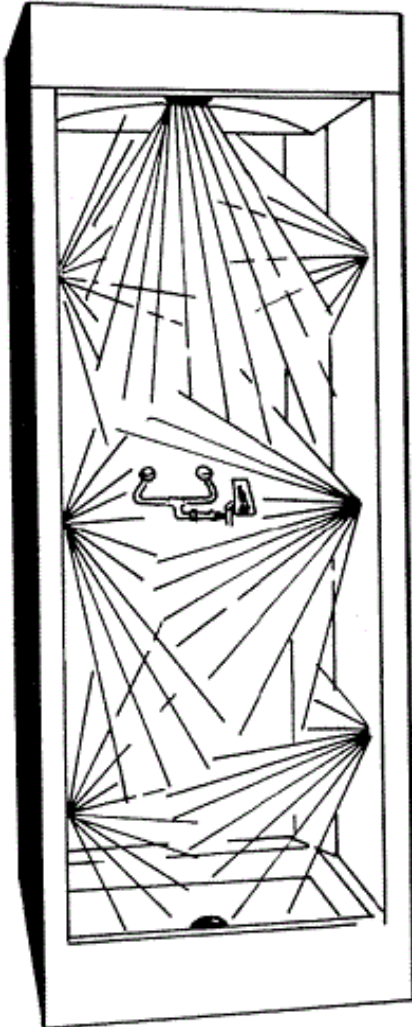


Figure 19.6. Multiple-Spray Shower and Eyewash.



Provides drenching from  
a variety of angles

**Figure 19.7. Wall-Mounted Permanent Eye and Face Wash.**

**19.13. Emergency Shower and Eyewash Units Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

19.13.1. Do supervisors ensure emergency showers and eyewashes are provided, inspected, tested and maintained IAW this standard? Reference [19.3](#)

19.13.2. Are hand-held drench hoses used only to supplement shower and eyewash units and not to replace them? Reference [19.4.2](#)

19.13.3. Are emergency shower and eyewash units in conspicuously identified accessible locations that do not require more than 10 seconds to reach? Reference [19.5](#)

19.13.4. Are emergency shower and eyewash units located so the water spray does not contact any electrical circuit? Reference [19.5](#)

19.13.5. Are emergency showers installed in conjunction with, or in close proximity to, eye and face or eyewash facilities? Reference [19.5](#)

19.13.6. Are the units connected to a supply of water free from contamination and equal in purity to potable water? Reference [19.6](#)

19.13.7. Is the delivered water temperature in a comfortable range that would not discourage use of the unit? Reference [19.6.1](#)

19.13.8. Are self-contained units and the water supply lines of permanently-installed units protected from freezing and from sunlight or other heat sources that could cause extremes in water temperature? Reference [19.6.1](#)

- 19.13.9. Are permanently-installed and self-contained units installed in a fixed location identified with a highly visible sign and well lighted? Reference [19.6.2](#)
- 19.13.10. Where shutoff valves are installed on water supply lines to emergency shower and eyewash units, have signs or tags been installed to prevent accidental shutoff? Reference [19.6.3](#)
- 19.13.11. When actuated, does the water flow remain on without use of the operator's hands? Reference [19.7.1](#)
- 19.13.12. Is the control valve simple to operate (push-pull) and does it go from "off" to "on" in less than one second? Reference [19.7.1](#)
- 19.13.13. Is the actuating device (pull handle, walk-on treadle, or push handle) readily accessible and easily located? Reference [19.7.2](#)
- 19.13.14. If audible alarms or blinking lights are installed to show that the unit is in use, are they working properly? Reference [19.8](#)
- 19.13.15. Do supervisors activate permanently installed shower and eyewash units weekly to verify proper operation? Reference [19.9.1](#)
- 19.13.16. Are units installed in unoccupied or infrequently used areas tested prior to commencing any operations that could expose personnel to hazardous substances? Reference [19.9.1](#)
- 19.13.17. Do supervisors inspect permanently installed units monthly IAW instructions in paragraph [19.12](#)? Reference [19.9.2](#)
- 19.13.18. Are eyewash bottles maintained IAW the manufacturer's instructions? Reference [19.9.4](#)
- 19.13.19. Are workers whose duties expose them to conditions that may warrant the use of emergency equipment properly trained? Reference [19.10](#)
- 19.13.20. When maintenance renders emergency shower or eyewash units inoperable, are adequate measures taken to safeguard employees? Reference [19.11](#)
- 19.13.21. Are emergency shower and eyewash actuating devices easy to locate and readily accessible to the user? Reference [19.12.2.1.3](#)
- 19.13.22. Is a means provided for eyewash units to ensure a controlled flow of potable water or its equivalent to both eyes simultaneously, at a pressure low enough not to be injurious to the user? Reference [19.12.2.1.1](#)
- 19.13.23. Is the stored fluid in self-contained units protected against contaminants and temperature extremes, and are instructions permanently affixed to the unit? Reference [19.12.5](#)
- 19.13.24. Have procedures been developed to prevent eyewash bottles from being exposed to extreme temperatures, and are the instructions and expiration dates permanently affixed to the unit? Reference [19.12.6](#)

## Chapter 20

### SAFETY COLOR CODING, LABELING AND MARKING FOR PIPING SYSTEMS

**20.1. General Information.** This chapter establishes minimum requirements for positive identification of hazardous material in piping systems except sections buried in the ground, concrete or part of vehicles or field mobility equipment/systems, etc. This standard requires a color code and lettered legend identification system, positioned in a distinctive manner as a visual aid, for marking piping systems. Color marking shall not be substituted for elimination of hazards by safety engineering, but shall be used to supplement other established mishap prevention practices.

**20.2. Hazards and Human Factors.** Deaths and injuries to personnel and damage to property may occur from mistakes made in turning valves on or disconnecting pipes at the wrong time or place. To lessen the risk from error, confusion or inaction, especially in an emergency, a uniform system for identification of piping contents shall be used to warn personnel when piping contents are inherently hazardous. Personnel working with piping systems shall be trained to associate various levels of hazards with common colors and lettered legends in piping systems to alert them to potential hazards.

#### 20.3. General Requirements.

20.3.1. Federal Regulatory Requirements. Essential regulatory requirements are contained in 29 CFR 1910, Subpart J, *General Environment Controls*, ASME A13.1, *Scheme For The Identification Of Piping Systems*, ANSI Z535.1, *Safety Colors*, MIL-STD-161G, *Identification Methods For Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels*, and MIL-STD-101B, *DoD Color Code for Pipelines and Compressed Gas Cylinder*. Follow MIL-STD-101B for agents not identified in ASME A13.1. Hazard identification using color coding and marking are included in this standard.

20.3.2. Marking. Marking of physical hazards by standard warning colors is not a substitute for elimination of the hazards.

20.3.3. Location. Each location shall be carefully evaluated to minimize the number of markings needed, thereby emphasizing markings which are used and eliminating confusion when colors are indiscriminately applied. For locations where all piping contains the same materials (for example — a liquid fuels pump house), minimal marking is required.

20.3.4. Labeling and Color Coding. Piping systems shall be labeled and color coded if they contain any of the following materials:

**Table 20.1. Piping Materials.**

<b>Piping Materials</b>
Flammable or easily ignitable materials.
Toxic or poisonous gasses or materials.
Corrosive materials.
Fire protection materials ( <b>NOTES:</b> 1 & 2)
Compressed air at or above 30 pounds per square inch, gauge (psig). ( <b>NOTES:</b> 1 & 3)
Potable water above 75 psig.

<b>Piping Materials</b>
Radioactive substances.
Oxidizing materials.
Steam.

**Note 1:** Piping systems containing “fire protection materials” only require labeling and not color coding. Paint all exposed interior piping. The color shall be the same as the walls and/or ceiling, or a complementing color. The use of red paint is not necessary. Exposed piping in fire protection equipment rooms and mechanical rooms and all unexposed piping in the facility may be left unpainted. Exposed plastic interior piping shall only be painted if permitted by its listing and the manufacturer’s instructions. Exposed and unexposed stainless steel piping shall be cleaned and remain unpainted.

**Note 2:** Mark all exposed interior fire protection piping at 26-foot (8-meter) intervals with plastic wraparound-type pipe labels conforming to ASME A13.1-1996, indicating the fluid carried and direction of flow. Paper, pressure sensitive or painted on labels are not permitted in new construction. Labels are not required on sprinkler system branch lines and other piping less than 2 inches (51 millimeters) in nominal size. The following legends shall be used on the labels:

— FIRE PROTECTION WATER – Used on dedicated potable and non-potable fire protection water supply lines.

— FOAM CONCENTRATE – Used on high-expansion or low-expansion foam concentrate lines.

— FIRE SPRINKLER or SPRINKLER FIRE – Used on standard water-only sprinkler systems.

— HIGH EXPANSION FOAM – Used on lines supplying low-level, high-expansion foam generators.

**Note 3:** Compressed air lines operating at low pressures, less than 30 psi, are not required to be marked or color coded. Compressed air lines operating at 30 psi or more require labeling only. Although this standard does not require color coding for compressed air lines, other directives such as laboratory or medical guidance, equipment TOs and MAJCOM/Installation guidance, may require air lines be labeled and/or colored.

#### 20.3.5. Method of Identification for Piping Systems.

20.3.5.1. Lettered Legend. Positive identification of piping system contents, hazardous materials and classification for fire protection shall be by lettered legend giving the name of the contents in full or abbreviated form in black or white, whichever provides suitable contrast to warning colors. These titles shall be prominently displayed adjacent to color warnings to prevent errors by personnel. Where the view is unobstructed, legends shall be lettered on the two lower quarters of the pipe or covering. Lettering in this position is unlikely to be obscured by dust collection or mechanical damage.

20.3.5.2. Location. Letter legends shall be visible from operating positions. Identifications by title and color shall be located immediately adjacent to all operating accessories such as valves, regulators, flow checks, strainers, cleanouts and vents. In addition, primary color warnings shall be painted throughout the system at convenient intervals. An arrow shape indicating direction of flow shall appear on piping systems in any color coded installation. A double-headed arrow shall be placed on lines subject to reverse flow. Lettering sizes shall conform to **Table 20.2** For pipes smaller than 3/4-inch in diameter, metal tags shall be used with lettering etched or filled in with enamel and



attached at the same locations color bands would be placed. Titles shall use upper case letters and Arabic numerals, whenever practical. **Note:** Labeling containers and fixed systems containing materials not meeting the definition of hazardous or dangerous materials is not required. However, such containers may be labeled when the occupational environment dictates (hospitals, laboratories, etc.). Refer to **Chapter 36, Hydrocarbon Fuels**, for additional information.

20.3.5.3. Color Band. Color bands shall completely encircle the pipe or the entire piping system may be painted the designated color.

20.3.5.3.1. Color band width may range from 8 to 32 inches according to the pipe diameter as specified in **Table 20.2**

20.3.5.3.2. Color bands may be painted on the pipe or the pipe may be wrapped with self-adhesive colored tape.

20.3.5.3.3. The direction of material flow within the pipe shall be indicated by an arrow at each color band or identification tag (except for electrical conduit). The arrow shall be the same color as used for the lettering (see **Figure 20.1**).

20.3.5.4. Color Band Location.

20.3.5.4.1. At some locations, it may be desirable to code pipes only at junctions or distribution points, while on other systems more frequent markings shall be required. In any case, the number and location of identification markings shall be based on the particular needs of each system to ensure the piping system is positively identified.

20.3.5.4.2. Color bands used for pipe identification shall be located at frequent intervals on straight pipe runs, close to valves and changes in directions, and where pipes pass through walls and floors. Color coding bands shall be used sparingly for fire protection piping in areas designed to be suitably pleasing. If desired, the entire piping system may be color coded.

20.3.5.5. Use of Colors. Primary and secondary warning colors applied to the piping system, either by paint or colored bands, shall conform to paragraphs **20.3.5.2** and **20.3.5.6**. These colors shall be used to identify the main classification of piping contents because the colors are readily distinguishable, one from another, under normal conditions.

20.3.5.5.1. The use of colors specified in paragraph **20.3.4** and **Table 20.4** on a piping system provides a warning of the hazards involved. Piping systems, which do not require warning colors, may be painted to match surroundings (if not in conflict with other color designations of this standard) or such systems may be painted aluminum, black or remain unpainted.

20.3.5.5.2. A primary warning color shall appear on all dangerous piping systems and fire protection materials. Primary warning colors shall consist of a single color applied as a band or bands which completely encircle pipes in the system. Color bands shall be applied IAW dimensional information in **Table 20.2** In lieu of color bands, all pipe and covering for an entire system may be painted the primary warning color if that color is different from the background color. The use of color bands is preferred. In addition, primary warning colors shall be used throughout the system,

where the system passes underground or through walls and at any other conspicuous places where warnings are required by safety authorities. If desired, operating accessories may also be painted with the primary warning color.

20.3.5.5.3. Secondary Warning Color. Any piping system with a secondary hazard distinctively different from that indicated by its primary warning color shall have a secondary warning color applied. The color of the band shall be selected according to the definitions for warning colors specified in this standard. Location on piping systems shall be immediately adjacent to all operating accessories such as valves, regulators, flowchecks, strainers, cleanouts, pumps, dispensing points and vents.

20.3.5.6. Use of Arrows. Arrows shall be used to indicate the normal direction of flow in a piping system. A double-headed arrow shall be placed on lines subject to reverse flow. When used, arrows shall appear adjacent to each primary warning color segment. When the entire piping system is paint, the primary warning color, the arrow, if desired, shall be black or white, whichever contrasts.

20.3.5.7. Cryogenics. Labels and paint will flake off pipes carrying cryogens (typically liquid oxygen and nitrogen). Metal signs with identification markings shall be attached above or hung below cryogen piping by metal bands.

20.3.5.8. Bulk Petroleum Product System and Hydrocarbon Missile Fuels. MIL-STD-161 contains specific marking guidance for these systems.

**20.4. Worker Training.** Supervisors shall ensure personnel working with piping systems are trained in the hazards of the system contents and requirements of this chapter. Job safety training shall be documented IAW AFI 91-202.

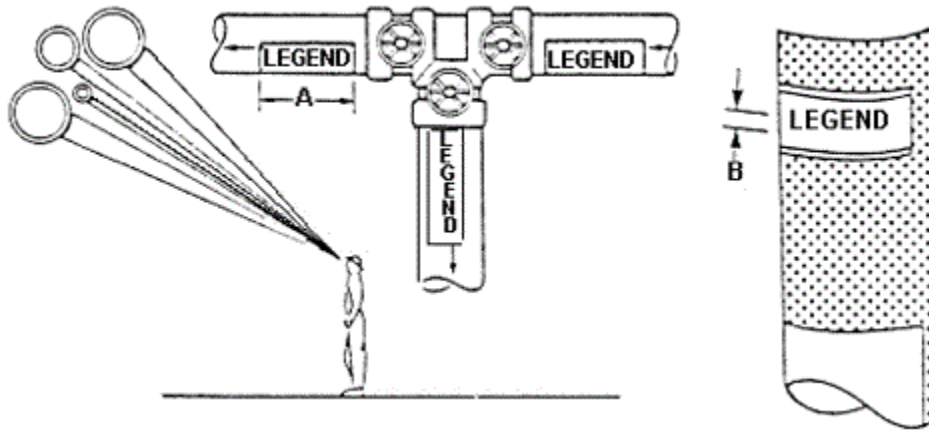
**20.5. Classification of Material in Piping Systems.** The classification of materials in a piping system shall be as specified in paragraph 20.3.5.1. Examples of legends are included in [Table 20.3](#) and color applications in [Table 20.4](#)

**Table 20.2. Legend and Color Band Dimensions.**

Legend and Color Band Dimensions		
Outside Diameter of Pipe Or Covering (Inches)	Length of Color Field A* (Inches)	Size of Letter Legend and Numerals (Inches) B*
Less than 3/4		See Paragraph 20.3.5.2.
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2
Over 13	32	3-1/2

**Note: See Figure 20.3.**

**Figure 20.1. Exact Identification Always by Name of Material Contained.**



**Table 20.3. Examples of Legend.**

Examples of Legend	
“HOT WATER”	“HYDRAULIC OIL”
“SLURRY”	“FOAM”
“AIR 100 PSIG”	“CARBON TETRACHLORIDE”
“ARGON 500 PSIG”	“CAUSTIC”
“H.P. RETURN”	“STEAM 100 PSIG”
“PROPANE”	“SULFURIC ACID”

**Table 20.4. Classification of Hazards of Materials and Designation of Colors<sup>1</sup>.**

Classification of Hazards of Materials and Designation of Colors		
Classification	Color Field	Color of Letter For Legend
<b>Materials Inherently Hazardous</b>		
Flammable or Explosive	Yellow	Black
Chemically Active or Toxic	Yellow	Black
Extreme Temperatures or Pressures	Yellow	Black
Radioactive <sup>2</sup>	Yellow	Black
<b>Materials of Inherently Low Hazard</b>		
Liquid or liquid Admixture <sup>3</sup>	Green	White
Gas or Gaseous Admixture	Blue	White
<b>Fire Quenching Materials</b>		
Water, Foam, CO2, Halon, etc.	Red	White

**Note 1:** Colors shall be as recommended in ANSI 535.1 latest revision, Safety Color Code.

**Note 2:** Previously specified radioactive markers using yellow and purple are acceptable if already installed and/or until existing supplies are depleted, subject to pertinent Federal Regulations.

**Note 3:** Markers with black letters on a green color field are acceptable if already installed and/or until existing supplies are depleted.

**20.6. Safety Color Coding, Labeling and Marking For Piping Systems Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

20.6.1. Is each location evaluated and the number of markings kept at a minimum? Reference [20.3.3](#)

20.6.2. Are piping systems labeled and color coded IAW guidance in paragraph [20.3.4](#)? Reference [20.3.4](#).

20.6.3. Does the method of identification of piping systems conform to the requirements in paragraph [20.3.5](#)? Reference [20.3.5.1](#).

20.6.4. Do the colors used to distinguish the hazard potential of piping systems conform to those in this standard? Reference [20.3.5.5.1](#)

20.6.5. Are hazardous materials in piping systems clearly identified? Reference [20.3.5.2](#)

20.6.6. Is a secondary warning color applied to a piping system possessing a secondary hazard? Reference [20.3.5.5.3](#)

20.6.7. Do supervisors ensure all personnel working with piping systems are trained on their hazards and is training documented? Reference [20.4](#)

## Chapter 21

### HAZARDOUS ENERGY CONTROL (LOCKOUT AND TAGOUT)

#### 21.1. General Information.

##### 21.1.1. Hazards.

21.1.1.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on the Job Safety Analysis (JSA) and job safety lesson plan. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process. (Example: TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, and aircraft specific procedural TOs.

21.1.1.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

21.1.2. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of industrial work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph **2.3** for additional information.

##### 21.1.3. Additional Information Related to This Chapter.

21.1.3.1. Affected Worker. A worker whose duties require him/her to work in the vicinity of or operate a machine or equipment being serviced or maintained under guidelines of this standard.

21.1.3.2. Authorized Worker. A worker who locks or tags out machines or equipment to perform servicing or maintenance on that machine or equipment.

21.1.3.3. Service/Administrative Lock. Any lock used for a purpose other than lockout/tagout (LOTO) and is distinguishable from LOTO authorized locks. The lock may be used for safety functions other than LOTO, equipment or machinery out of service for an extended period with no maintenance, a configuration control function or other purposes.

21.1.3.4. Equipment not under active maintenance shall not be locked with a LOTO lock. Refer to paragraphs **21.4.9** and **21.4.9.1.1** for additional guidance on service/administrative locks and long-term lockout.

21.1.3.5. Manually-operated machines and equipment that require the operator to perform functions by hand may store energy or pose hazards to workers if broken or defective.

#### 21.2. Specific Information.

21.2.1. This chapter establishes requirements for procedures, training and periodic inspection for an energy control (Lockout/Tagout, LOTO) program to prevent unexpected start-up. It applies to all machines, equipment, Air Force workers and contractors who may be exposed to hazardous energy during servicing, maintenance or modification activity. The LOTO program requires:

- 21.2.1.1. Energy isolating devices and procedures to LOTO all machines and equipment.
- 21.2.1.2. Retrofit of machines and equipment, as needed, to accept a lockout device. A JSA shall be conducted to ensure all hazards are identified and steps put in place prior to performing maintenance until the machine or equipment can be replaced or modified.
- 21.2.1.3. Identification of hazardous energy sources, such as: electrical; pressure/vacuum (hydraulic, pneumatic); chemical; ionizing and non-ionizing radiation sources; thermal, kinetic or mechanical (rotational, gravity) energy; energy stored in capacitors, springs or gravity equipment; machinery or system components that are suspended, blocked or choked; hydraulic or compressed air accumulators, etc. **Note:** Manual (non-powered) equipment energy sources must also be identified.
- 21.2.1.4. Procedures be developed and documented for safe and proper use of locks and tags on energy isolating devices. Refer to paragraph **21.5**, and **Figures 21.7** and **21.8** for further guidance. **Note:** Push buttons, selector switches, interlock circuits and other control-type devices are not energy-isolating devices.
- 21.2.1.5. LOTO procedures be strictly followed when working on equipment that may generate, hold or release any form of hazardous energy while the equipment is shut down.
- 21.2.1.6. A training plan for initial and recurring LOTO training. Refer to paragraph **21.5**
- 21.2.1.7. All LOTO devices provide a positive means to isolate and prevent uncontrolled release of hazardous energy. LOTO is required whenever service, maintenance or modification will be performed on equipment or machinery where unexpected energizing, start-up or release of stored energy could injure personnel or damage equipment.
- 21.2.1.8. Lockout of all energy sources prior to inspection, maintenance or servicing actions (including but not limited to: installation, set up, adjustments, lubrication, cleaning or tool changes) requiring removal of guards. Energy sources shall remain locked out until all actions are complete.
- 21.2.1.9. Use of occupational safety and health signs and tags IAW **Chapter 29, Mishap Prevention Signs and Tags**. Refer to paragraph **21.3.3** for additional guidance.
- 21.2.1.10. LOTO program self-assessment and annual inspections be conducted and documented to ensure requirements of this standard are followed. Refer to paragraphs **21.6.1** and **21.6.2** for additional guidance.

### **21.3. Specifications for Lockout/Tagout (LOTO).**

21.3.1. LOTO devices and tags are not required when:

21.3.1.1. Working on cord and plug connected electrical equipment if:

21.3.1.1.1. There is a single energy source which can be easily identified and isolated.

21.3.1.1.2. All hazardous energy is controlled by unplugging the equipment and there is no potential for stored, residual or accumulated hazardous energy.

21.3.1.1.3. The plug remains under continuous positive control of the worker performing servicing, maintenance or modification. **Note:** A plug LOTO device is recommended.

21.3.1.2. Operations on energized equipment (e.g. measuring, troubleshooting, calibration), when continuity of service is essential to safety or shutdown cannot be reasonably accomplished. **Note:** Supervisor approval is required for such operations and documented safety procedures that provide an equivalent level of safety shall be established and followed.

21.3.1.3. Minor tool changes, adjustments and servicing during normal operations provided:

21.3.1.3.1. Such activities are routine, repetitive and integral to use of the equipment,

21.3.1.3.2. Work is done using alternative measures that provide effective worker protection.

21.3.1.4. Hot Tap Operations. Work on transmission and distribution systems, such as gas, steam, water or petroleum products, can be performed on pressurized pipeline systems if:

21.3.1.4.1. The supervisor or authorized worker demonstrate continuity of service is essential.

21.3.1.4.2. System shutdown is impractical and documented procedures are in place and used.

21.3.1.4.3. Appropriate PPE is used that will provide effective protection for workers.

21.3.2. Authorized Lockout Devices. These locks are used only to ensure safety of authorized workers when servicing, maintenance or modification of equipment and machines and shall:

21.3.2.1. Be readily identifiable as a lockout device, i.e., numbered (CESM-1, CEOI-3, etc.), specific color lock or band, like red, and/or labels affixed to the lock.

21.3.2.2. Not be used for any other purpose.

21.3.2.3. Be singularly keyed with only authorized workers retaining the key(s) to the lock(s) when in use; a log shall be maintained by the shop supervisor to identify equipment being locked out under the LOTO program.

21.3.2.4. Be applied to energy isolation device(s) prior to any servicing, maintenance or modification actions.

21.3.2.5. Be substantial to prevent removal except by excessive force using special tools, such as bolt cutters or other metal cutting tools.

21.3.2.6. Be inventoried and maintained to ensure accountability. There's no requirement to inventory devices, zip ties, chains or tags. However, LOTO devices should be adequate to support the expected LOTO requirements identified in the shop specific procedures.

21.3.3. Authorized Tagout Devices. **AF Form 983**, *Danger – Equipment Lockout Tag* (**Figure 21.2**) shall be used in conjunction with energy-isolating devices. **AF Forms 979**, *Danger Tag*, or **982**, *Do Not Start Tag*, (**Figures 21.3** and **21.6**) shall be used in conjunction with service/administrative locks. These tagout devices immediately alert workers to existing and/or potential hazards from servicing, maintenance or modifications to equipment or machinery. All mishap prevention tags shall be standardized Air Force forms as listed in **Chapter 29**, *Mishap Prevention Signs and Tags*, and available through normal form distribution channels. The functional manager or supervisor shall ensure an adequate supply of locks and tags is available.

21.3.3.1. **AF Form 983**, *Danger – Equipment Lockout Tag*. The **AF Form 983** or equivalent DoD tag are the only tags authorized for lockout purposes and shall be used only for lockout situations. This tag shall be placed on equipment that has been removed from service for maintenance purposes. All employees shall be instructed that these tags indicate that equipment is locked out for maintenance. **Note:** Commercial tags are no longer authorized.

21.3.3.2. **AF Form 979**, *Danger Tag*. All employees shall be instructed that *Danger* tags indicate immediate danger and that special precautions are necessary. A *Danger* tag shall be placed on damaged equipment and the equipment removed from service until the energy-isolating device is locked out and an **AF Form 983** is attached. *Danger* tag wording shall read, “DO NOT USE THIS EQUIPMENT” or “DEFECTIVE EQUIPMENT, DO NOT USE.”

21.3.3.3. **AF Form 980**, *Caution Tag* (**Figure 21.4**). The **AF Form 980** shall be to warn against potential hazards, caution against unsafe practices and to prescribe precautions to protect personnel and property. *Caution Tags* shall only be removed by the supervisor only after the condition has been corrected or equipment locked out.

21.3.3.4. **AF Form 981**, *Out of Order Tag* (**Figure 21.5**). The **AF Form 981** shall only be used to indicate a piece of equipment, machinery, utility or system is out of order and its use might be hazardous or if powered on, the equipment could result in injury or damage. Applicable equipment records, when available, shall be annotated in addition to completing the *Out of Order* tag. The *Out of Order* tag will only be removed when the equipment is locked out.

21.3.3.5. **AF Form 982**, *Do Not Start Tag*. When **AF Form 979**, *Danger Tag*, is attached to equipment, it is not necessary to retag the equipment with **AF Form 982**, *Do Not Start Tag*. The *Do Not Start* tag shall be used to alert personnel of hazards associated with restarting the equipment and shall only be used until the energy isolating device is locked out and an AF Form 983 attached. *Do Not Start* tags shall be placed in a conspicuous location or manner where they block the starting mechanism being energized. *Do Not Start* tags shall only be removed by the supervisor and only after the condition has been corrected or equipment locked out.

21.3.3.6. Tagout devices shall:

21.3.3.6.1. Withstand the environment for the duration of expected exposure.



21.3.3.6.2. Be constructed and printed so they do not deteriorate or become illegible, especially in wet or corrosive environments. Laminated devices (tags) are acceptable.

21.3.3.6.3. Warn against hazardous conditions if equipment or machinery is energized.

21.3.3.6.4. Clearly identify the worker who applies them.

21.3.3.6.5. Be secured with a self-locking, non-reusable and non-releasable attachment, such as a nylon or plastic cable tie, with a minimum unlocking strength of 50 pounds.

#### 21.3.4. Responsible Parties.

21.3.4.1. All workers are responsible for recognizing when LOTO is being used, the general reasons for LOTO and the importance of not tampering with or removing LOTO devices.

21.3.4.2. Authorized workers are responsible for:

21.3.4.2.1. Recognizing work conditions that require LOTO, assessing all hazardous energy sources, using correct LOTO procedures and materials, and maintaining control of their key(s).

21.3.4.2.2. Applying their own locks and tags when performing servicing, maintenance or modifications, and shall never apply LOTO for anyone else.

21.3.4.3. Workers shall immediately advise the work area supervisor of inoperable equipment or machinery. Supervisors shall determine if LOTO devices are needed and, if so, that appropriate devices are attached. They shall coordinate placement of tags and assignment of Risk Assessment Codes (RACs), if necessary, IAW paragraph **29.6**, *General Requirements for Use of Tags*.

21.3.4.3.1. Service/Administrative locks and tags appropriate for the hazard level shall be used to lock equipment that will not be repaired or serviced immediately. Equipment and machinery shall be shutdown and locked out IAW paragraph **21.4**.

21.3.4.3.2. Equipment not under active maintenance shall not be locked with a LOTO lock. Refer to paragraph **21.4.9** for additional guidance on service/administrative locks and long-term lockout.

21.3.4.3.3. The work area supervisor of the equipment or machinery shall initiate application of service/administrative locks. These devices shall remain in place until CE or contract repair personnel repair the equipment or machinery.

21.3.4.3.4. Responsibility for equipment lockout transfers from the supervisor to the repairing authority, i.e., CE or contract repair, when maintenance is performed, suspended (for parts) or until complete. See paragraph **21.4.10** for procedures on transfer of locks and tags.

21.3.4.3.5. The work area supervisor shall have the overall responsibility for service/administrative locks.

21.3.5. Supervisors shall:

- 21.3.5.1. Generate and maintain equipment-specific written LOTO procedures, i.e., a LOTO continuity book.
- 21.3.5.2. Perform a self-assessment of work environments using these procedures at least semi-annually. Refer to paragraph [21.6.1](#) for additional guidance on LOTO self-assessments.
- 21.3.5.3. Determine appropriate training and assure workers are provided needed training.
- 21.3.5.4. Prohibit workers from working on equipment requiring LOTO until trained and authorized to perform LOTO.
- 21.3.5.5. Assign and document worker LOTO authorization.
  - 21.3.5.5.1. Designate specific equipment or categories of equipment and develop control procedures.
  - 21.3.5.5.2. Verify worker is qualified to perform necessary energy-control procedures.
- 21.3.5.6. Ensure consistent application and enforcement of LOTO policies.
- 21.3.5.7. Keep accurate LOTO logs. See [Figure 21.12](#) for sample log.
  - 21.3.5.7.1. Ensure authorized workers make log entries when applying/removing LOTO devices.
  - 21.3.5.7.2. Ensure LOTO logs are readily available for equipment or machinery being serviced, i.e., on equipment or machinery or in a centralized location for those areas where multiple maintenance tasks are being performed.
- 21.3.5.8. Ensure necessary LOTO hardware is available.
  - 21.3.5.8.1. Maintain a log of all LOTO locks and assign LOTO locks to authorized personnel.
  - 21.3.5.8.2. Control LOTO tags before and after use. Tags shall be maintained for one year after removal, to verify the status of locks and tags used during a review period, once servicing, maintenance or modifications are complete.
- 21.3.5.9. Control emergency keys for LOTO locks.
- 21.3.5.10. Remove LOTO devices only in an emergency. Refer to paragraph [21.4.5](#) for additional guidance.
- 21.3.5.11. Maintain LOTO tags after removal from machinery or equipment.
- 21.3.5.12. Be trained as an authorized worker.
- 21.3.6. Contractors. Contract personnel engaged in activities that require LOTO shall:
  - 21.3.6.1. Comply with OSHA regulations for lockout/tagout procedures including a written plan and employee training certificates.
  - 21.3.6.2. Inform unit site-supervisors of the contractor's LOTO procedures.

21.3.6.3. Be familiar with Air Force LOTO procedures.

21.3.6.4. Ensure all individuals involved in the activity understand and comply with restrictions and prohibitions of hazardous energy control procedures applicable to activities being performed.

21.3.7. Verification. All LOTO operations shall use written procedures. Refer to paragraph **21.3.5.1**.

21.3.7.1. All sources of hazardous energy shall be shut off and secured. Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. Markings shall be sufficiently durable to withstand the environment involved. Refer to **Chapter 8, *Electrical Safety*** and NFPA 70, *National Electrical Code*, for further guidance on disconnecting means.

21.3.7.2. LOTO shall be performed at each identified hazardous energy control point by each worker authorized to work on the equipment. Each authorized worker shall:

21.3.7.2.1. Apply their issued or assigned LOTO device when servicing, maintaining or modifying machinery or equipment, regardless of duration of activity or proximity to the energy-isolating device (e.g., circuit breaker, switch or valve).

21.3.7.2.2. Personally witness or verify the absence of hazardous energy or assure that the verification has been performed.

21.3.8. Equipment-Specific Energy Control. An equipment-specific written procedure shall be developed and used unless the equipment or machine undergoing servicing, modification or maintenance meets the requirements of paragraph **21.3.1**. Supervisors need not document LOTO procedures for machines or equipment if ALL of the following elements are met:

21.3.8.1. No potential for stored or residual energy or re-accumulation of energy after shutdown.

21.3.8.2. Has a single energy source easily identified and isolated.

21.3.8.3. Isolation and lock out of single energy source completely de-energizes and deactivates the equipment or machinery.

21.3.8.4. Isolation from energy source maintained for duration of maintenance or servicing.

21.3.8.5. A single lockout device and tag achieve lock out of the equipment or machinery.

21.3.8.6. The lockout device is under the exclusive control of the authorized worker performing maintenance or servicing.

21.3.8.7. Maintenance or servicing does not create hazards for other workers.

21.3.8.8. No accidents involving the unexpected activation or reenergization of the machine or equipment during servicing or maintenance have occurred when utilizing this exception.

21.3.9. Equipment-Specific Written Procedures. The supervisor shall:

21.3.9.1. Develop equipment-specific written energy control procedures with input from authorized workers most familiar with the equipment or machine. If procedures exist in equipment TOs, the supervisor shall review those procedures to ensure they are specific and address all types of hazardous energy contained in the equipment or machinery. See [Figure 21.7](#).

21.3.9.2. Ensure equipment or machines requiring written procedures are identified and procedures posted on equipment or readily available to workers authorized to LOTO the equipment. Also see paragraph [21.3.9.5](#).

21.3.9.2.1. Written procedures shall be specific to each piece of equipment (by model or serial number) or machine, shall address all types of hazardous energy contained, and shall be written to the level of detail necessary to safeguard personnel.

21.3.9.2.2. Complex equipment may require a separate procedure for each type of hazardous energy to be controlled.

21.3.9.2.3. If the procedure is not posted on the equipment, the equipment shall be clearly labeled to indicate the availability and location of the procedure. The supervisor or worker responsible for the equipment may determine the appropriate format and content of the label.

21.3.9.2.4. Consult maintenance and service manuals to ensure accuracy and sufficient level of LOTO detail. Review TOs, manuals, drawings, tags, labels and signs to identify and locate all disconnecting means to ensure power is interrupted by a physical break and not only de-energized by a circuit interlock. Make a list of disconnecting means to be locked/tagged.

21.3.9.2.4.1. Review disconnecting means to determine their interrupting ability. Determine if it is possible to verify a visible open point or if other precautions are necessary.

21.3.9.2.4.2. Review other work activity in the area, identify where and how other personnel might be exposed to electrical and other types of energy hazards, and establish energy control methods.

21.3.9.3. Ensure LOTO procedures are used by authorized workers on the equipment or machine.

21.3.9.4. Review and update procedures as necessary when there is a change in the equipment or associated hazards.

21.3.9.5. LOTO Procedure Required Content. Equipment-specific written procedures shall incorporate all applicable elements of general LOTO procedures and any specific information. Each LOTO step shall be clearly explained in the context of the specific equipment or machine. Written procedures shall include the specific equipment or machine to which the procedure applies and must identify:

21.3.9.5.1. All jobs to be accomplished and equipment involved.

21.3.9.5.2. The procedure that requires control of hazardous energies.

21.3.9.5.3. Components or locations generating hazardous energies to be controlled.

21.3.9.5.4. Energy sources/types that shall be controlled.

21.3.9.5.5. Process for notifying affected workers before controls are applied and after removal.

21.3.9.5.6. Procedural steps to shut down and secure equipment or machinery. (Includes specific locations to shut down, isolate, block, and safe releasing and securing of all potentially stored or residual hazardous energies.)

21.3.9.5.7. Type of LOTO hardware required and procedural steps for applying LOTO.

21.3.9.5.8. Procedural steps to test and verify lockout effectiveness for hazardous energy control.

21.3.9.5.9. Procedural steps to restart equipment or machinery.

21.3.9.5.10. Workers authorized to perform LOTO.

**21.4. LOTO Procedures.** Only authorized workers shall perform LOTO procedures. Personnel directly affected by the operation or shutdown of the equipment or machine shall be notified of LOTO devices. Notification shall be given before controls are applied and after they are removed. Refer to paragraph 21.7 for sample procedures. Procedures for applying locks or tags shall include and be performed in the following order. **Note:** Whenever high energy electrical sources are to be locked out, workers shall be assigned in teams (minimum of two [2] people).

21.4.1. Prior to Start. Prior to starting any procedure, authorized worker(s) shall physically locate and identify all isolating devices to ensure that switches, valves or other energy isolating devices are locked and tagged out and manual or freely moving components are blocked or chocked to prevent movement. Authorized worker(s) shall resolve questions on identification of electrical or other energy sources with their supervisor before proceeding. If following equipment-specific written procedures would compromise safety, the authorized worker, with supervisor approval, may modify the sequence of steps, but all steps shall be performed.

21.4.2. The Eight Step LOTO Process. The Authorized Worker shall:

21.4.2.1. Step One – Preparation. Determine if equipment-specific written energy control procedures are applicable to the task. If so, the worker shall review control procedures and ensure they are followed correctly.

21.4.2.1.1. Prior to shutting down equipment or machines, the supervisor, authorized worker or operator must have knowledge of and assess the type (e.g. electrical, mechanical, hydraulic), magnitude (e.g. 120 volts, 60 psi, etc.) and hazards of the energy to be controlled, including hidden energy sources such as springs, capacitors, elevated parts, etc. **Note:** Equipment or machinery may contain more than one type of energy.

21.4.2.1.2. Determine, IAW written procedures, appropriate methods for controlling the hazardous energy. Methods for energy-isolation may include, but are not limited to, circuit breakers, disconnect switches or valves. See examples in **Figure 21.1**.

21.4.2.2. Step Two – Notification. Notify all affected workers of the impending shutdown and that they shall not disturb lockout devices or attempt to re-start the equipment until informed it is safe to resume normal operations.

21.4.2.3. Step Three – Shutdown. Verify it is safe to shut down the equipment or machine.

21.4.2.3.1. The equipment or machine shall be turned off or shut down using normal stopping and shutdown procedures (depress stop button, open toggle switch, close shut off valve, etc.).

21.4.2.3.2. When equipment or machines use a simple wall plug as the single energy source and all hazardous energy, including stored, residual or accumulated hazardous energy is controlled by unplugging of the equipment, it shall be unplugged and the plug controlled by the supervisor or authorized worker IAW paragraph [21.3.1.1.3](#).

21.4.2.4. Step Four – Isolation and Verification.

21.4.2.4.1. Isolate all energy sources by operating (switch off, valve off, etc.) energy-isolating device(s).

21.4.2.4.2. Verify the correct energy-isolating device has been operated and that steps taken to ensure energy isolation (LOTO applied to disconnect, valve, etc.) correctly correspond to the equipment that requires LOTO.

21.4.2.4.3. Ensure all energy isolating devices needed to control the energy to or contained within the equipment or machine are used.

21.4.2.5. Step Five – LOTO Device Application.

21.4.2.5.1. Affix LOTO devices (typically locks) to hold energy-isolating devices in an “off” or “safe” position that physically prohibits normal operation of the energy-isolating device. Both tags and locks shall be installed. Tags are warning devices attached to energy isolating devices and cannot provide the physical restraint or security of a lock.

21.4.2.5.1.1. Tags shall indicate date, time, reason and name of the worker installing the device.

21.4.2.5.1.2. To prevent inadvertent or accidental detachment, tags shall be securely attached with a self-locking and non-releasable attachment (i.e., a nylon or plastic cable tie-off strap) with a minimum unlocking strength of 50 pounds.

21.4.2.5.1.3. Tags may cause a false sense of security. Workers shall understand the use and limitations of tags as part of the overall energy control program. Refer to paragraph [21.4.3](#) for more detailed information on tagout procedures.

21.4.2.5.1.4. Initial LOTO devices shall be attached to each energy-isolating device by the first authorized worker. Additional authorized workers who perform service, maintenance or modification on the equipment or machine shall apply their own locks during their maintenance activities. Refer to paragraph [21.4.4](#) for additional information on multiple lockouts.

21.4.2.6. Step Six – Additional Measures. Once the system is locked and tagged out, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained or otherwise rendered safe.

21.4.2.6.1. Insert physical restraints (blocks, chocks) for moving or raised parts, blind flanges for pressurized piping, disconnect springs (if safe to do so), etc., to ensure moving parts are physically restrained or disconnected.

21.4.2.6.2. The authorized worker shall completely release or otherwise control any stored energy and block any unexpected motion. Equipment or machines shall be in a zero energy state.

21.4.2.6.2.1. For stored mechanical energy, vent valves, spring releases, blocking devices or equipment repositioning, as appropriate, shall be used.

21.4.2.6.2.2. For stored electrical energy, approved grounding wands or discharge devices shall be used. If re-accumulation of stored energy to a hazardous level is possible, verification of isolation, such as leaving the ground wand in place, shall be continued until servicing, maintenance or modification is complete.

21.4.2.6.3. The authorized worker shall demonstrate the equipment or machine is de-energized or isolated before starting work on LOTO equipment or machinery.

21.4.2.7. Step Seven – Isolation Confirmation.

21.4.2.7.1. Physically attempt to operate energy-isolating devices and attempt to restart the equipment or machine using normal controls. **Caution:** Return operating controls to “safe” or “off” position after the test.

21.4.2.7.2. Test potential energy sources using appropriately rated and calibrated instruments or testers. Instruments used to test voltage, pressure or temperature shall be checked for proper operation both before and after use. If the authorized worker is not qualified to test the energy being isolated, he or she shall ensure the energy is tested by a qualified person.

21.4.2.8. Step Eight – Keep LOTO Devices in Place. A lock and tag shall remain in place until work on the equipment or machine is complete.

21.4.2.8.1. In rare circumstances, it may be necessary to temporarily remove LOTO devices before work is complete, such as for adjustment or repositioning equipment.

21.4.2.8.2. Use the following sequence of actions when LOTO devices must be temporarily removed from the energy-isolating device:

21.4.2.8.2.1. Notify all affected workers and supervisors.

21.4.2.8.2.2. Clear equipment or machine of tools and materials.

21.4.2.8.2.3. Remove all workers from equipment or machine area and ensure required tools are safely and properly positioned.

21.4.2.8.2.4. Remove all repositioning and blocking devices and return all vents and valves to normal operating positions.

21.4.2.8.2.5. Remove all grounding/shorting conductors, hooks or wands.

21.4.2.8.2.6. Put on any required PPE.

21.4.2.8.2.7. Energize and proceed with testing or positioning.

21.4.2.8.2.8. De-energize all systems; reapply lockout/tagout measures; notify all affected workers and supervisors; and continue servicing, maintenance or modification of equipment or machine.

21.4.3. Tag-Out Only. A “tag-out only” procedure may be used in the rare case a device cannot be locked out. Use extra caution with Tag-Out Only procedures as tags are warning devices and do not provide the physical restraint and security of a lock. Tags may evoke a false sense of security by the worker. A Tag-Out Only procedure may be used if:

21.4.3.1. A justifiable and verifiable need is identified.

21.4.3.2. Approval is obtained from the supervisor.

21.4.3.3. Authorized workers follow LOTO procedures, with the following changes:

21.4.3.3.1. Omit placement of the lock.

21.4.3.3.2. In place of the lock, a secondary means of isolation shall be used. Removing an isolating circuit element, blocking a controlling switch, opening an extra disconnect device or removing a valve handle are examples of secondary measures. The secondary means of isolation shall be identified on the tag affixed IAW equipment-specific written LOTO procedures.

21.4.3.3.3. The tag is secured with a self-locking and non-releasable attachment (i.e., a nylon or plastic cable tie-off strap) with a minimum unlocking strength of 50 pounds. A tag used without a lock shall be supplemented with at least one additional safety measure that provides a level of safety equivalent to that obtained by use of a lock. These devices shall be attached so they interfere with the operation of energy isolating devices (worker has to undo or remove the tag to operate isolating device).

21.4.3.3.4. If tag placement would compromise safety by obscuring indicator lights or controls or where a tag cannot be attached directly to the energy-isolating device due to design, the tag shall be located as close as safely possible to the device, in a position immediately obvious to anyone trying to operate the device. **Note:** Energy-isolating devices for such equipment or machinery shall be modified or designed to accept a lockout device whenever new equipment or machinery is installed or major replacement, repair, renovation or modification is performed.

21.4.4. Multiple Lockout. If more than one worker needs to LOTO equipment or machinery:

21.4.4.1. Each authorized worker shall place his/her own lock on the lockout device and install their own tagout device.

21.4.4.2. A multiple lockout device (hasp) shall be used when an energy-isolating device cannot accept multiple locks.

21.4.4.3. Each worker shall remove his/her own LOTO devices when work is complete.



21.4.5. Three Step Release from Lockout/Tagout Process. (See [Figure 21.8](#)).

21.4.5.1. Step One – Preparation and Notification. Before removing lockout or tagout devices and reenergizing machines or equipment, the authorized worker shall:

21.4.5.1.1. Notify all affected workers the system is ready for return to service. Ensure all personnel are clear of the equipment point of operation and other hazard zones.

21.4.5.1.2. Inspect the work area and ensure all tools, debris and non-essential personnel are removed or are a safe distance from the equipment or machinery.

21.4.5.1.3. Replace safety guards, inspect equipment or machinery and ensure guards are operational.

21.4.5.2. Step Two – Removal of Additional Devices.

21.4.5.2.1. The authorized worker shall remove any additional devices applied IAW LOTO Application Step Six. See paragraph [21.4.2.6](#).

21.4.5.2.2. Remove all safety grounding devices.

21.4.5.2.3. Verify the work for which LOTO was applied is complete and it is safe to reenergize the equipment or machinery.

21.4.5.3. Step Three – Removal of all Locks and Tags.

21.4.5.3.1. Each LOTO device shall be removed only by the authorized worker who applied it. When the authorized worker who applied a LOTO device is not available to remove it, his or her supervisor may remove the device using emergency removal procedures in paragraph [21.4.6](#). This is considered an emergency procedure, undertaken only in extreme circumstances, i.e., use of equipment or machinery is required immediately.

21.4.5.3.2. Authorized workers shall remove all LOTO devices and restore the energy isolating device to the 'ON' position.

21.4.5.3.3. Notify all workers the lockout condition has been cleared (locks and tags removed) and equipment or machinery is ready for service.

21.4.5.3.4. Energize the equipment or machinery and restore to normal operating condition.

21.4.5.3.5. Annotate LOTO log with clearance information.

21.4.6. Emergency Removal of LOTO Devices. In some instances, a lock and/or tag may have to be removed by someone other than the person who applied the lockout device. For example, contractors may complete their work and leave without removing their issued locks, or a worker may be absent due to illness or other reasons. Under such circumstances, the supervisor may need to remove the lock, but the supervisor assumes responsibility for the safety of the equipment and those who work with it. If the authorized worker who applied a LOTO device is not available to remove it, the supervisor may remove the device, if it is safe to do so, provided:

21.4.6.1. Specific training and procedures are developed, documented and incorporated into the shop energy control program which demonstrate safety equivalent to removal of the device by the authorized worker who applied it. Locks should never be removed in haste or confusion.

21.4.6.2. The supervisor verifies the authorized worker who applied the device is not at the facility. Before removing another's lock, the supervisor must perform all of the following steps, in the order listed:

21.4.6.2.1. The supervisor makes every reasonable effort to contact the authorized worker who applied the device. This shall include a thorough search of the premises, the individual's normal workplace (if different) and telephone calls to both home and office numbers.

21.4.6.2.1.1. These efforts are documented (e-mail, voicemail, etc.).

21.4.6.2.1.2. If the authorized worker is contacted, the supervisor informs the worker their LOTO device must be removed and the reason for the removal. The supervisor shall determine if the worker can return to work and, if not, shall advise the worker his/her LOTO device will be removed and returned by the supervisor.

21.4.6.2.2. Determine and understand the reason for the lockout.

21.4.6.2.3. Determine and understand the need for removal of the lock by someone other than the person placing it.

21.4.6.2.4. Thoroughly examine all parts of the locked out system and assess its readiness for use. This requires a visual inspection of all wiring, conduit, piping, etc., between the energy isolating device and the equipment, and a complete inspection and understanding of the equipment. If the supervisor is not completely familiar with the equipment, he/she must enlist the aid of those who are. Supervisors are cautioned that the person asking to have the lock removed may not be the best consultant on this issue.

21.4.6.2.5. If the supervisor is satisfied that the person who placed the lock cannot be contacted or cannot be present, that there is an immediate need to operate the equipment, that the equipment and all connected apparatus are safe for operation and the supervisor has verified it is safe to remove the LOTO device, he or she may use the emergency key to remove the LOTO device or cut it off if the key is not available. Procedures for release from lockout/tagout covered under paragraph **21.4.5** shall be followed when removing LOTO device(s).

21.4.6.2.6. It is essential the person who originally placed the lock be notified as soon as possible that the lock has been removed. The supervisor ensures the worker is given the removed lock and informed of the reasons for removal before the worker returns to duty.

21.4.7. Temporary LOTO Device Removal. If necessary to temporarily remove LOTO devices to start equipment or machinery for test or component repositioning, restoration procedures shall be performed IAW paragraph **21.4.2.8.1** thru **21.4.2.8.2.8**. The equipment or

machinery shall be locked and tagged out IAW paragraph [21.4.2.5](#) when test or repositioning procedures are complete.

21.4.8. Group LOTO. A group LOTO procedure may be appropriate when multiple authorized workers perform servicing, maintenance or modification on the same equipment or machinery and multiple lockout procedures in paragraph [21.4.4](#) are not feasible.

21.4.8.1. The supervisor shall:

21.4.8.1.1. Determine if a group LOTO procedure is appropriate.

21.4.8.1.2. Convene a meeting of all members of the group covered by the procedure.

21.4.8.1.3. Describe tasks to be performed.

21.4.8.1.4. Delegate primary LOTO responsibility to a designated authorized worker for the group.

21.4.8.1.5. Ensure each member of the group is trained and authorized to work LOTO IAW paragraph [21.3.5.3](#).

21.4.8.2. The designated authorized worker shall:

21.4.8.2.1. Follow each step of the LOTO procedures.

21.4.8.2.2. Place his/her key(s) inside a gang lock box. Gang lock boxes shall be constructed to permit attaching multiple locks to the outside of the enclosure to prevent opening until all locks are removed.

21.4.8.2.3. All other workers in the group shall assure each step of the LOTO procedures is complete, then lock and tag the gang lock box to prevent access until all locks are removed.

21.4.8.2.4. When work is complete, each worker shall remove his/her lock from the gang lock box, the designated authorized worker shall remove his/her lock off of the gang lock box, obtain the key(s) from the lock box and return the equipment to service IAW paragraph [21.4.5](#).

21.4.9. Long-Term Lockout. If equipment or machinery is locked out for several shifts, with no maintenance planned, appropriate service/administrative lock/tagout devices shall be attached. The shop supervisor shall be responsible for applying and controlling service/administrative locks. The tagout shall explain the purpose for the lockout.

21.4.9.1. Do not use a LOTO lock to lockout equipment unless the equipment is under active maintenance. A service/administrative lock shall be applied to each energy isolating device when the authorized worker has completed his/her shift but the work is not completed or when the worker must leave the building for any reason. When the issued or assigned LOTO lock is removed, a service/administrative lock shall be applied. A service/administrative lock is used to maintain the integrity of the lockout between workers and does not replace an issued or assigned LOTO lock. When work continues, the service lock shall be removed and replaced with an issued or assigned LOTO lock, and the authorized worker shall verify all energy sources are at zero energy.

21.4.9.1.1. Service/Administrative locks and tags shall:

21.4.9.1.1.1. Be clearly distinguishable from locks and tags used for lockout/tagout (i.e., if red banded locks are used for LOTO they shall not be used as service/administrative locks). **AF Form 983** shall not be used as a service/administrative tag.

21.4.9.1.1.2. Use a separate tag and/or integrate a label on the lock.

21.4.9.1.1.3. Contain supervisor contact information and name of person/organization applying the lock.

21.4.9.1.1.4. Identify the purpose of the lock.

21.4.9.1.1.5. Have tags appropriate for the hazard (i.e., *Danger, Caution, Do Not Start* or *Out of Order*).

21.4.9.1.1.6. Be used for safety purposes and not be limited to locking out equipment not in use.

21.4.9.1.2. Examples of suitable use of service/administrative locks and tags include:

21.4.9.1.2.1. Equipment is (or suspected of being) defective or faulty and cannot be used without producing further damage.

21.4.9.1.2.2. Equipment is placed out-of-service for extended period of time (i.e., shop move, waiting on repair parts).

21.4.9.1.2.3. Equipment is awaiting service personnel who will perform lockout/tagout.

21.4.9.1.2.4. Equipment is configured in a special manner or deemed to be essential in its operational state, and any changes in operating parameters or configuration will impair its proper operation or pose a hazardous situation for personnel.

21.4.9.1.2.5. An actual or potentially hazardous environment exists, and access shall be restricted.

21.4.9.1.2.6. Equipment may require special training or authorization to use.

21.4.9.1.2.7. Newly installed equipment or systems are not fully tested or approved for use.

21.4.9.1.3. Service/Administrative locks and tags are not transferred during shift changes; they shall stay in place until the equipment or machinery is repaired or moved. Once maintenance operations start, service/administrative locks and tags shall be replaced with LOTO devices IAW paragraph **21.4.2.5** after verification of the energy state.

21.4.9.2. The equipment or machinery logbook shall indicate, at a minimum:

21.4.9.2.1. Why equipment or machinery is locked out.

21.4.9.2.2. Person responsible for lockout, and their contact information (i.e. shop supervisor, CE, etc.).

21.4.10. Shift Changes. Specific, written procedures shall be developed and used during shift or personnel changes to ensure continuity of lockout and tagout protection. This includes provision for orderly transfer of LOTO devices between off-going and on-coming supervisors and authorized workers to minimize exposure to hazards from unexpected energization, start-up or release of stored energy from equipment or machinery.

21.4.10.1. The authorized worker going off-shift shall leave his/her lock/tag on the lockout until the oncoming authorized worker has placed his/her own lock/tag on the lockout.

21.4.10.2. The off-going authorized worker may then remove his/her lock/tag from the lockout.

21.4.10.2.1. The off-going authorized worker shall provide the on-coming authorized worker and supervisor information regarding the status of equipment or machinery affected.

21.4.10.2.2. All such transfers shall be documented in the appropriate lockout/tagout log.

21.4.10.3. Verification of the lockout (energy state) shall be performed by a supervisor or designated authorized worker for the on-coming shift prior to any maintenance or servicing on locked out equipment or machinery. Any authorized worker on the equipment or machinery may verify the lockout status during/after shift change. **Note:** All authorized workers are strongly encouraged to perform their own verification of lockout before performing duties on locked out equipment or machinery.

21.4.10.4. Equipment or machinery shall remain locked out during maintenance and servicing activities.

21.4.10.5. Basic Shift Change Examples:

21.4.10.5.1. Guiding Principles:

21.4.10.5.1.1. There shall be no loss of LOTO continuity during shift changes.

21.4.10.5.1.2. Procedures for LOTO during shift changes shall be documented and followed.

21.4.10.5.1.3. Each authorized worker shall have a specific key, and keys shall not be traded between authorized workers.

21.4.10.5.2. Example 1: Outgoing shift authorized workers need to remove their locks at the end of their shift.

21.4.10.5.2.1. The on-coming shift authorized workers:

21.4.10.5.2.1.1. Apply their locks before the out-going shift authorized workers remove theirs.

21.4.10.5.2.1.2. Perform any necessary LOTO steps.

21.4.10.5.2.1.3. Verify the energy state.

21.4.10.5.3. Example 2: Responsibility is transferred between designated authorized workers.

21.4.10.5.3.1. Ideally, both are present for a formal exchange in which on-coming authorized workers apply their locks, and then out-going authorized workers remove theirs.

21.4.10.5.3.2. Keys to LOTO devices in lockboxes may be transferred; however, keys to issued or assigned locks shall not be transferred.

21.4.10.5.3.3. Other LOTO steps are performed as necessary, including verification of energy state.

## 21.5. LOTO Training.

21.5.1. General Awareness Training. General awareness training shall ensure affected workers know and understand the purpose, contents and application of the LOTO program to the level required to perform their job.

21.5.1.1. Workers with duties in areas where LOTO procedures may be used shall be instructed in LOTO awareness during initial job safety briefings, including: the energy control program, how to recognize LOTO, why LOTO is required and the prohibition against restarting or reenergizing locked and tagged out equipment or machinery.

21.5.1.2. LOTO may only be performed by authorized workers with LOTO training and task/equipment specific training and supervisor authorization. Awareness training is not a substitute for LOTO training.

21.5.2. Authorized Workers. An authorized worker is a worker trained and authorized by his or her supervisor to perform LOTO procedures.

21.5.2.1. Training. Supervisors shall ensure authorized workers and qualified equipment maintenance personnel understand the purpose and function of the LOTO program, including knowledge and skills required to safely use LOTO procedures in paragraph [21.4](#).

21.5.2.1.1. Supervisors shall verify training of authorized workers includes:

21.5.2.1.1.1. Recognition of hazardous energy.

21.5.2.1.1.2. Type and magnitude of energy found in the workplace.

21.5.2.1.1.3. Means and methods of isolating and/or controlling energy.

21.5.2.1.1.4. Means to verify effective energy control, and the purpose of procedures to be used.

21.5.2.1.2. Verify affected workers have been instructed in purpose and use of energy control procedures.

21.5.2.1.3. Verify that all other personnel who may be affected by the energy control procedures are instructed about the procedure and against restarting or reenergizing such machines or equipment.

21.5.2.2. Each authorized worker or qualified equipment maintenance person shall receive initial job training on the type and magnitude of applicable hazardous energy

sources, the methods and means necessary for energy isolation and control and use of LOTO procedures.

21.5.3. Recurring Training. Recurring training shall be performed at least annually. The training shall establish employee proficiency, include an in-depth review of current and previous procedures and introduce new or revised control methods and procedures, as necessary.

21.5.4. Retraining. Authorized workers, supervisors and qualified equipment maintenance personnel shall be retrained when:

21.5.4.1. There is a change in job assignments.

21.5.4.2. New equipment, machinery, chemicals or processes are used.

21.5.4.3. New hazards are introduced in the work environment.

21.5.4.4. New energy-control procedures are implemented.

21.5.4.5. A self-assessment or periodic inspection reveals a deficiency in the authorized worker's, supervisor's or qualified equipment maintenance person's knowledge or ability to implement LOTO policy correctly.

21.5.5. Training Documentation. All training, i.e., familiarization, initial and recurring, shall be documented. Training documentation shall be certified, current, include each individual's name, type and dates of training and be documented on the AF IMT 55, *Employee Safety and Health Record*, or equivalent product IAW AFI 91-202. All training documentation shall be readily available during inspections and LOTO program evaluations.

21.5.5.1. The supervisor shall maintain AF IMT 55 or equivalent product and update training when necessary. For enlisted personnel, this form may be filed with the AF Form 623, *Individual Training Record Folder*; for civilian personnel, file the form with the AF Form 971, *Supervisor's Employee Brief*; for all others, file the AF IMT 55 or equivalent product where designated by the supervisor.

## 21.6. LOTO Program Evaluations.

21.6.1. Self-Assessments. Shop LOTO self-assessments shall be conducted by an authorized worker or supervisor on a semi-annual basis, to ensure compliance with all program elements. Self-assessments shall be designed to correct any deviations or inadequacies observed. Refer to **Figure 21.10** for a sample assessment sheet. The assessment shall be documented, provide for a demonstration of the procedures and include, as a minimum:

21.6.1.1. Identification of equipment and machinery for which the LOTO program applies.

21.6.1.2. Review of LOTO log books for equipment or machinery in LOTO program.

21.6.1.3. A review of each worker's responsibilities under the program.

21.6.1.4. That all necessary training has been conducted, is current and properly documented.

21.6.1.5. The date of the inspection and the unit representative conducting the self-inspection.

21.6.2. Annual Inspection. Functional managers and commanders shall ensure annual inspections of LOTO procedures within their organization are conducted by an individual above the shop level supervisor to verify and document effectiveness of the energy control procedures. A qualified ground safety inspector shall review LOTO inspection reports during organization safety inspections to ensure compliance. Refer to [Figure 21.11](#) for a sample inspection sheet. The inspection shall include, as a minimum:

21.6.2.1. Review of LOTO procedures with authorized workers.

21.6.2.2. Observation of LOTO procedures to ensure workers understand and follow procedures.

21.6.2.3. Review of training and self-assessment documentation to ensure LOTO requirements are met.

21.6.2.4. Out-brief of shop or unit supervisor or, as appropriate, documented in the written report.

**21.7. Sample Lockout/Tagout Procedures.** The following sample lockout/tagout procedures are provided to help supervisors and authorized workers comply with requirements in this chapter and 29 CFR 1910.147. It includes a basic LOTO checklist for developing LOTO procedures. Refer to [Figure 21.7](#) and [21.8](#).

21.7.1. Preparation for Lockout/Tagout. Workers required to use LOTO procedures shall be knowledgeable of the type and magnitude of the energy, the hazards to be controlled and the method or means to control the energy. Authorized workers shall notify all affected workers of the application of LOTO devices before they shut down equipment or machinery. Notification shall be given prior to controls being applied and after controls are removed from equipment or machinery.

21.7.1.1. There are four (4) common types of energy sources: electrical (most common form), hydraulic or pneumatic, fluids and gases, and mechanical. Some equipment or machinery uses more than one energy source, so equipment-specific procedures shall be followed to properly identify and lockout/tagout all energy sources.

21.7.2. Electrical.

21.7.2.1. Shutoff power at machine and disconnect.

21.7.2.2. Disconnecting means shall be locked and tagged.

21.7.2.3. Press start button to verify correct systems are locked out.

21.7.2.4. Return controls to their safest position.

21.7.2.5. Safety precautions:

21.7.2.5.1. Capacitors, if present, shall be drained of stored energy. **Warning:** Workers should be aware that capacitors may take several minutes to completely discharge.

21.7.2.5.2. Possible disconnecting methods include: power cords, power panels (look for primary and secondary voltage), breakers, the operator's station, motor circuit relays, limit switches or electrical interlocks.



21.7.2.5.3. Some equipment may have a motor isolating shutoff and a control isolating shutoff.

21.7.2.5.4. If electrical energy is removed by simply unplugging the power cord, the cord shall be kept under control of the authorized worker or the cord's plug end locked out or tagged out.

#### 21.7.3. Hydraulic/Pneumatic.

21.7.3.1. Shut off all energy sources (pumps and compressors). If pumps and compressors supply energy to more than one piece of equipment or machinery, lockout/tagout the valve supplying energy to the equipment or machinery.

21.7.3.2. Drain and bleed stored pressure from hydraulic/pneumatic lines. **Caution:** Draining and bleeding hydraulic/pneumatic lines and accumulators could cause equipment movement. Use manufacture actuator/cylinder locking devices, as required.

21.7.3.3. Ensure controls are returned to their safest position (off, stop, standby, etc.).

#### 21.7.4. Fluids and Gases.

21.7.4.1. Identify the type of fluid or gas.

21.7.4.2. Close valves to prevent flow, then lockout/tagout.

21.7.4.3. Determine the isolating device, close and lockout/tagout.

21.7.4.4. Drain and bleed lines to zero energy state. Also see paragraph [21.7.3.2](#) **Note:** Some systems may have electrically controlled valves. If so, they must be shut off, locked and tagged out.

21.7.4.5. Check for zero energy state at the equipment or machinery.

#### 21.7.5. Mechanical Energy (gravity activation or stored in springs, etc).

21.7.5.1. Block out or use safety chain.

21.7.5.2. Apply lockout and tagout safety device(s).

21.7.5.3. Shut off and lockout/tagout electrical system.

21.7.5.4. Check for zero energy state.

21.7.5.5. Return controls to safest position.

#### 21.7.6. Release from Lockout/Tagout.

21.7.6.1. Inspection. Ensure work is complete, tools inventoried and equipment used is serviced, maintained and any modification is complete.

21.7.6.2. Clean-up. Remove all towels, rags, work-aids, chemicals/lubricant spills, etc.

21.7.6.3. Replace guards. Replace all guards possible. Sometimes a guard may need to be left off until the start sequence is over to allow adjustment. However, all other guards should be in place.

21.7.6.4. Check controls. All controls shall be in their safest position.

21.7.6.5. The work area shall be checked to ensure all employees are safely positioned and notified that lockout/tagout devices are being removed.

21.7.6.6. Remove locks/tags. Remove only issued or assigned locks and tags.

21.7.7. Procedures involving more than one worker. When more than one authorized worker performs servicing, maintenance or modification, each authorized worker shall place his/her own lock and tag on the energy-isolating source. If the equipment cannot be locked out, then each authorized worker must place his or her tag on the equipment or machinery.

21.7.8. Removal of Authorized Worker's Lock. When a supervisor removes an authorized worker's lockout/tagout, he/she shall verify the authorized worker who applied the device is not in the facility, make a reasonable effort to advise the worker his/her device has been removed and ensure the worker is informed his/her device was removed before he/she resumes work. The supervisor shall return the worker's LOTO devices and keys. Refer to paragraph [21.4.6](#).

**21.8. Contractors.** Supervisors shall be aware of each contractor's responsibilities, how they apply to their workplace and requirements of this chapter. Refer to AFPAM 91-210, *Contract Safety*, for further information on contracts and responsibilities. Supervisors will contact the installation Contracting Office in the event contractors are not in compliance with Air Force and/or OSHA requirements. **Note:** This paragraph and accompanying subparagraphs cover contractor operations in buildings/facilities still Air Force-owned, Air Force-controlled and occupied by Air Force personnel. Confined space procedures performed by contractors will be specified in the contractor's contract (e.g., contractor follow OSHA standards or AF guidance).

21.8.1. When contractor personnel are engaged in activities covered by this instruction, the on-site supervisor and contractor shall inform each other of their respective lockout/tagout procedures. The on-site supervisor shall ensure his/her personnel understand and comply with the contractor's energy control procedures. Air Force and contractor personnel conducting joint lockout/tagout operations shall use requirements in this standard.

21.8.2. The unit supervisor and the authorized worker most familiar with the equipment or machinery being serviced by the contractor shall review the contractor's LOTO program, in detail, to ensure workers will not be injured by allowing use of the contractor's LOTO program and procedures at the facility. All affected workers shall be trained in LOTO and familiarize themselves with the contractor's LOTO procedures. Authorized lockout and tagout devices shall be used IAW paragraphs [21.3.2](#) – [21.3.3](#). The installation contracting office shall inform the unit (per line item entry in the written contract) to supply the contractor with an ample supply of Air Force tags, i.e., **AF Form 983, Danger – Equipment Lockout Tag**, and any other required tags.

21.8.3. To protect workers, contractor work areas shall be isolated and access by Air Force personnel restricted, unless working in conjunction with the contractor. If this is impractical or cannot be accomplished, the on-site supervisor shall assure the contractor's compliance with proper work procedures, energy isolation procedures and contractor employee compliance.

21.8.4. The responsibility for LOTO training of contractor employees lies with their employer.

21.8.4.1. If there are any discrepancies, the contractor supervisor shall ensure his/her workers understand and comply with any restrictions and prohibitions of the contractor's LOTO program.

21.8.4.2. Contractors not following OSHA Hazardous Energy Control requirements shall be notified by the installation contracting office to suspend or terminate their work until their LOTO program is in compliance.

**Figure 21.1. Lockout/Tagout Methods.**

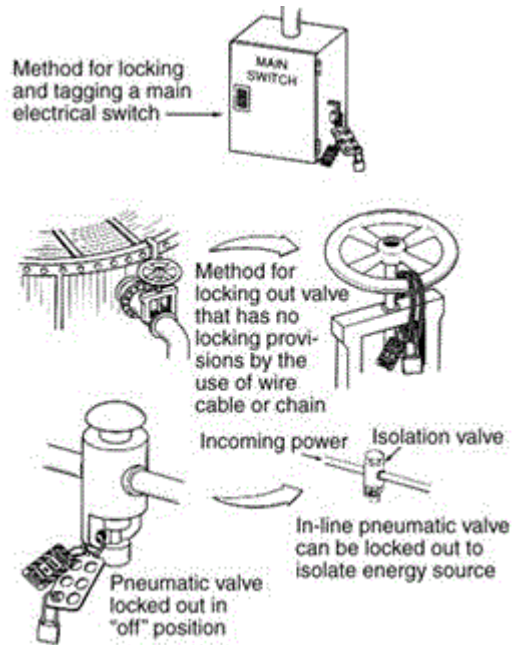


Figure 21.2. AF Form 983, Danger – Equipment Lockout Tag.



Figure 21.3. AF Form 979, Danger Tag.

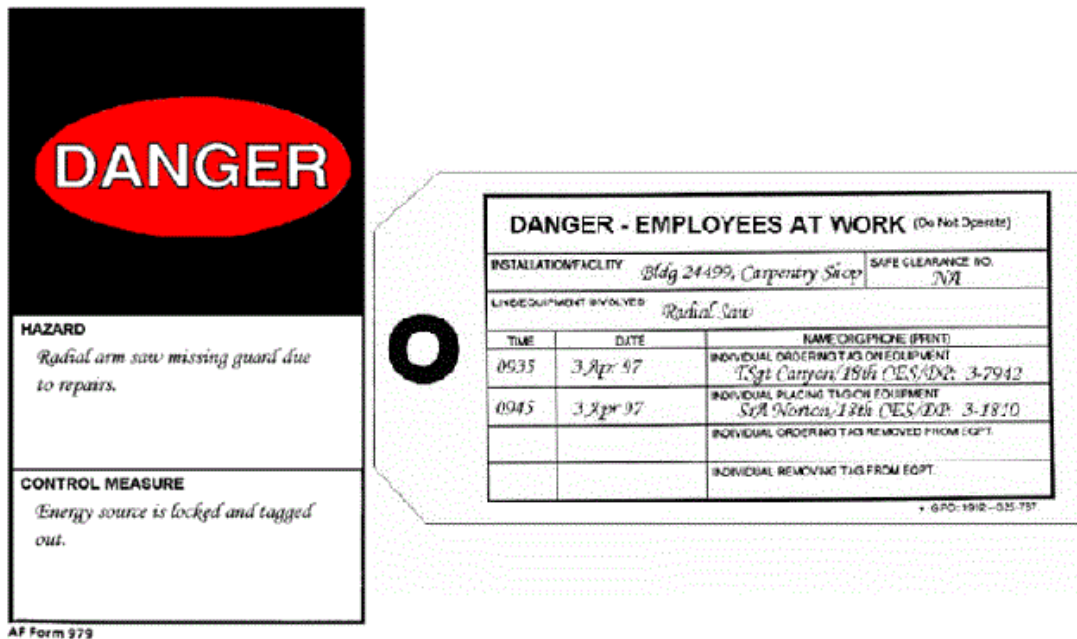


Figure 21.4. AF Form 980, Caution Tag.

CAUTION

**HAZARD**  
*B4 Stand has one inoperative brake.*

**CONTROL MEASURE**  
*Tagged. Use only in hangar. Do not use on flightline until brake is repaired.*

CAUTION—ABNORMAL CONDITIONS

INSTALLATION/FACILITY <i>Kirtland / Hangar 14</i>		SAFE CLEARANCE NO.			
LINE/EQUIPMENT INVOLVED <i>B4 Stand</i>					
ABNORMAL CONDITIONS <i>One brake inoperative</i>					
SPECIAL CONDITIONS					
TIME	0245	DATE	1 Jul 97	NAME /ORG (PRINT) PHONE	INDIVIDUAL ORDERING TAG ON EQUIPMENT
	INDIVIDUAL PLACING TAG ON EQUIPMENT <i>SSgt Johnson - 18th OG, DP: 3791</i>				
				INDIVIDUAL ORDERING TAG REMOVED FROM EQPT.	
				INDIVIDUAL REMOVING TAG FROM EQPT	

AF Form 980, (REVERSE)

AF Form 980

Figure 21.5. AF Form 981, Out of Order Tag.

OUT OF ORDER

**HAZARD**  
*Ladder missing anti-skid tips. Do not use until replaced.*

**CONTROL MEASURE**  
*Replace - Remove from work area.*

HAZARD IDENTIFICATION/NOTICE OF HAZARD

ITEMS 1 THRU 4 TO BE COMPLETED BY INDIVIDUAL PLACING TAG  
(Last entry in these items is individual currently responsible for tag)

1. TIME	2. DATE	3. SHOP OR CEC SERVICE	4. REPORTED ORGAN, NAME AND PHONE NO.

ITEMS 5 THRU 7 MUST BE COMPLETED BY RESPONSIBLE SUPERVISOR  
(Prior to completing these items, the supervisor must coordinate with the responsible functional manager to ensure elimination of AF Form 3, USAF Hazard Abatement Log. See AFI 91-101)

5. HAZARD/DEFICIENCY CATEGORY	6. VERIFICATION DATE	7. FUNCTIONAL NO.

DO NOT REMOVE UNTIL HAZARD IS ABATED/CORRECTED

AF FORM 981

Figure 21.6. AF Form 982, Do Not Start Tag.

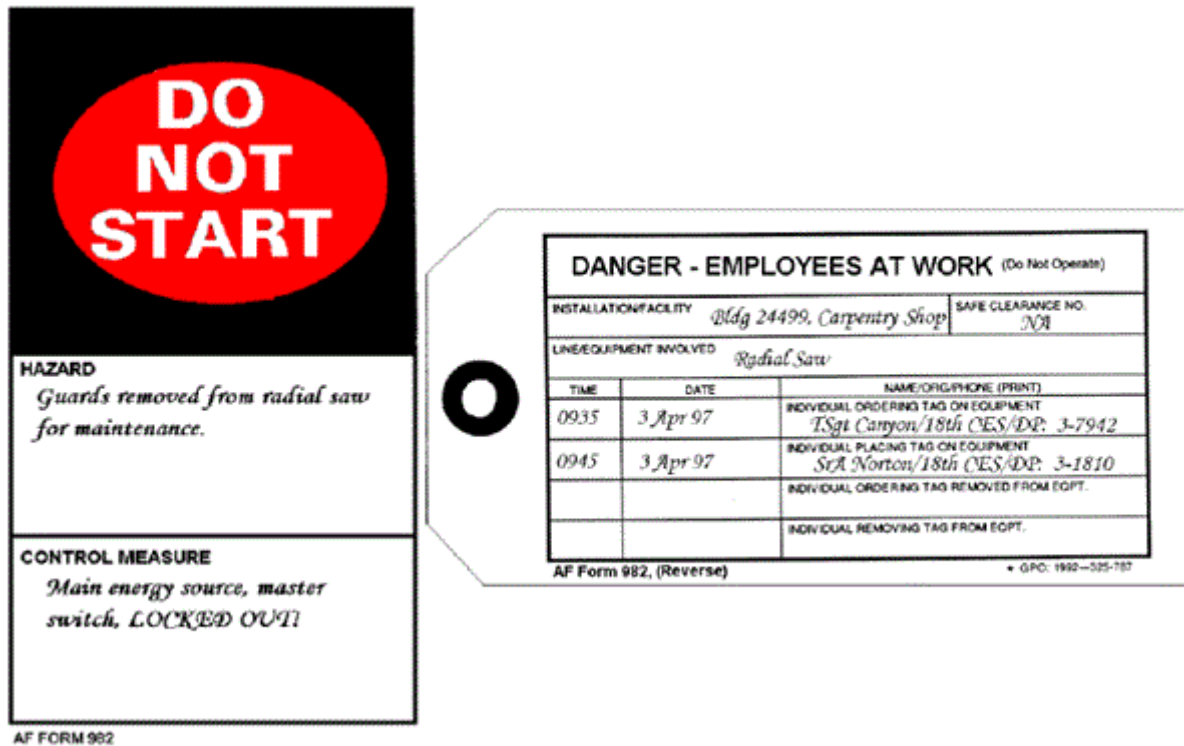


Figure 21.7. Basic LOTO Checklist.

**Note:** Steps shall be followed in sequence. *This checklist is a tool and does not replace a written LOTO program. Refer to paragraph 21.4.*

Step	Action
1.	<input type="checkbox"/> Preparation. <ul style="list-style-type: none"> <li><input type="checkbox"/> Review equipment-specific written procedures.</li> <li><input type="checkbox"/> Identify and assess all hazardous energy sources to be controlled.</li> <li><input type="checkbox"/> Determine appropriate methods for controlling hazardous energy; ensure all energy-isolating devices will accept a lock and tag.</li> <li><input type="checkbox"/> Gather necessary tools and equipment, including LOTO locks, tags and devices.</li> <li><input type="checkbox"/> Identify supporting equipment or systems that must also be shut down (if applicable).</li> </ul>
2.	<input type="checkbox"/> Notification. Notify affected workers of impending shutdown, the reason why, importance of not disturbing the lockout and not to re-start equipment or machinery until maintenance operations are complete.

3.  Shutdown. Shut down equipment by normal methods (stop button, toggle switch, shut off valve, etc.).  
Note: Use an orderly shutdown to avoid additional hazards.
4.  Isolation and Verification.
- Isolate or block all hazardous energy sources for the equipment or machinery.
  - Verify correct energy isolating device(s) has been operated and that steps taken to ensure energy isolation correspond to equipment or machinery requiring LOTO.
  - Ensure all energy isolating devices needed to control energy to or contained within the equipment or machinery are used.
5.  LOTO Device Application. Apply lockout locks and tags.
- Affix devices, tags and locks to each energy-isolating device in a safe or off configuration.
  - For tagout procedures, apply the tag at the point where a lock would be used, or as near as possible to it. Refer to paragraph **21.4.3**.
6.  Additional Measures.
- Release all stored energy. Release, restrain, block, disconnect or otherwise render residual or stored energy safe.
  - Insert physical restraints (blocks, chocks) for moving or raised parts, etc., to ensure moving parts are physically restrained or disconnected.
  - Use energy drains (drain pressurized lines, free-wheeling shafts, active ground, etc.) whenever possible.
  - If hazardous energy can re-accumulate during shutdown, continually verify a safe energy level until lockout/tagout is removed.
7.  Isolation Confirmation.
- Physically verify energy isolation by operating controls or measuring the energy state (use a meter to verify energy, operating the startup controls, etc.).  
CAUTION: Return operating controls to “safe” or “off” position after the test (if start up controls are operated).  
Note: If the work area has been left unattended, repeat this step and verify the integrity of the lock and tag (against tampering) before continuing work.
8.  Keep LOTO Devices in Place. LOTO devices shall remain in place until all maintenance activities are complete.

**Figure 21.8. Basic Release From LOTO Checklist.**

**Note:** Steps shall be followed in sequence. *This checklist is a tool and does not replace the need for a written LOTO program.* Refer to paragraph **21.4.5**.

Step	Action
1.	<input type="checkbox"/> Preparation and Notification <ul style="list-style-type: none"> <li><input type="checkbox"/> Notify all affected workers that the system is ready for return to service and make the work area safe.</li> <li><input type="checkbox"/> Inspect the work area to ensure all individuals are clear of hazard area.</li> <li><input type="checkbox"/> Inspect the work area to ensure nonessential items have been removed and equipment or machine components are operationally intact (e.g., guards reinstalled).</li> </ul>
2.	<input type="checkbox"/> Removal of Additional Devices <ul style="list-style-type: none"> <li><input type="checkbox"/> Remove physical restraints (blocks, chocks), safety grounding devices and any other additional devices applied.</li> <li><input type="checkbox"/> Verify all maintenance work is complete and it is safe to reenergize the equipment or machinery.</li> </ul>
3.	<input type="checkbox"/> Removal of ALL Locks and Tags <ul style="list-style-type: none"> <li><input type="checkbox"/> Remove locks, tags and devices.</li> <li><input type="checkbox"/> Notify affected workers that lockout or tagout devices have been removed.</li> <li><input type="checkbox"/> Energize equipment or machinery and proceed with normal operations, testing or positioning.</li> </ul>



**Figure 21.9. Equipment Specific LOTO Checklist.**

A. Equipment Identification:		Location:												
B. This procedure covers servicing and maintenance of machines and equipment in which “unexpected” energization or start up of the machines or equipment, or release of stored energy could injure employees. Authority: 29 CFR 1910.147(c)(4)														
SCOPE OF THIS PROCEDURE:														
C. HAZARDOUS ENERGY TYPE ( <i>Hazard</i> ): (Check All That Apply)														
<p>1. Electrical: (<i>shock, electrocution, arc flash</i>)</p> <p><input type="checkbox"/> a. Voltage: AC &lt; 30 or DC &lt; 50 volts</p> <p><input type="checkbox"/> b. Voltage: AC or DC but ≤ 600 volts</p> <p><input type="checkbox"/> c. Voltage: &gt; 600 volts</p> <p><input type="checkbox"/> d. High current: &gt; 25 amperes at any voltage</p> <p>Include: Capacitors and Batteries IAW AFI32-1064, <i>Electrical Safe Practices</i></p> <p>2a. <input type="checkbox"/> Pneumatic / Hydraulic: &gt; 1 Atmosphere which results in hazardous energy (<i>crush, whipping, noise, shrapnel</i>)</p> <p>Include: Reservoirs, Receivers, Tanks</p>	<p>2b. <input type="checkbox"/> Mechanical: (<i>crush, drop, punch, pinch, grab, cut, rotate</i>)</p> <p>Include: Springs, Platforms (raised), Pendula, Bungees, Flywheels</p> <p>2c. <input type="checkbox"/> Vacuum: &lt; 1 Atmosphere (<i>crush, whipping, noise, shrapnel</i>)</p> <p>Include: Reservoirs, Receivers, Tanks</p> <p>2d. <input type="checkbox"/> Thermal, High temperature: &gt; 120° F surface temperature (<i>burns</i>)</p> <p>2e. <input type="checkbox"/> Thermal, Cryogenic: Unguarded delivery line or conduction to a part where exposure potential exists, potential contact with a cryogenic liquid. (<i>extreme freezing, asphyxiation</i>)</p>	<p>3. <input type="checkbox"/> Chemical: Explosion, Fire, Corrosion, Oxidization, Toxin, Asphyxiation, Mutation, Instability</p> <p>4. <input type="checkbox"/> Radiation: Electro-magnetic, Microwave, Infrared, LASER, Ultraviolet, Ionizing.</p> <p>5. <input type="checkbox"/> Other: Specify:</p>												
D. JOB SPECIFIC LOCKOUT INFORMATION														
<p>D.1 <u>Specific Lockout Locations</u>      <u>Lockout Procedure Order</u></p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:60%;">Identification</th> <th style="width:40%;">Location/Isolation Device</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>	Identification	Location/Isolation Device											<p>D.2 <u>Dissipate stored energy at these points:</u></p>  <p>D.2 <u>Block these parts/remove linkages:</u></p>	
Identification	Location/Isolation Device													

E. NAMES OF AUTHORIZED WORKERS PERFORMING THIS LOCKOUT:	F. NAMES OF PERSONNEL AFFECTED BY THIS LOCKOUT:
G. VERIFICATION REQUIREMENTS:	H. SAFETY MEASURES/SPECIAL INSTRUCTIONS: (i.e. PPE)
I. LIST ADDITIONAL INFORMATION AS REQUIRED:	
<b>J. BASIC LOCKOUT PROCEDURES</b>	
<ol style="list-style-type: none"> <li>1. <input type="checkbox"/> Preparation.</li> <li>2. <input type="checkbox"/> Notification.</li> <li>3. <input type="checkbox"/> Shutdown.</li> <li>4. <input type="checkbox"/> Isolation and Verification.</li> <li>5. <input type="checkbox"/> LOTO Device Application.</li> <li>6. <input type="checkbox"/> Additional Measures.</li> <li>7. <input type="checkbox"/> Isolation Confirmation.</li> <li>8. <input type="checkbox"/> Keep LOTO Devices in Place.</li> </ol>	<b>K. RELEASE FROM LOCKOUT/TAGOUT</b> Notes/Comments:  <ol style="list-style-type: none"> <li>1. <input type="checkbox"/> Preparation and Notification.</li> <li>2. <input type="checkbox"/> Removal of Additional Devices.</li> <li>3. <input type="checkbox"/> Remove ALL Locks and Tags.</li> </ol>
L. SIGNATURE	
Signature: _____	Date: _____

Checklist Instructions:

A.	EQUIPMENT IDENTIFICATION: Identify equipment to be serviced or maintained and list location (i.e., Site, Bldg, Rm.).
B.	SCOPE: Write brief description of work activity.
C.	IDENTIFICATION OF HAZARDOUS ENERGY: Identify all hazardous energy sources associated with the equipment to be serviced or maintained including those that may not require LOTO for activity being performed.
D1.	JOB SPECIFIC LOCKOUT OR TAGOUT INFORMATION. Identify and state location of specific hazardous energy sources associated with equipment that requires lockout or tagout to ensure personnel performing maintenance or service and personnel working near the equipment are protected from unexpected release of hazardous energy.
D2.	List locations where stored energy requires de-energization.
D3.	List parts/equipment/components that require blocking.
D4.	List any other related system that may require shutdown during maintenance or servicing activity.
E.	NAMES OF AUTHORIZED WORKERS PERFORMING THIS LOCKOUT: List names of all authorized workers performing LOTO (attach continuation sheet, if needed).
F.	NAMES OF PERSONNEL AFFECTED BY THIS LOCKOUT: List names of personnel affected when performing this LOTO.
G.	VERIFICATION REQUIREMENTS: Specific requirements for testing a machine or piece of equipment to determine and verify effectiveness of LOTO devices and other energy control measures.
H.	SAFETY MEASURES/SPECIAL INSTRUCTIONS: List any special safety concerns associated with this work activity (i.e., electrically rated gloves, hearing protection, safety glasses, face shields, etc.).
I.	ADDITIONAL INFORMATION: (Optional) List any additional information not identified elsewhere on this form (i.e. special sequencing, reference manuals, reference other TOs, etc.)
J.	BASIC LOCKOUT PROCEDURES. Complete steps 1-8, as applicable.
K.	RELEASE FROM LOCKOUT/TAGOUT: Complete steps 1-3, as applicable.
L.	SIGNATURE: Signature of Authorized Worker completing form.

**Note:** This is a tool and shall not replace a written LOTO program.

### RESTRICTIONS

All workers shall comply with restrictions/limitations imposed on them while using LOTO.

Authorized Workers shall perform the LOTO activities as prescribed in this procedure

Only Authorized Workers are permitted to perform lockout activities prescribed by this procedure.

This procedure shall be used during all activities involving maintenance (repair) or servicing (adjustments, modifications, cleaning, or inspections) of equipment. No worker shall attempt to start/energize or use/operate locked out equipment.

If the designated Authorized Worker is replaced, relieved, or augmented, the new Authorized Worker(s) shall place his/her own lock & tag on the lockout devices **before** the relieved worker removes his/hers.

No worker shall provide locks/tags nor vouchsafe for another worker for any or all isolation points at any time.

If the Authorized Worker leaves sight of the job, even momentarily, that worker shall re-verify the lockout and zero energy state of the equipment before resuming work.

In an emergency, the supervisor shall apply his lock over that of the Authorized Worker until the Authorized Worker can verify a safe state for the operation

In the event of undetermined (long-term) absence of an Authorized Worker who has not released the equipment from LOTO, the supervisor may remove the lock.

Removal shall be performed under the provisions of, paragraph **21.4.5.**, Release from Lockout/Tagout.

If this procedure is part of a larger, more general procedure, energy sources that are part of the larger procedure, but not applicable to this procedure, shall be identified and listed, with an explanation of why they are not a hazard and not applicable or relevant to this procedure.

### **\*Lockout of High Energy Electrical Sources**

High energy electrical sources (over 600 volts) require special caution and attention to detail. The following steps are in addition to those required for a normal lockout whenever equipment connected to high energy electrical sources is to be worked on.

1. **Workers shall be assigned in teams (minimum of two [2] people)** whenever high energy electrical sources are to be locked out.
2. The high energy source shall be isolated from the equipment by at least two (2) energy isolating devices placed electrically in series. Both devices shall be locked open and tagged out before work begins. Each member of the team may elect to place one lock or two.
3. Voltmeters shall not be used to determine that the high energy source has been disconnected. "Tic Tracers" with both audible and visual indications are the preferred instrument.

4. After both locks are placed (following lockout procedure outlined above), the LINE side of the second energy isolating device shall be grounded. The grounds shall remain in place for the entire duration of the work.
5. Workers shall ensure all stored energy, particularly from stray capacitance (in cables, lightning arrestors, power factor correction capacitors, etc.), is safely discharged from all parts of the circuit to be locked out. Grounds shall be in place on all conductors in the work area whenever work is in progress. If grounds are removed for any reason, they shall be replaced before continuing work.
6. When removing locks from a high energy source, at least two (2) people shall independently perform complete inspections of the work area, the equipment worked on, and the entire circuit from the first lock to the equipment. All grounds shall be removed, all tools and parts stored, all areas clean, and all covers and other safety devices installed and secured.

**Figure 21.10. LOTO Self-Assessment Tool (Example).**

Facility: \_\_\_\_\_ Equipment ID: \_\_\_\_\_

Responsible Worker: \_\_\_\_\_

Appraisal Conducted by: \_\_\_\_\_ Date: \_\_\_\_\_

Lockout/Tagout Program Requirements	Satisfactory (Yes/No)	Comments
Written lockout/tagout procedures		
Management responsibilities understood		
Authorized worker responsibilities understood		
Lockout/tagout procedure review		
Correct lockout/tagout sequences		
Communication with contractors working on site, as required.		
Record and documentation system established		
Training for authorized workers		
Roles and responsibilities		
Periodic retraining completed, if applicable		
Refresher training completed		
Training records maintained, AF IMT 55		
Standardized locks used		
AF-standardized tags used		
Lockout devices available to workers		
Annual inspections conducted		
Tagout-only procedure established		
Lockout/tagout records completed		
Removing locks in absence of authorized workers is documented		
Group lockout/tagout procedure established		
Shift/schedule change procedure established		
Procedures followed during program execution		
<b>Additional Comments/Recommendations</b>		

**Note:** This is a tool and does not replace established checklists or procedures.

**Figure 21.11. LOTO Annual Inspection Sheet (Example).**

Location: \_\_\_\_\_ Date: \_\_\_\_\_

System/Equipment under maintenance: \_\_\_\_\_

**Authorized Worker(s)**

Name: \_\_\_\_\_ Name: \_\_\_\_\_

AFSEC: \_\_\_\_\_ AFSEC: \_\_\_\_\_

**Types of energy being isolated (circle):**

Electrical	Chemical	Hydraulic	Pneumatic
Mechanical	Steam	Gas	Other: _____

1. Has equipment or machinery being isolated had a hazard assessment to identify all sources of energies present?

Yes      No

2. If equipment or machinery energy(s) cannot be controlled by a single source, are specific procedures written and posted?

Yes      No

3. Has authorized worker(s) received training and shown satisfactory knowledge of procedure requirements?

Yes      No

4. Have authorized worker(s) been issued locks, tags and other devices as needed?

Yes      No

5. Did authorized worker(s) verify system/equipment energy(s) was isolated before conducting maintenance?

Yes      No

Comments/Recommendations:

Inspector's Signature: \_\_\_\_\_ Location: \_\_\_\_\_

Date: \_\_\_\_\_

**Note:** This is a tool and does not replace established checklists or procedures.

Figure 21.12. LOTO Log Book Sheet (Example).

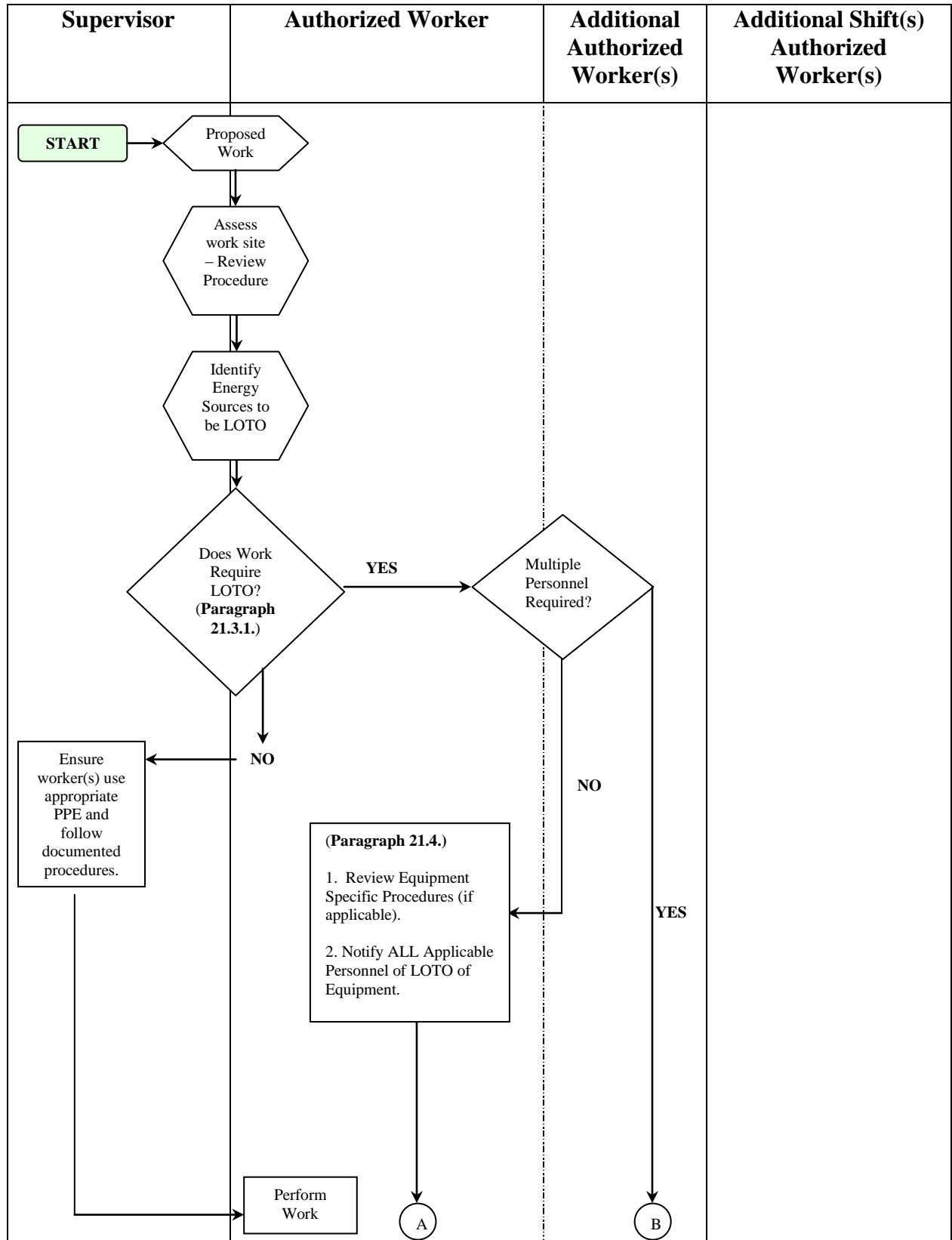
**Lockout/Tagout Log :** \_\_\_\_\_ (*Shop ID*)

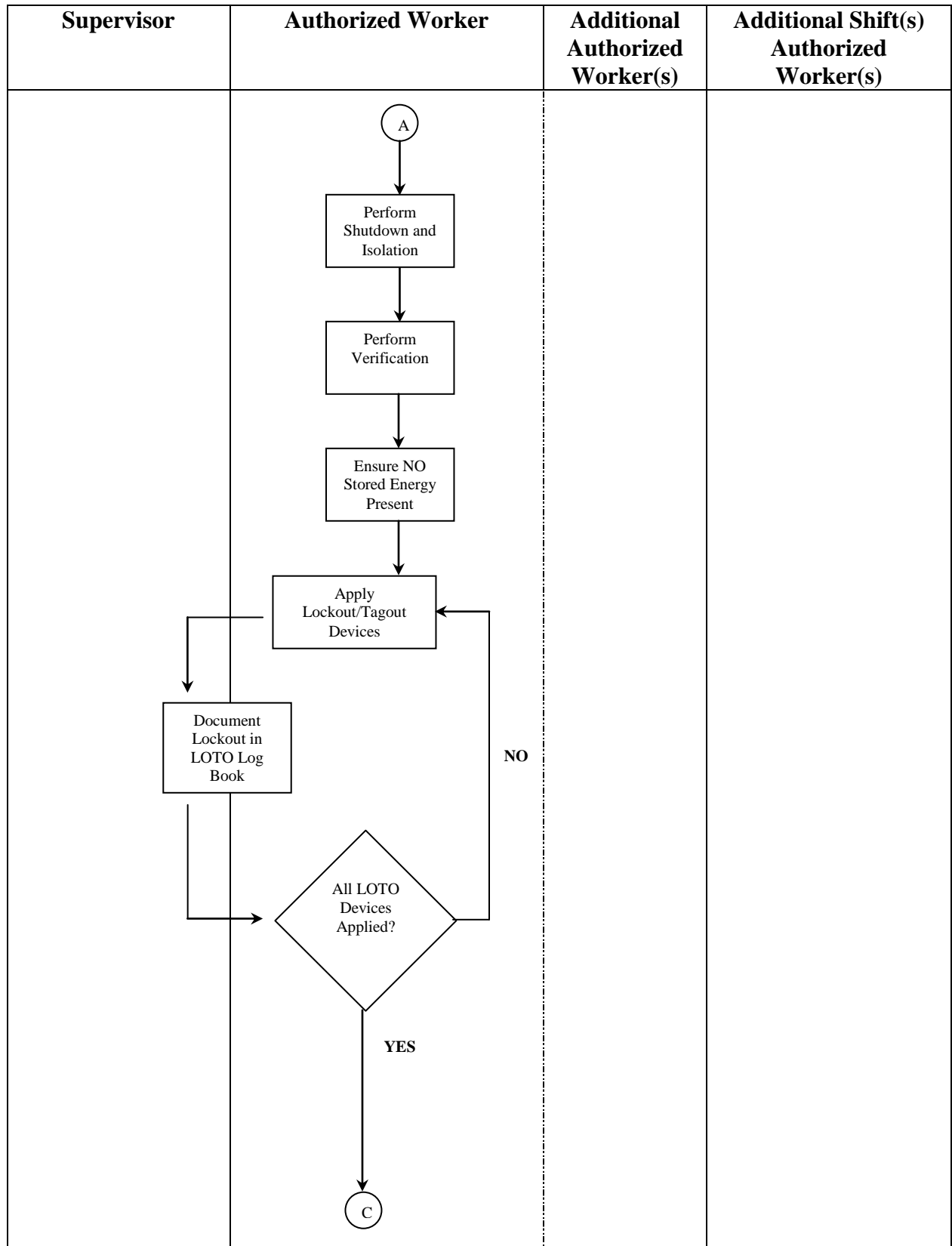
Lock Number	Date Applied	Date Removed	Review (initial/date)	Equipment/Machine Locked Out/Serial Number	Reason Applied (maintenance/shutdown)	Name	Phone

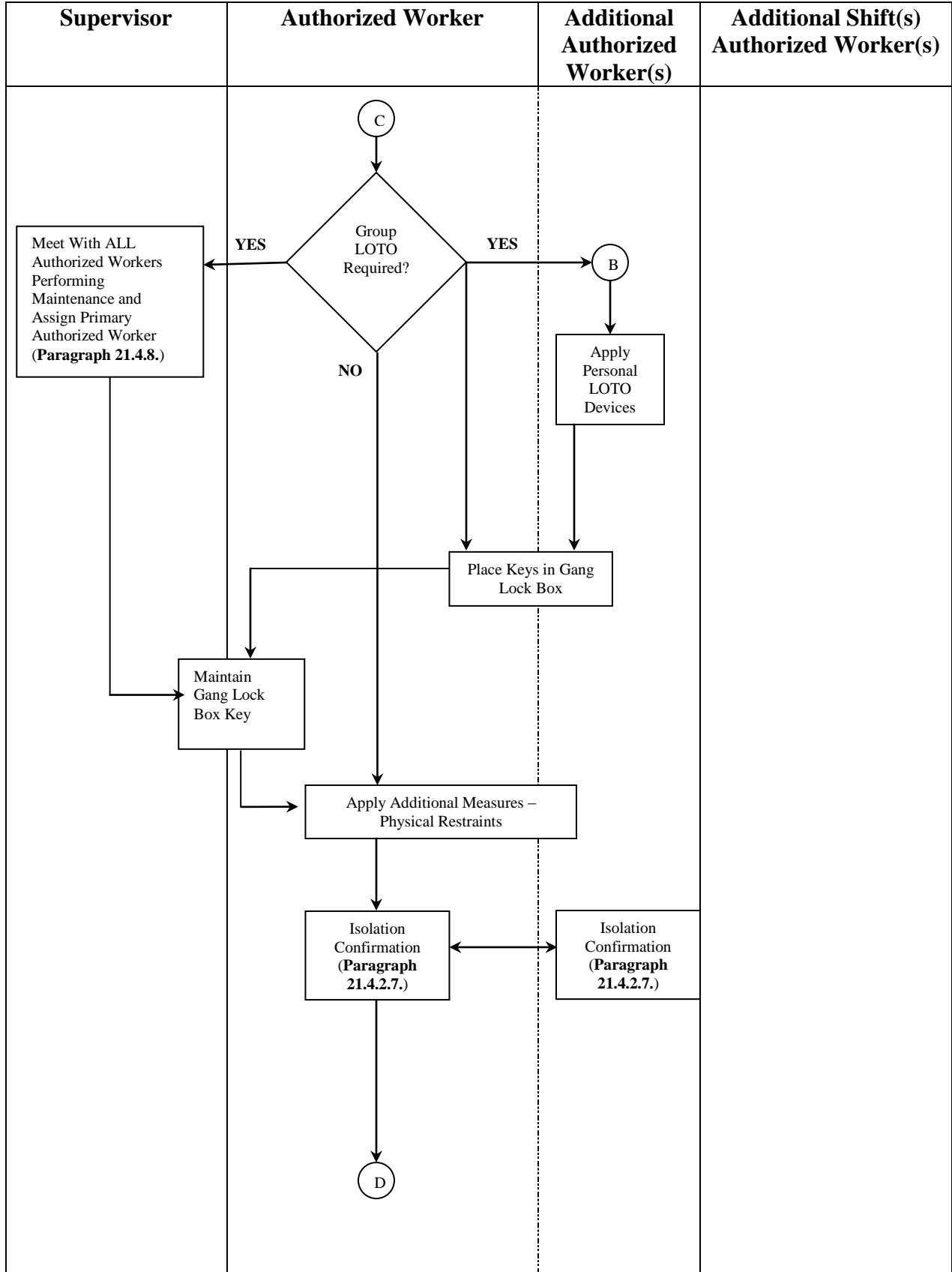
**Note:** A log shall be used to document the use, location and review of Lockout/Tagout, where appropriate. This is a tool and does not replace established documents or procedures.

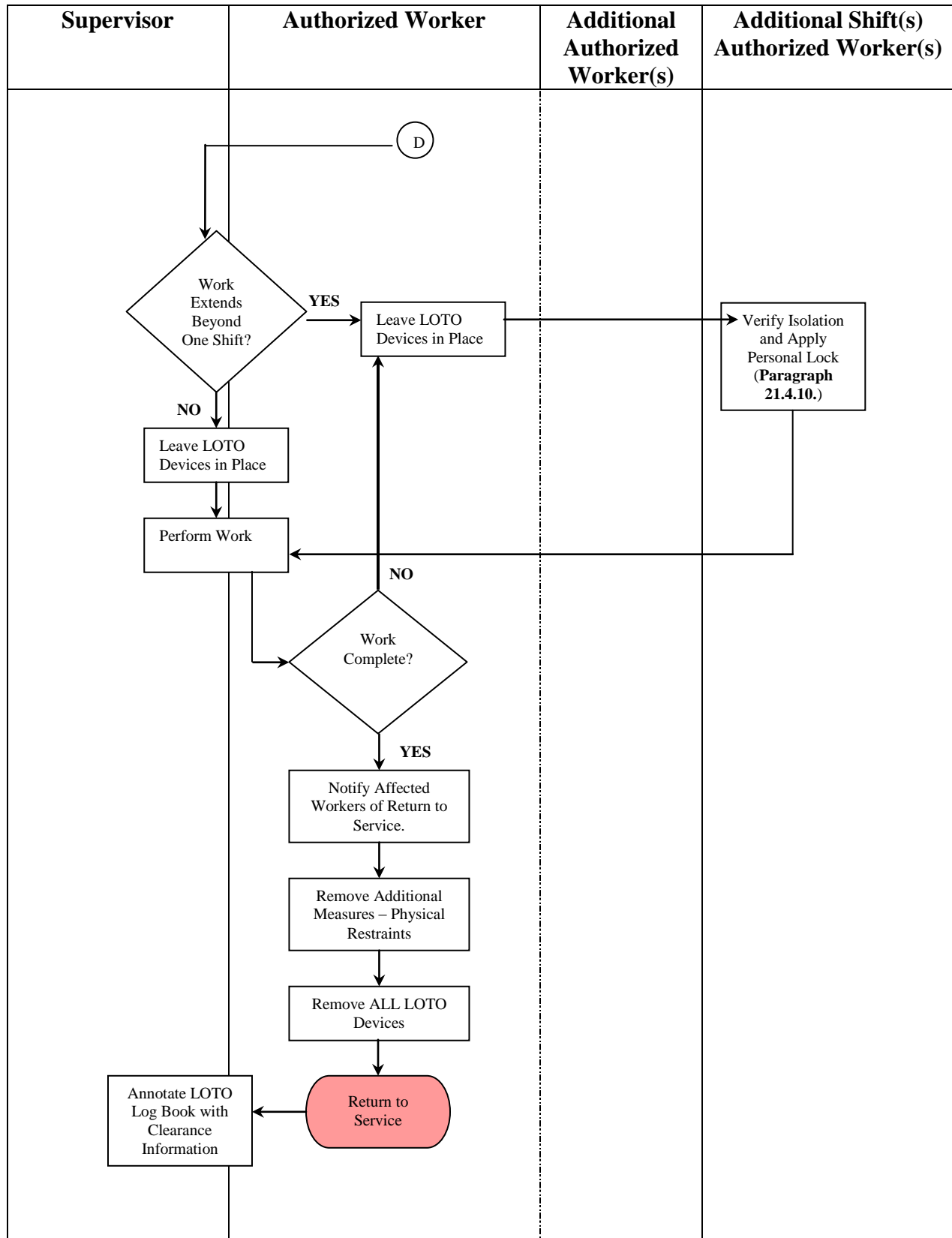


Figure 21.13. Lockout/Tagout Decision Flow Chart, Page 1 of 4.









**21.9. Hazardous Energy Control (Lockout and Tagout) Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

21.9.1. Are procedures developed and documented for safe and proper use of locks and tags? Reference [21.2.1.4](#)

21.9.2. Has a training plan been developed for initial and recurring training on lockout and tagout procedures? Reference [21.2.1.6](#)

21.9.3. Are LOTO devices (typically locks) used as a positive means of isolating energy sources and preventing unexpected start-up of machines and equipment? Reference [21.2.1.7](#)

21.9.4. Is an inspection of the lockout and tagout program conducted annually? Reference [21.2.1.10](#)

21.9.5. Is an adequate supply of safety tags and locks available for use? Reference [21.3.3](#)

21.9.6. Are all workers responsible for recognizing when LOTO is used, the general reasons for LOTO and the importance of not tampering with or removing LOTO devices? Reference [21.3.4.1](#)

21.9.7. Have equipment-specific, written procedures been developed for use when equipment or machinery undergoes servicing, modification or maintenance? Reference [21.3.8](#)

21.9.8. Are affected personnel in the area notified before and after lockout or tagout controls are used? Reference [21.4](#)

21.9.9. Does the supervisor, authorized worker and operator responsible for the equipment or machinery know the type, magnitude and hazards of the energy source(s)? Reference [21.4.2.1.1](#)

21.9.10. Are lockout devices attached in a manner that will hold the energy isolating devices in a “safe” or “off” position? Reference [21.4.2.5.1](#)

21.9.11. Are service/administrative locks and tags replaced when maintenance on equipment and machinery starts? Reference [21.4.9.1.3](#)

21.9.12. Are specific, written procedures utilized during shift or personnel changes to ensure the continuity of lockout or tagout protection? Reference [21.4.10](#)

21.9.13. Is initial and recurring lockout and tagout program job training current and documented? Reference [21.5.5](#)

21.9.14. Are periodic self-inspections conducted and documented by the unit? Reference [21.6.1](#)

## Chapter 22

### FLAMMABLES AND COMBUSTIBLES

**22.1. General Information.** This chapter addresses key flammable and combustible liquids criteria, specific aspects of flammable and combustible liquids storage, use and handling, and implements 29 CFR 1910.106, *Flammable and Combustible Liquids*. It includes storage (inside/outside), use and handling of these liquids in containers or tanks of 60 gallons or less and in portable tanks up to 660 gallons capacity. It also includes storage in fuel tanks of two (2) gallons or less located on small gasoline-powered equipment such as lawnmowers and snowblowers. It does not apply to petroleum products in fuel tanks of motor vehicles, aircraft, boats, other watercraft, large portable or stationary engines, petroleum products in portable tanks over 660 gallons, alcoholic beverages when packed in individual glass, plastic, metal or ceramic containers not exceeding 4 liters in volume, medicines, foodstuffs and cosmetics, special purpose vehicles designed and maintained for storage and transportation of flammable or combustible liquids, or liquids having no flashpoint which may not burn under normal conditions. **Note:** While this section deals primarily with flammable and combustible liquids, flammable and combustible gases in compressed gas cylinders present similar fire hazards. Gases in cylinders, i.e., acetylene, propane, hydrogen, shall be stored and handled IAW AFJMAN 23-227(I), *Storage and Handling of Liquefied and Gaseous Compressed Gasses and Their Full and Empty Cylinders*. Use of these gases shall comply with requirements in this and other parts of this instruction, i.e., **Chapter 27**, *Welding, Cutting and Brazing*, along with requirements in the NFPA 70, *National Electric Code*, National Fire Codes, etc., related to use and storage of flammable materials.

22.1.1. Personnel working with or handling flammable and combustible liquids may be exposed to spills, hazardous vapors, accidental mixture of flammable and combustibles, or industrial hazards associated with handling of containers and products. Physical hazards from these materials include fires and explosions. Preventing fires and explosions caused by static electricity or unauthorized defective electrical equipment requires increased attention during handling and storage of these liquids.

22.1.2. Flammable Liquids. A flammable liquid has a closed cup flashpoint below 100 degrees Fahrenheit (F) (37.8 degrees Celsius [C]) and a vapor pressure not exceeding 40 pounds per square inch, gauge (psig) (2068 millimeters [mm] mercury [Hg]) at 100 degrees F (37.8 degrees C). Flammable liquids are categorized as Class I liquids and are further subdivided as follows below. Refer to NFPA 30, *Flammable and Combustible Liquids Code*, for additional information and guidance on flammable liquids. **Note:** There are a few chemicals with a flashpoint outside these limits, such as anhydrous ammonia, that are still considered flammable liquids.

22.1.2.1. Class IA flammable liquids have a flashpoint below 73° F (22.8° C) and a boiling point below 100° F (37.8° C).

22.1.2.2. Class IB flammable liquids have a flashpoint below 73° F (22.8° C) and a boiling point at or above 100° F (37.8° C).

22.1.2.3. Class IC flammable liquids have a flashpoint at or above 73 degrees F (22.8 degrees C) and below 100 degrees F (37.8 degrees C).

22.1.3. Combustible Liquid. A liquid having a closed cup flashpoint at or above 100 degrees F (37.8 degrees C). Combustible liquids are categorized as Class II or Class III liquids and are further subdivided as follows):

22.1.3.1. Class II liquids have a flashpoint at or above 100 degrees F (37.8 degrees C) and below 140 degrees F (60 degrees C).

22.1.3.2. Class IIIA liquids have a flashpoint at or above 140 degrees F (60 degrees C) and below 200 degrees F (93.3 degrees C), except any mixture having components with flashpoints of 200 degrees F (93 degrees C), or higher. Refer to 29 CFR 1910.106. for additional guidance.

22.1.3.3. Class IIIB liquids have flashpoints at or above 200 degrees F (93.3 degrees C). **Note:** This instruction does not cover Class IIIB liquids. Where the term Class III liquids is used in this instruction, it shall mean only Class IIIA liquids. Refer to 29 CFR 1910.106. for additional guidance.

**22.2. Human Factors.** Refer to **Chapter 2, Human Factors**, for additional guidance. Being unaware of the hazardous properties of flammable and combustibles and their control can contribute to or even be the cause of a mishap. Refer to AFI 90-821, *Hazard Communication*, and 29 CFR 1910.1200, *Hazard Communication*, for additional information.

### **22.3. Hazards.**

22.3.1. Flammable and combustible liquids require careful handling at all times. Many of these liquids are used by the Air Force, and mishandling is a significant cause of injury or occupational illness. Hazards associated with use of flammable or combustible liquids include explosions, burns from fire, chemical burns, asphyxiation, inhalation of vapors, absorption through the skin, skin irritation and eye damage from direct contact or exposure. The volatility of flammable or combustible liquids is increased by heat and, when heated to temperatures higher than their flashpoints, they present a greater hazard.

22.3.2. Solvents with flammable characteristics must be handled with care. Solvents can burn or explode if handled or used improperly.

22.3.3. Air Force personnel must be aware of hazards associated with the use of flammable and combustible liquids used at the worksite. Job safety training shall include, as a minimum, information on the need for and use of approved PPE; maintenance and care of PPE, safe chemical handling procedures; and emergency treatment practices in case of exposure, ingestion or inhalation of liquids or vapors. Refer to **Chapter 14, Personal Protective Equipment (PPE)**, and AFI 90-821 for additional guidance.

22.3.4. Some flammable and combustible liquids are highly reactive with other substances, subject to explosive decomposition or have other properties that dictate extra safeguards. Contact the installation Ground Safety office, Fire Emergency Services (FES) Flight or BE when in doubt or for additional guidance. The following lists some common water-reactive substances:

22.3.4.1. Alkali Metals (Lithium [Li]).

- 22.3.4.2. Potassium [K].
- 22.3.4.3. Sodium [Na].
- 22.3.4.4. Cerium [Ce].
- 22.3.4.5. Calcium [Ca].
- 22.3.4.6. Hydrides.
- 22.3.4.7. Phosphorous Trichloride.
- 22.3.4.8. Phosphorous Pentasulfide.

**Note:** Water-reactive materials shall not be stored where fire protection sprinklers are in place. These materials shall not be stored with flammable or combustible liquids. Refer to 29 CFR 1910.106. and the latest edition of the Emergency Response Guide. Ensure emergency response personnel are advised that water-reactive materials are present.

22.3.5. Sparks resulting from accumulation of static electricity can ignite flammable vapors or gases. The flow of flammable liquids through non-conductive hoses or passages can also produce static charges. Unless safely conducted to a ground, these charges accumulate and become an ignition source. Refer to NFPA 30 for additional guidance.

22.3.6. Supervisors and workers engaged in operations where fuels, solvents or other flammable liquids are used must be constantly alert and avoid unsafe practices. It is hazardous to use fuels (such as gasoline) to clean floors or clothing, or use open solvent or gasoline containers near electrical equipment or pilot lights. The use of low-flashpoint petroleum solvents shall be avoided, when possible. Open flames, open heaters, equipment not properly grounded and non explosion-proof electrical equipment shall not be used in the presence of flammable or combustible liquids. Refer to NFPA 30 for additional guidance.

## **22.4. Responsibilities.**

22.4.1. Functional Managers and/or Supervisors shall ensure:

22.4.1.1. All workers and handlers of flammable or combustibles have accomplished appropriate training associated with tasks and hazards related to the work environment.

22.4.1.2. Personnel handling, storing or using hazardous materials are trained IAW AFI 90-821.

22.4.1.3. Individuals involved in dispensing of flammable or combustible liquids are instructed on hazards of static electricity.

22.4.1.4. Workers handling and storing flammable or combustible liquids are trained in fire prevention and protection as it relates to their duties.

22.4.1.5. Appropriate spill and containment control materials are readily available at storage or dispensing areas.

22.4.1.6. PPE is available and appropriately worn when handling flammable or combustible liquids.

## **22.5. General Requirements.**



22.5.1. Facility Pre-Fire Plans. Facility pre-fire plans shall be developed for flammable and combustible liquid warehouses, laboratory and storage buildings. These plans shall be maintained in the installation FES Flight and on vehicles designated by the Fire Chief. Refer to AFI 32-2001, *Fire Emergency Services Program*, for additional information. The plans include the hazardous materials contained in installation facilities, their locations and emergency procedures to be followed.

22.5.2. Containers. Containers and portable tanks shall meet handling, storage and dispensing requirements specified in this standard for the product concerned. Refer to NFPA 30 for additional guidance.

22.5.2.1. The capacity of flammable and combustible liquid containers shall be IAW **Table 22.1**, except that glass or plastic containers of no more than 1-gallon capacity may be used for Class IA or IB flammable liquids if:

22.5.2.1.1. Such liquid would be rendered unfit for its intended use by contact with metal or would excessively corrode a metal container and create leaks.

22.5.2.1.2. The user's process would require more than one (1) pint of a Class IA liquid or more than one (1) quart of a Class IB liquid of a single assay lot to be used at one time, or would require maintenance of an analytical standard liquid of a quantity not met by the specified standards of liquids available, and the quantity of the standard liquid required in any one control process exceeds one-sixteenth the capacity of the container allowed under **Table 22.1** for the class of liquid.

22.5.2.2. Flammable liquids shall be kept in covered containers when not in use. Refer to NFPA 30 for additional information.

22.5.2.3. Storage of flammable and combustible liquids shall be prohibited in office occupancies except when required for maintenance and operation of buildings and equipment. Such storage shall be the smallest quantity required, in approved self-closing metal containers stored in a storage cabinet or in safety cans or an inside storage room not having a door that opens into that portion of the building used by personnel. Maximum quantities shall meet the requirements of the storage cabinet, container or room IAW paragraph **22.5.3** and **Table 22.9**

22.5.3. Storage Cabinets. All flammable/combustible storage cabinets shall be listed/approved for the specific class of storage. Not more than 120 gallons (460 liters) of Class I, Class II and Class IIIA liquids may be stored in a storage cabinet. The combined total of Class I and Class II liquids may not exceed 60 gallons per storage cabinet, nor more than 120 gallons of Class III liquids may be stored in a storage cabinet. Not more than three (3) such cabinets (120 gallons each) may be located in a single fire area except in an industrial area. Refer to **Attachment 1** for definition of a fire area. Additional cabinets may be located in the same fire area of an individual area if the additional cabinet, or group of more than three (120 gallons each) cabinets, is separated from other cabinets or group of cabinets by at least 100 feet. The total aggregate volume of Class I, Class II and Class IIIA liquids in a group of storage cabinets shall not exceed maximum allowable quantity (MAQ) of flammable and combustible liquids per control area based on the occupancy where the cabinets are located. The MAQs of liquids allowed in each control area shall not exceed the amounts specified in **Table 22.9** If a unit requires more than three (3) storage cabinets, it

must coordinate with the FES Flight. Refer to NFPA 30 and [Table 22.9](#) for additional information. NFPA 30 is available for review at the FES Flight. **Note:** The limit of three (3) cabinets in a single area can be increased where smaller cabinets are used. However, the maximum amount of flammable storage cannot exceed that which could be stored in three 120 gallon capacity cabinets (460 liters).

22.5.3.1. HAZMAT Pharmacies and Other Areas that may Exceed MAQs Limit. In HAZMAT Pharmacies, buildings and/or portions of buildings where liquids are stored that may exceed MAQs per control area shall be classified as High-Hazard Level 2 or High-Hazard Level 3, as established by NFPA 30.

22.5.3.1.1. High-Hazard Level 2. Contents that present a deflagration hazard or a hazard from accelerated burning. This includes Classes I, II and IIIA liquids that are used or stored in normally open containers or systems, or in closed containers or systems at gauge pressures 15 psi or greater.

22.5.3.1.2. High-Hazard Level 3. Contents that readily support combustion or that present a physical hazard. This includes Classes I, II and IIIA liquids that are used or stored in normally closed containers or in closed containers or systems at gauge pressures of less than 15 psi.

22.5.3.2. Cabinets shall be labeled with conspicuous lettering, “Flammable — Keep Fire Away.” Additional guidance for marking storage containers is contained in [Chapter 20](#), *Safety Color Coding, Labeling, and Marking*.

22.5.3.3. The cabinet is not required to be vented for fire protection purposes. However, the following shall apply:

22.5.3.3.1. If the cabinet is vented, for whatever reasons, the cabinet inlet shall be vented outdoors in a manner that will not compromise performance of the cabinet.

22.5.3.3.2. If the cabinet is not required to be vented, the vent opening, as applicable, shall be sealed with bungs supplied with the cabinet or specified by the manufacturer of the cabinet.

22.5.3.4. Storage cabinets that meet at least one of the following sets of requirements shall be acceptable for the storage of liquids.

22.5.3.4.1. Storage cabinets designated and constructed to limit the internal temperature at the center of the cabinet and 1 inch (2.5 centimeter [cm]) from the top of the cabinet to not more than 325° F (162.8° C), when subjected to a 10-minute fire test that simulates the fire exposure of the standard time-temperature curve specified in NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials*, shall be acceptable. All joints and seams shall remain tight and the door shall remain securely closed during the test.

22.5.3.4.2. Metal storage cabinets constructed in the following manner are acceptable. The bottom, top, door and sides of the cabinet shall be at least No. 18 gauge sheet steel and double-walled, with 1 1/2 inches (38 mm) of air space. Joints shall be riveted, welded or made tight by some equally effective means. The door

shall have a three-point latch arrangement and a doorsill raised at least 2 inches (50 mm) above the bottom of the cabinet to retain spilled liquid within the cabinet.

22.5.3.4.3. Wooden cabinets constructed in the following manner are acceptable. The bottom, sides and top shall be constructed of exterior grade plywood at least 1 inch (25 mm) thick that shall not break down or delaminate under fire conditions. All joints shall be rabbeted and fastened in two directions with wood screws. Where more than one door is used, there shall be a rabbeted overlap of at least 1 inch (25 mm). Doors shall be equipped with a means of latching and hinges shall be constructed and mounted in such a manner as to not lose their holding capacity when subjected to fire. A raised sill or pan capable of containing 2 inches (50 mm) of liquid shall be provided at the bottom of the cabinet to retain spilled liquid within the cabinet.

22.5.3.5. Grounding or bonding of flammable/combustible liquid storage cabinets is not required whenever the cabinet meets national fire codes and OSHA requirements for design materials and for quantities of liquids stored.

22.5.4. Inside Storage Rooms. Refer to NFPA 30 for additional guidance.

22.5.4.1. Inside storage rooms shall meet specifications of NFPA 251 and the required fire-resistive rating for their use. Openings to other rooms or buildings shall have noncombustible liquid-tight raised sills or ramps at least four (4) inches in height or, as an alternative, the floor in the storage area shall be at least four (4) inches lower than the surrounding floor. Rooms shall be liquid-tight where walls join the floor. An additional alternative to the sill or ramp is an open-grated trench inside the room draining to a safe location. Self-closing fire rated doors meeting requirements of NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, shall be used. Where other portions of the building or other properties are exposed, windows shall be protected as required by NFPA 80. Wood of at least 1-inch nominal thickness may be used for shelving, racks, dunnage, scuffboards and floor overlay.

22.5.4.2. Class I liquids shall not be stored or handled within a building having a basement or pit where flammable vapors can travel, unless such area is provided with ventilation that will prevent the accumulation of flammable vapors.

22.5.5. Electrical. Electrical wiring and equipment located in inside storage rooms used to store Class I liquids shall meet requirements for Class I, Division 1 hazardous classified locations. Refer to 29 CFR 1926.152, *Flammable and Combustible Liquids*, and NFPA 70, *National Electrical Code*, for additional guidance.

22.5.5.1. Electrical equipment and wiring in inside storage rooms used to store only Class II and Class III liquids shall be suitable for general purpose use.

22.5.5.2. Transfer of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded). When flammables are not being transferred from one container to another, there is no requirement to have the containers bonded. Refer to 29 CFR 1910.106. for additional information.

22.5.6. Ventilation. Liquid storage areas where dispensing is conducted shall be provided with either a gravity or continuous mechanical exhaust ventilation system. Areas in which flammable or combustible liquids are transferred from one container to another tank or

container in quantities greater than 5 gallons shall be separated from other similar operations by 25-feet or by construction with a fire resistance of at least one (1) hour. Drainage or other means shall be provided to control spills. Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapors at or below 10 percent Lower Explosive Limit (LEL). Mechanical ventilation shall be used if Class I liquids are dispensed within the room. Refer to 29 CFR 1910.106 for additional information.

22.5.6.1. Exhaust air shall be taken from a point near a wall on one side of the room and within one (1) foot of the floor with one or more make-up inlets located on the opposite side of the room within one (1) foot of the floor. The location of both the exhaust and inlet air openings shall be arranged to provide air movement across all portions of the floor to prevent accumulation of flammable vapors. Exhaust from the room shall be directly to the exterior of the building without re-circulation.

22.5.6.2. Mechanical ventilation systems shall provide for a complete change of air within the room at least six (6) times per hour. If a mechanical exhausting system is used, it shall be controlled by a switch located outside the door. The ventilating equipment and any lighting fixtures shall be operated by the same switch. The switch shall be illuminated or an electric warning pilot light shall be adjacent to the switch if flammable liquids are dispensed within the room. The mechanical ventilation system for dispensing areas shall be equipped with an airflow switch or equally reliable method interlocked to sound an audible alarm upon failure of the ventilation system.

22.5.6.3. Ventilation ducts and airflow requirements shall comply with UFC 3-410-04H, *Industrial Ventilation*, and NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*.

22.5.7. Additional Requirements for Inside Rooms. For storage capacity and required fire resistive ratings for inside rooms, refer to [Table 22.2](#) Storage rooms shall not have an opening into any portion of a building used by the public. At least one clear 3-foot wide aisle shall be maintained in all inside storage areas. Containers in excess of 30-gallon capacity shall not be stacked. Dispensing shall be IAW paragraph [22.5.5.2](#) for Class I flammable liquids. All other dispensing shall be by approved pump or self-closing faucet only. Refer to NFPA 30 for additional information.

22.5.7.1. At least one portable fire extinguisher having a rating of at least 40-B shall be located outside of, and within 10 feet of, the door opening into an inside liquid storage area.

22.5.7.2. At least one portable fire extinguisher rated at least 40-BC shall be located within 30 feet of any Class I or Class II liquid storage area outside of a storage room but inside a building.

22.5.7.3. Installed fire suppression systems shall be approved IAW UFC 3-600-01, *Fire Protection Engineering for Facilities*. Additionally, consult the installation FES Flight for further guidance.

22.5.8. Storage Inside Buildings. When storage of flammable or combustible liquids is required and the storage is incidental and not the primary purpose of the area, storage shall comply with NFPA 30 (Refer to 29 CFR 1910.106. for additional information):

22.5.8.1. Storage shall not physically obstruct a means of egress from the building or area and not be placed in such a manner that a fire would prevent safe egress from the area.

22.5.8.2. Containers shall remain tightly sealed except when transferred, poured or applied. Workers shall remove from the storage container only that portion required to accomplish a particular job.

22.5.8.3. Leaking containers shall be removed to a safe location outside the building, and the contents transferred to an undamaged container IAW guidance from the installation FES Flight and Environmental Management office.

22.5.8.4. If a flammable and combustible liquids storage building is used, it shall be one-story and devoted principally to handling and storing of flammable or combustible liquids. The building shall have a 2-hour fire-rated exterior wall with no openings within 10 feet of stored material.

22.5.8.5. Flammable paints, oils and varnishes in 1 to 5 gallon containers, used for building maintenance purposes, may be stored temporarily in closed metal containers outside approved storage cabinets or rooms if kept at the job site for less than 10 calendar days.

22.5.8.6. At least one portable fire extinguisher with a rating of at least 12-B shall be located outside of, but not more than 10 feet from, the door opening into any room used for storage of flammable or combustible liquids.

22.5.8.7. Water reactive materials shall not be stored in the same room with flammable or combustible liquids. **Exception:** Small quantities may be stored in laboratories. Refer to paragraph [22.6.1](#) and NFPA 30 for additional guidance.

22.5.8.8. Base supply warehouses, base exchange storage rooms and commissary storage areas shall be IAW [Table 22.3](#) Buildings or portions of such buildings utilized for flammable and/or combustible storage shall be isolated by standard fire walls approved for the type and quantity of liquids being stored. Materials which create no fire hazard may be stored in the same area.

22.5.8.9. When flammable or combustible liquid warehouse or storage is within 50 feet of a building or adjoining property line that may be built upon, the wall facing the building or property lines shall be a blank wall having a fire-resistance rating of at least 2 hours.

22.5.8.10. The total quantity of liquids within a building is not restricted, but arrangement of storage shall comply with [Table 22.3](#) and [Table 22.4](#)

22.5.8.11. Stacked containers of flammable liquids shall be separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls. Refer to paragraph [22.5.7](#) for guidance on stacking containers.

22.5.8.12. Portable tanks stored over one tier high shall be designed to nest securely, without dunnage. Adequate materials handling equipment shall be available to handle tanks safely at the upper tier level.

22.5.8.13. No stack shall be closer than three (3) feet to the nearest beam, chord, girder or other construction member and shall be at least three (3) feet below sprinkler deflector or discharge orifice of water spray or other installed fire protection systems.

22.5.8.14. Aisles at least three (3) feet wide shall be provided for clear access to all doors, windows or fire department standpipe connections.

22.5.8.15. All containers shall be clearly labeled to identify contents and indicate hazards.

22.5.9. Outside Storage. **Table 22.5** and **Table 22.6** provide maximum quantities and separation criteria for outside storage of flammable and combustible liquids. Refer to 29 CFR 1910.106. for additional information.

22.5.9.1. Maximum storage of 1,100 total gallons may be located adjacent to other buildings provided: (Reference NFPA 30.)

22.5.9.1.1. A minimum distance of 10 feet is maintained between buildings and nearest container.

22.5.9.1.2. The storage area is graded IAW paragraph **22.5.9.3**.

22.5.9.1.3. The storage area is protected against tampering or unauthorized entry where necessary and kept free of weeds, debris and other combustible material not necessary to the storage.

22.5.9.2. Where the quantity stored exceeds 1,100 gallons, refer to **Table 22.6** for quantities and separation distances.

22.5.9.3. The storage area shall be graded to divert possible spills away from buildings or other facilities or shall be surrounded by a curb at least six (6) inches high. When curbs are used, provisions shall be made for draining accumulations of ground or rainwater or spills of flammable or combustible liquids. Drains shall terminate at a safe location and shall be accessible and operate under fire conditions.

22.5.9.4. At least one portable fire extinguisher rated at least 20-B shall be located between 10 feet and 25 feet travel distance from any Class I or Class II liquid storage area outside of a storage room.

22.5.9.5. Installed fire suppression systems shall be approved IAW UFC 3-600-01. Contact the installation FES Flight for further guidance.

22.5.9.6. Containers and portable tanks used for Class I liquids shall be electrically grounded and bonded during liquid transfer. Positive measures shall be taken to eliminate any source of ignition: open flames, electrical, smoking, cutting and welding, hot surfaces, static, mechanical sparks, radiant heat or spontaneous ignition sources.

22.5.9.7. All containers having flammable or combustible materials shall be protected from heat sources to prevent the contents expanding and pressurizing the container, which could rupture the container. Open flame or smoking shall not be permitted within 50 feet of flammable or combustible liquid storage areas.

22.5.9.8. Welding, cutting or brazing shall be accomplished IAW **Chapter 27**, *Welding, Cutting and Brazing*. Refer to **Chapter 27** and 29 CFR 1910.252, *Welding, Cutting and Brazing*, for additional guidance.

22.5.10. Handling Flammable and Combustible Liquids. Flammable and combustible liquids shall be drawn from or transferred into vessels, containers or portable tanks within a building only through a closed piping system, from safety cans, by means of a device through the top, or from a container or portable tanks by gravity through an approved self-closing valve. Transferring by means of air pressure on the container or portable tanks is prohibited. Refer to 29 CFR 1910.106. for additional information.

22.5.10.1. Only approved safety containers shall be used for transporting and dispensing flammable liquids in quantities of five (5) gallons or less.

22.5.10.2. Flammable liquids shall be kept in covered containers when not actually in use.

22.5.10.3. Means shall be provided to clean up and remove spills. Refer to appropriate Material Safety Data Sheet (MSDS) for spill clean-up procedures and PPE required.

22.5.10.4. Class I liquids shall be used only where there are no open flames or other sources of ignition within the area or possible path of vapor travel.

22.5.10.5. Safety cans or other portable containers of flammable liquids having a flashpoint at or below 80° F shall be red in color with additional clearly visible identification in the form of a yellow band around the container and the contents conspicuously stenciled or painted in black. If the contents are stenciled or painted in yellow, then the yellow band is not required to be around the container. **Exception:** Shipping containers. Refer to NFPA 30 for additional guidance.

22.5.11. Incidental Storage of Flammable Liquids in Industrial Areas. Incidental storage shall be authorized only after the following requirements are met: (Reference NFPA 30.)

22.5.11.1. Incidental storage shall be in industrial areas only.

22.5.11.2. Storage shall be in metal cabinets stenciled, “FLAMMABLE—KEEP FIRE AWAY” (metal wall lockers meet this requirement).

22.5.11.3. Storage shall be limited to 1 gallon (4 liters) of Class I or 10 gallons (40 Liters) of Class II and Class III liquids, not to exceed 10 gallons (40 liters) total per cabinet, in closed containers. Storage shall be limited to a 5-day supply of flammables in a metal cabinet, and in closed containers not to exceed limits specified in paragraphs **22.5.7** and **22.5.9**. Each work center shall be limited to one cabinet.

22.5.11.4. The installation FES Flight shall be consulted prior to establishing incidental storage areas in industrial shops.

## 22.6. Specific Applications.

22.6.1. Laboratories.

22.6.1.1. General. Many laboratory operations require special control flammable and combustible liquids to protect personnel and equipment. Two types of laboratories are

covered by this section: general laboratories and health-related laboratories. Refer to NFPA 30 for additional guidance.

22.6.1.2. A list of working supplies and operating instructions on handling flammable and combustible liquids shall be published. The aggregate total outside of storage cabinets in any laboratory shall not exceed 10 gallons. All quantities of flammable and combustible liquids in one laboratory in excess of 10 gallons shall be stored in an approved storage cabinet or in an approved storage room. Flammable or combustible liquids shall not be stored or transferred from one vessel to another in any exit way, corridor or passageway leading to an exit. A minimum of one approved storage room shall be available within any building housing a laboratory which regularly maintains a reserve storage capacity in excess of 300 gallons. Refer to NFPA 45, *Standard for Fire Protection for Laboratories Using Chemicals*, for additional guidance.

22.6.1.3. Flammable or combustible liquids shall not be brought into a laboratory, receiving area, storage area or storage facility unless design, construction and fire protection requirements are suitable for the hazard and quantity involved. Container types and maximum capacities shall comply with [Table 22.7](#) or [Table 22.8](#), as appropriate. Plastic containers, if used to avoid breakage problems posed by glass containers or contamination problems with metal containers, must be approved for the liquid used. Containers used to draw from an original container must be marked to identify their contents. Refrigerators or cooling equipment used to store or cool flammable liquids shall be approved for the material being stored or cooled and labeled or stenciled, "Approved for Flammable Liquid Storage." See NFPA 45, Appendix A, for additional details on explosion proof, laboratory-safe, modified domestic or unmodified domestic refrigerators to achieve needed degree of protection and meet labeling requirements.

22.6.1.4. Flammable and combustible liquids shall not be positioned near Bunsen burners, hot surfaces, steam pipes, valves or other sources of heat.

22.6.1.5. Refer to AFOSH Standard 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories*, for additional information regarding flammable, combustible and hazardous materials handling in laboratories.

22.6.2. Fire Protection. All laboratories shall have fire protection appropriate for their fire hazard classification. Fire protection shall include, as a minimum, portable fire extinguishers, an alarm system and an evacuation and emergency plan. For additional details regarding required fire protection requirements, refer to NFPA 45.

22.6.3. Disposal. Hazardous materials shall normally be removed and disposed of by a commercial disposal specialist who must comply with published environmental regulations. Contact the installation environmental management office for assistance. Also refer to AFI 32-7042, *Waste Management*, for additional information.

**22.7. Military Exchanges, Commissaries and Associate Retail Stores.** In rooms or areas accessible to the public, storage of flammable and combustible liquids shall be limited to quantities needed for display and normal merchandising purposes, not to exceed two (2) gallons per square foot of gross floor area. The gross floor area used for computing the maximum



quantity permitted is that portion of the store actually being used for merchandising flammable and combustible liquids. Refer to NFPA 30 for additional guidance.

22.7.1. Storage of Class IA liquids shall be prohibited in basement display areas and limited to one (1) gallon per square foot on any other floor. In areas not protected, storage of Class IB, IC and II liquids on other than the ground floor shall be limited to one (1) gallon per square foot of gross floor area. Protected shall mean protected with automatic sprinklers installed IAW NFPA 13, *Standard for the Installation of Sprinkler Systems*.

22.7.2. On floors above ground level, storage or display of Class I and Class II liquids shall be limited to 60 gallons in unprotected occupancies and 120 gallons in protected occupancies.

22.7.3. Containers in a display area shall not be stacked more than three (3) feet or two (2) containers high, whichever is greater.

22.7.4. Shelving shall be capable of supporting the load and containers on shelves must be arranged so they are not easily knocked off the shelves to the floor.

22.7.5. Leaking containers shall be removed to a safe location outside the building, the contents transferred to an undamaged container, appropriately labeled, and the leaking container disposed in a safe manner.

22.7.6. Storage shall be IAW **Table 22.3** Buildings or portions of such buildings utilized for flammable and/or combustible storage shall be isolated by standard fire walls approved for the type and quantity of liquids being stored. Materials which create no fire hazard to the liquids may be stored in the same area.

22.7.7. If the storage building is located 50 feet or less from a building or adjacent property line that may be built upon, the wall facing the building or property lines shall be a blank wall having a fire-resistance of at least two 2 hours. Refer to 29 CFR 1910.106. for additional information.

22.7.8. The total quantity of liquids within the building is not restricted, but the arrangement of storage shall comply with **Table 22.3**

22.7.9. Stacked containers of flammable liquids shall be separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls.

22.7.10. No stack shall be closer than three (3) feet to the nearest beam, chord, girder or other construction object, and shall be at least three (3) feet below sprinkler deflectors or discharge orifices of water spray or other installed fire protection systems.

22.7.11. Aisles at least three (3) feet wide shall be provided for clear access to doors, windows or fire department connections.

22.7.12. Containers shall bear clearly legible labels to identify contents and indicate hazards.

**22.8. Small Gasoline Engine Powered Equipment.** This section applies to lawnmowers, snow blowers, generators, outboard marine motors, portable water pumps, small watercraft, powered gardening tools and other implements powered by gasoline engines, typically 5-horsepower or less. Refer to the latest edition of the National Safety Council (NSC), Accident Prevention Manual and NFPA 30 for additional guidance.

22.8.1. Fueling operations shall be conducted in outside areas free from ignition sources. Fuel tanks shall not be filled or drained inside buildings or other facilities where fuel vapors or other explosive gases can accumulate.

22.8.2. Operators shall not refuel a running engine or one that is hot from recent use. They shall allow a minimum of five (5) minutes cooling time before starting refueling operations.

22.8.3. Fueling and/or refueling operations shall be accomplished using a safety can with pouring spout or an appropriate sized funnel. Care shall be taken not to spill fuel onto hot surfaces. Spilled fuel shall be cleaned up before attempts are made to start equipment.

22.8.4. Equipment shall be serviced after use and prior to extended off-season storage:

22.8.4.1. Equipment shall be stored IAW manufacturer's instructions.

22.8.4.2. The operator shall ensure equipment is thoroughly cleaned, functioning properly and the fuel tank is drained.

22.8.4.3. Storage facilities shall be protected against tampering or unauthorized entry and area around the facility shall be kept free of weeds, debris and other combustibles.

22.8.4.4. Workplace storage facilities shall be inspected monthly by supervisor and/or building custodian. The supervisor and/or building custodian shall document each inspection.

22.8.5. Gasoline powered equipment shall not be stored in military family housing living areas, including basements, unless the storage room or area has walls and is separated from the living area by an un-pierced 1-hour rated fire-resistant partition and ceiling. All storage areas must be inspected (one-time inspection) and approved by the installation FES Flight. Subsequent inspections shall be accomplished IAW manufacturer's inspection and on a as required basis as determined by the installation FES Flight.

22.8.6. Custodians of dormitories, multiple living quarters, assembly, institutional, military exchange, commissary and warehouse facilities shall store small gasoline powered equipment in an enclosed 1-hour fire-rated storage room. Boiler rooms and other utility rooms shall not be utilized as storage areas.

22.8.7. Cleaned and drained small gasoline powered equipment may be stored during the off-season in inspection and testing facilities, munitions maintenance facilities, fire stations, shops and maintenance facilities. However, this equipment shall not be stored in hangars, nose docks, corrosion control, fuel cell repair or missile assembly and repair facilities. When stored, the equipment shall be isolated from potential ignition sources.

22.8.8. Storage in theaters, conference facilities, open messes, clubs, recreation facilities, dormitories, temporary quarters or multiple unit family housing buildings containing more than three dwelling units, and hotels is limited to 10 gallons or less of Class I and II liquids and 20 gallons or less of Class III liquids stored in an approved storage container or in safety cans. Refer to [Table 22.2](#) for additional guidance on storage in inside rooms.

22.8.9. Storage of Class I, II and III liquids is limited to 10 gallons per resident unit. Included are single residences and those dwellings containing not more than three (3) dwelling units with attached or detached garages.

**Table 22.1. Maximum Allowable Size Containers and Portable Tanks.**

Maximum Allowable Size Containers and Portable Tanks					
Class	Flammable Liquids			Combustible Liquids	
	IA	IB	IC	II	III
<b>Container Type</b>					
Glass or Approved Plastic <sup>1</sup>	1 pt	1 qt	1 gal	1 gal	1 gal
Metal (Other than Department of Transportation [DOT] Drums)	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2 gal	5 gal	5 gal	5 gal	5 gal
Metal Drums (DOT specification)	60 gal	60 gal	60 gal	60 gal	60 gal
Approved portable tanks	660 gal	660 gal	660 gal	660 gal	660 gal
Polyethylene DOT Specification 34 or as Authorized by DOT exception.	1 gal	5 gal	5 gal	60 gal	60 gal

Reference 29 CFR 1910.106, Table H-12.

**Note:** Nearest metric size is also acceptable for glass and plastic containers listed.

**Table 22.2. Storage in Inside Rooms.**

Storage in Inside Rooms			
Fire Protection (Note: 1) Provided	Fire Resistance (Hours)	Maximum Size (Sq. Ft.)	Total Allowable Quantities (Note: 2) (gals/sq. ft. floor area)
Yes	2	500	10
No	2	500	5
Yes	1	150	4
No	1	150	2

Reference 29 CFR 1910.106, Table H-13.

**Note 1:** Fire protection system will be sprinkler, water spray or equivalent.

**Note 2:** If metric containers are being stored, use the nearest metric equivalent.

**Table 22.3. Indoor Container Storage.**

Indoor Container Storage			
		Protected Storage (Sprinkler System) <u>Maximum per Pile</u>	Unprotected Storage <u>Maximum per Pile</u>
Class Liquid	Storage Level	Gallons	Gallons
IA	Ground & Upper Floors 55 Gallon drums Basement	2,750 (50) Not Permitted	660 (12) Not Permitted

<b>Indoor Container Storage</b>			
		<b>Protected Storage (Sprinkler System) Maximum per Pile</b>	<b>Unprotected Storage Maximum per Pile</b>
IB	Ground & Upper Floors 55 Gallon drums Basement	5,500 (100)	1,375 (25)
IC	Ground & Upper Floors 55 Gallon drums Basement	5,500 (100) Not Permitted	1,375 (25) Not Permitted
II	Ground & Upper Floors 55 Gallon drums Basement	16,500 (300) 5,500	4,125 (75) Not Permitted
III	Ground & Upper Floors 55 Gallon drums Basement 55 Gallon drums	55,000 (1000) 8,250 (150)	13,750 (250) Not Permitted

Reference 29 CFR 1910.106, Table H-14.

**Note 1:** When two (2) or more classes of materials are stored in a single pile, the maximum gallonage permitted in that pile will be the smallest of the two (2) or more separate gallonages.

**Note 2:** Aisles in general purpose warehouse storage will be provided so no container is more than 12 feet from an aisle. Main aisles shall be at least three (3) feet wide and side aisles at least four (4) feet wide.

**Note 3:** Each pile shall be separated from each other by at least four (4) feet.

**Note 4:** Refer to paragraph 22.7. for information on the storage of flammable aerosol containers classified as Class I liquids and stored in military exchanges, commissaries or associated retail stores.

**Note 5:** Numbers in parentheses indicate corresponding number of 55-gallon drums.

**Table 22.4. Indoor Portable Tank Storage.**

<b>Indoor Portable Tank Storage</b>			
<b>Class Liquid</b>	<b>Storage Level</b>	<b>Protected Storage (Sprinkler System) Maximum per Pile (Gallons)</b>	<b>Unprotected Storage Maximum per Pile (Gallons)</b>
IA	Ground & Upper Floors Basement	Not Permitted Not Permitted	Not Permitted Not Permitted
IB	Ground & Upper Floors Basement	20,000 Not Permitted	2,000 Not Permitted
IC	Ground & Upper Floors Basement	40,000 Not Permitted	5,500 Not Permitted

<b>Indoor Portable Tank Storage</b>			
<b>Class Liquid</b>	<b>Storage Level</b>	<b>Protected Storage (Sprinkler System) Maximum per Pile (Gallons)</b>	<b>Unprotected Storage Maximum per Pile (Gallons)</b>
II	Ground & Upper Floors	40,000	5,500
	Basement	20,000	Not Permitted
III	Ground & Upper Floors	60,000	22,000
	Basement	20,000	Not Permitted

Reference 29 CFR 1910.106, Table H-15.

**Note 1:** When one or more classes of material are stored in a single pile, the maximum gallonage permitted in the pile will be the smallest of the two (2) or more separate maximum gallonages.

**Note 2:** Aisles will be provided so no portable tank is more than 12 feet from an aisle. Main aisles will be at least eight (8) feet wide and side aisles at least four (4) feet wide.

**Note 3:** Each pile will be separated from each other by at least four (4) feet.

**Table 22.5. Outdoor Container Storage.**

<b>Outdoor Container Storage</b>				
<b>Liquid Classification</b>	<b>Maximum Gallons per pile<sup>1</sup></b>	<b>Distance between piles (ft)<sup>2</sup></b>	<b>Distance to property line that can be built upon (ft)<sup>3 &amp; 4</sup></b>	<b>Distance to street, alley, public way (ft)<sup>4</sup></b>
IA	1,000	5	20	10
IB	2,200	5	20	10
IC	4,400	5	20	10
II	8,800	5	10	5
III	22,000	5	10	5

Reference 29 CFR 1910.106, Table H-16

**Note 1:** When two (2) or more classes of material are stored in a single pile, the maximum gallonage in that pile shall be the smallest of the two (2) or more separate gallonages.

**Note 2:** Within 200 feet of each container, there shall be a 12-foot wide access way to permit approach of fire control apparatus.

**Note 3:** The distance listed applies to properties that have protection for exposures as defined. If there are exposures, and such protection for exposures do not exist, the distance in column 4 (distance to property line that can be built upon) shall be doubled.

**Note 4:** When total quantity stored does not exceed 50 percent of maximum pile, the distance in column 4 (distance to property line that can be built upon) and column 5 (distance to street, alley, public way) may be reduced 50 percent, but will not be reduced to less than 3 feet.

**Table 22.6. Outdoor Portable Tank Storage.**

Outdoor Portable Tank Storage				
Liquid Classification	Maximum Gallons per pile <sup>1</sup>	Distance between piles (ft) <sup>2</sup>	Distance to property line that can be built upon (ft) <sup>3 &amp; 4</sup>	Distance to street, alley, public way (ft) <sup>4</sup>
IA	2,200	5	20	10
IB	4,400	5	20	10
IC	8,800	5	20	10
II	17,600	5	10	5
III	44,000	5	10	5

Reference 29 CFR 1910.106, Table H-17.

**Note 1:** When two (2) or more classes of material are stored in a single pile, the maximum gallonage in that pile shall be the smallest of the two (2) or more separate gallonage.

**Note 2:** Within 200 feet of each portable tank, there shall be a 12-foot wide access way to permit approach of fire control apparatus.

**Note 3:** The distance listed applies to properties that have adequate protection for structures adjacent to the storage tanks. If there are exposures, and such protection does not exist, the distance to the property line that can be built upon shall be doubled.

**Note 4:** When total quantity stored does not exceed 50 percent of the maximum per pile, the distance to property line that can be built upon and distance to street, alley, and public way may be reduced 50 percent, but will not be reduced to less than 3 feet.

**Table 22.7. Maximum Allowable Size of Containers — General Laboratories.**

Maximum Allowable Size of Containers — General Laboratories					
Class of Flammable or Combustible Liquid	IA	IB	IC	II	III
<b>Container Type</b>					
Glass	1 pt <sup>1</sup>	1 qt <sup>1</sup>	1 gal <sup>1</sup>	1 gal <sup>2</sup>	1 gal <sup>2</sup>
Metal (Other than DOT drums) and Approved Plastic Safety Cans	1 gal	5 gal <sup>3</sup>	5 gal <sup>3</sup>	5 gal <sup>3</sup>	5 gal <sup>3</sup>
Safety Cans (metal)	2 gal	5 gal <sup>3</sup>	5 gal <sup>3</sup>	5 gal <sup>3</sup>	5 gal <sup>3</sup>
Metal drums (DOT Spec)	N/A	5 gal <sup>3</sup>	5 gal <sup>3</sup>	60 gal <sup>3</sup>	60 gal <sup>3</sup>

Reference NFPA 45.

**Note 1:** Nearest metric equivalent is acceptable. Sizes as large as one gallon or four (4) liters may be used if the liquid would be adversely affected by storage in metal or if the liquid would cause excessive corrosion of the metal container.

**Note 2:** Nearest metric equivalent.

**Note 3:** In instructional laboratories, containers of Class I or Class II liquids will not exceed one gallon or three (3) liters, except for safety cans where two (2) gallons capacity may be used.

**Table 22.8. Maximum Allowable Size of Containers — Health-Related Laboratories.**

Maximum Allowable Size of Containers — Health-Related Laboratories					
Class of Flammable Or Combustible Liquid	IA	IB	IC	II	III
Glass or approved plastic <sup>1</sup>	1 pt <sup>2</sup>	1 qt <sup>2</sup>	1 gal <sup>2</sup>	1 gal <sup>2</sup>	1 gal <sup>2</sup>
Safety Cans	1 gal	2 gal	2 gal	2 gal	2 gal

Reference NFPA 45.

**Note 1:** Gravity feed containers not permitted.

**Note 2:** Nearest metric equivalent is acceptable.

**Table 22.9. Maximum Allowable Quantities per Control Area.**

Maximum Allowable Quantities per Control Area				
MAQ of Flammable and Combustible Liquids per Control Area				
		Quantity		
	Liquid Class(es)	gal	L	Notes
Flammable liquids	IA	30	115	1, 2
	IB and IC	120	460	1, 2
	IA, IB, IC combined	120	460	1, 2, 3
Combustible liquids	II	120	460	1, 2
	IIIA	330	1,265	1, 2
	IIIB	13,200	50,600	1, 4

Reference: Table 34.1.3.1 of NFPA 5000, 2006 edition.

**Note 1:** Quantities are permitted to be increased 100 percent where stored in approved flammable liquids storage cabinets or in safety cans in accordance with the fire code.

Where Note 2 also applies, the increase for both notes is permitted to be applied accumulatively.

**Note 2:** Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Where Note 1 also applies, the increase for both notes is permitted to be applied accumulatively.

**Note 3:** Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC flammable liquids, individually.

**Note 4:** Quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*

**Table 22.10. Classifications of Flammable and Combustible Liquids.**

<b>Classifications of Flammable and Combustible Liquids</b>		
<b>Designation</b>	<b>Class</b>	<b>Subclass Definition</b>
<b>Flammable</b>	Class I	Any liquid with flashpoint below 100°F; 37.7°C.
	Class IA	Includes liquids having flashpoints below 73°F; 22.7°C and having a boiling point below 100°F; 37.7°C
	Class IB	Includes liquids having flashpoints below 73°F; 22.7°C and having a boiling point at or above 100°F; 37.7°C.
	Class IC	Includes liquids having flashpoints at or above 73°F; 22.7°C and below 100°F; 37.7°C.
<b>Combustible</b>	Class II	Includes those liquids with flashpoints at or above 100°F; 37.7°C and below 140°F; 60°C.
	Class III	Includes those liquids with flashpoints at or above 140°F; 60°C.
	Class IIIA	Includes those liquids with flashpoints at or above 140°F; 60°C and below 200°F; 93.3°C.
	Class IIIB	Includes those with flashpoints at or above 200°F; 93.3°C.

**22.9. Flammable and Combustible Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

22.9.1. Have all personnel been provided appropriate PPE and been trained on its use, care, maintenance and reporting procedures on unserviceable PPE? Reference [22.3.3](#)

22.9.2. Have all personnel handling, storing or using flammable or combustible liquids received the appropriate levels of training commensurate with the degree of hazard? Reference [22.4.1.2](#)



- 22.9.3. Have pre-fire plans been developed for the flammable and combustible liquids area? Reference [22.5.1](#)
- 22.9.4. Have appropriate containers and portable tanks been procured to meet handling, storage and dispensing requirements? Reference [22.5.2](#)
- 22.9.5. Is the capacity of flammable or combustible liquid containers IAW [Table 22.1](#)? Reference [22.5.2.1](#)
- 22.9.6. Are flammable and combustible liquids prohibited from office occupancies except those required for maintenance and operation of building and operating equipment? Reference [22.5.2.3](#)
- 22.9.7. Are no more than 120 gallons of Class I, Class II and Class IIIA liquids stored in a storage cabinet? Reference [22.5.3](#)
- 22.9.8. Are cabinets conspicuously labeled “Flammable — Keep Fire Away”? Reference [22.5.3.2](#)
- 22.9.9. Does electrical wiring and equipment located within flammable or combustible storage rooms meet the requirements of NFPA 70 for hazardous location as determined by the class of materials stored? Reference [22.5.5](#)
- 22.9.10. Are containers used for dispensing or transferring of liquids electrically interconnected (bonded) to prevent static discharges? Reference [22.5.5.2](#)
- 22.9.11. Is every inside storage room provided with a gravity or mechanical exhaust ventilation system? Reference [22.5.6](#)
- 22.9.12. Is drainage provided in locations where dispensing or transfers are accomplished? Reference [22.5.6](#)
- 22.9.13. Does exhaust air from the room go directly to the exterior of the building? Reference [22.5.6.1](#)
- 22.9.14. Are storage and fire resistive ratings in compliance with [Table 22.2](#)? Reference [22.5.7](#)
- 22.9.15. Are 3-foot aisles maintained in all inside storage areas? Reference [22.5.7](#)
- 22.9.16. Are containers over 30-gallon capacity not stacked one upon the other? Reference [22.5.7](#)
- 22.9.17. Is there at least one 40-B portable fire extinguisher located outside of and within 10 feet of the door opening into an inside liquid storage area? Reference [22.5.7.1](#)
- 22.9.18. Is there at least one portable fire extinguisher rated at least 40-BC located within 30 feet of any Class I or Class II liquid storage area outside of a storage room but inside a building? Reference [22.5.7.2](#)
- 22.9.19. Does the inside storage of any flammable or combustible liquids not physically obstruct a means of egress from the building or area? Reference [22.5.8.1](#)
- 22.9.20. Are leaking containers removed to a safe location outside the building and the contents transferred to an undamaged container? Reference [22.5.8.3](#)

22.9.21. Are flammable paints, oils and varnishes in 1 to 5 gallon containers, used for building maintenance purposes, only stored temporarily in closed containers outside approved storage cabinets or rooms if kept at the job site for less than 10 calendar days? Reference [22.5.8.5](#)

22.9.22. Are water reactive materials not stored in the same room with flammable and combustible liquids? Reference [22.5.8.7](#)

22.9.23. Do base supply warehouses, base exchange storage rooms and commissary storage areas comply with [Table 22.3](#)? Reference [22.5.8.8](#)

22.9.24. Are buildings or portions of buildings used for the storage of flammables or combustibles isolated by standard fire walls approved for the type and quantity of liquids being stored? Reference [22.5.8.8](#)

22.9.25. Does the arrangement of liquid storage within a building comply with [Table 22.3](#) and [Table 22.4](#)? Reference [22.5.8.10](#)

22.9.26. Are stacked containers of flammable liquids separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls? Reference [22.5.8.11](#)

22.9.27. Are portable tanks which are stored over one tier high designed to nest securely without dunnage? Reference [22.5.8.12](#)

22.9.28. Is adequate material handling equipment available to handle tanks safely at upper tier levels? Reference [22.5.8.12](#)

22.9.29. Is no stack closer than three (3) feet to the nearest beam, chord, girder or other obstruction and at least three (3) feet below sprinkler deflector or discharge orifices of water spray or other installed fire protection system? Reference [22.5.8.13](#)

22.9.30. Do containers bear clearly legible labels to identify contents and indicate hazards? Reference [22.5.8.15](#)

22.9.31. When curbs are used, are provisions made for draining accumulations of ground or rain water or spills of flammable or combustible liquids? Reference [22.5.9.3](#)

22.9.32. Do drains terminate at a safe location and are they directly accessible to the fire operations? Reference [22.5.9.3](#)

22.9.33. Is at least one portable fire extinguisher rated not less than 20-B located between 10 feet and 25 feet travel distance of any Class I or Class II liquid storage area outside of a storage room? Reference [22.5.9.4](#)

22.9.34. Are containers and portable tanks used for Class I liquids grounded and bonded during liquid transfer? Reference [22.5.9.6](#)

22.9.35. Are containers having flammable or combustible liquids protected from heat sources? Reference [22.5.9.7](#)

22.9.36. Are open flame devices and smoking prohibited within 50 feet of the flammable or combustible storage area? Reference [22.5.9.7](#)

- 22.9.37. Are approved safety cans used for transporting and dispensing flammable liquids in quantities of five (5) gallons or less? Reference [22.5.10.1](#)
- 22.9.38. Are flammable liquids kept in covered containers when not actually in use? Reference [22.5.10.2](#)
- 22.9.39. Are plans made and means available to promptly clean up or remove spills? Reference [22.5.10.3](#)
- 22.9.40. Are Class I liquids used only where there are no open flames or other sources of ignition within the area or possible path of vapor travel? Reference [22.5.10.4](#)
- 22.9.41. Has a list of working supplies and operating instructions on handling of flammable and combustible liquids been developed? Reference [22.6.1.2](#)
- 22.9.42. If the total quantity of flammable or combustible liquids exceeds 10 gallons, are they stored in an approved storage cabinet or storage room? Reference [22.6.1.2](#)
- 22.9.43. Are flammable or combustible liquids prohibited from being stored or transferred from one vessel to another in any exit way, corridor or passageway leading to an exit? Reference [22.6.1.2](#)
- 22.9.44. Are flammable and combustible liquids prohibited from receiving areas, storage areas or storage facilities unless adequately approved design, construction and fire protection requirements are suitable for the hazard and quantity involved? Reference [22.6.1.3](#)
- 22.9.45. Are containers used to draw from an original container marked to identify their contents? Reference [22.6.1.3](#)
- 22.9.46. Are refrigerators or cooling equipment labeled or stenciled “Approved for Flammable Liquid Storage”? Reference [22.6.1.3](#)
- 22.9.47. Are flammables and combustibles kept away from open flames, hot surfaces, steam pipes or other heat sources? Reference [22.6.1.4](#)
- 22.9.48. Do laboratories have fire protection appropriate for their fire hazard classification? Reference [22.6.2](#)
- 22.9.49. In rooms or other areas accessible to the public, is storage limited to quantities needed for display and normal merchandising purposes not to exceed two (2) gallons per square foot of gross floor area? Reference [22.7](#)
- 22.9.50. Are Class IA flammables prohibited in basement areas and limited to one (1) gallon per square foot on any other floor? Reference [22.7.1](#)
- 22.9.51. Are Class IB, IC and II liquids in areas, other than the ground floor, not protected limited to one (1) gallon per square foot of gross floor area? Reference [22.7.1](#)
- 22.9.52. On floors above ground level, is storage or display of Class I and Class II liquids limited to 60 gallons in unprotected occupancies and 120 gallons in protected occupancies? Reference [22.7.2](#)
- 22.9.53. Are containers in a display not stacked more than three (3) feet or two (2) containers high, whichever is greater? Reference [22.7.3](#)

- 22.9.54. Are leaking containers removed to a safe location and the contents transferred to an undamaged container, appropriately labeled, and the leaking container disposed of in a safe manner? Reference [22.7.5](#)
- 22.9.55. Are stacked containers separated by pallets or dunnage where necessary, to provide stability and to prevent excessive stress on the containers' walls? Reference [22.7.9](#)
- 22.9.56. Are stacks no closer than three (3) feet from the nearest beam, chord, girder or other construction object, and no closer than three (3) feet below sprinkler deflector or discharge orifices of water spray or other installed fire protection system? Reference [22.7.10](#)
- 22.9.57. Are aisles at least three (3) feet wide provided for clear access to doors, windows or fire department connections? Reference [22.7.11](#)
- 22.9.58. Do all containers bear clearly legible labels to identify contents and indicate hazards? Reference [22.7.12](#)
- 22.9.59. Are fueling operations conducted in outside areas free from ignition sources? Reference [22.8.1](#)
- 22.9.60. Are fuel tanks not filled or drained inside buildings or other facilities where vapors can accumulate? Reference [22.8.1](#)
- 22.9.61. Are refueling operations conducted after engines have had a minimum of five (5) minutes of cooling time? Reference [22.8.2](#)
- 22.9.62. Are refueling operations accomplished using a safety can with pouring spout or funnel? Reference [22.8.3](#)
- 22.9.63. Are fuel spills appropriately cleaned up before attempting to start any engine? Reference [22.8.3](#)
- 22.9.64. Are storage facilities protected against tampering or unauthorized entry and the area around the facility free of weeds, debris and other combustibles? Reference [22.8.4.3](#)
- 22.9.65. Are all storage areas or facilities inspected frequently and documented by the supervisor and/or building custodian? Reference [22.8.4.4](#)
- 22.9.66. Are storage areas in military family housing inspected and approved by the installation FES Flight prior to use? Reference [22.8.5](#)
- 22.9.67. Are boiler rooms, equipment rooms and other utility rooms not utilized as storage areas for gasoline powered equipment? Reference [22.8.6](#)
- 22.9.68. Are there restrictions on storing small gasoline powered equipment in hangars, nose docks, corrosion control, fuel cell repair, or missile assembly and repair facilities? Reference [22.8.7](#)
- 22.9.69. When stored, is gasoline powered equipment isolated from potential ignition sources? Reference [22.8.7](#)
- 22.9.70. Is storage of Class I, II and III liquids limited to 10 gallons per resident unit in single residences and those dwellings containing not more than three (3) dwelling units with garages? Reference [22.8.9](#)

## Chapter 23

### CONFINED SPACES

#### 23.1. General Information.

23.1.1. Hazards. Personnel entering or working in confined spaces may encounter a number of potentially serious hazards. These may include atmospheric hazards such as insufficient oxygen to support life, excessive oxygen levels that increase the danger of fire or explosion, flammable or explosive atmospheres and materials, or toxic gases or materials. In addition, the confined work space may include electrical or mechanical hazards that must be locked out, or engulfment or entrapment hazards. Many of these hazards are not readily apparent, detectable by odor or visible, which may result in workers entering confined spaces without consideration of potential dangers. Workers must consider that all confined spaces contain unfavorable and unsafe conditions. They shall not enter or work in these spaces until tests, evaluation and prescribed requirements of this standard and any locally-developed procedures are performed to ensure safe conditions exist prior to entry and are maintained during the entire work period.

23.1.2. Human Factors. Refer to **Chapter 2, Human Factors**, for guidance and information on human factors.

#### 23.2. Responsibilities.

23.2.1. Major Commands (MAJCOM), Direct Reporting Units (DRU) and Field Operating Agencies (FOA) will:

23.2.1.1. Ensure the Environmental, Safety and Occupational Health Council (ESOHC) provides program oversight through a variety of means that may include Environmental, Safety, and Occupational Health Compliance Assessment Programs (ESOH-CAMPs), inspections, evaluations and Staff Assistance Visits (SAV), to include assistance with resolution of identified deficiencies.

23.2.1.2. Ensure subordinate units' confined space programs are reviewed as part of internal/external ESOHCAMPs, during Program Evaluations, ESOH visits, a separate review by the ESOHC or SAV. The review shall include the number and type of confined spaces, the installation's major issues/challenges and the number of entry permits and Master Entry Plans (MEPs) approved. Results of this review will be to determine both positive and negative trends in the confined space program.

23.2.1.3. Standardize MEP documentation to fit command needs as required.

23.2.2. Installation Ground Safety (SEG). The Chief of Ground Safety/Ground Safety Manager will:

23.2.2.1. Serve as the focal point for implementation of this standard.

23.2.2.2. Coordinate the installation confined space program.

23.2.2.3. Lead the installation Confined Space Program Team (CSPT).

23.2.2.4. Ensure any ground safety representative on the CSPT is trained in confined space program requirements. This training shall include a formal confined space course

and a hands-on portion. Formal training may be accomplished via computer-based training (CBT), available through the AFCESA Virtual Learning Center (VLC) under the ADLS Gateway, the OSHA Course 226, *Permit-Required Confined Space Entry*, or other MAJCOM-approved CBTs. Hands-on training will cover the requirements of this guidance and specific local issues and conditions. Training shall be documented in the individual's OJT records. The AFCESA VLC CBT, *Confined Space General Worker: Entrant, Attendant, and Supervisors Course*, has been developed to ensure all personnel involved in confined space operations are trained on confined space program requirements. Each MAJCOM may develop and present training in methods (power point presentations, training plans, etc.) other than CBT.

23.2.2.5. Maintain confined space records provided by the organization, whether located on or off the installation, i.e., geographically separated units. Records will include a listing of all permit-required and non-permit confined spaces. Listing, at a minimum, shall include unit and location of the confined space. A map of the confined spaces may be included, but is not mandatory.

23.2.2.5.1. Verify all possible means have been employed in an effort to reduce the hazard classification of the space.

23.2.2.5.2. Verify organizational entry supervisors are trained, qualified and experienced to authorize permit-required confined space entries.

23.2.2.5.3. Verify organizational procedures and confirm appropriate rescue teams and equipment are immediately available prior to planned entry.

23.2.2.6. Evaluate the effectiveness of unit procedures implemented to protect the entrants.

23.2.2.7. In conjunction with BE, assist entry supervisors and functional managers in the selection of personal protective equipment (PPE).

23.2.2.8. Assist, as required, training entry supervisors who issue entry permits and authorize entries into permit-required confined spaces.

23.2.2.9. When required, assist the functional manager in obtaining training for confined space entry team members.

23.2.2.10. Upon request, train organizational confined space entry team members on the requirements contained in this standard.

23.2.2.11. Review and recommend approval of non-routine entry permits which are not contained in an organization MEP to the CSPT.

23.2.3. Installation Fire Chief will:

23.2.3.1. Ensure the Fire Emergency Services (FES) Flight representative(s) on the CSPT is (are) trained in confined space requirements. Each individual shall have attended a formal confined space course.

23.2.3.2. When requested, assist the functional manager in obtaining training for entrants, entry supervisors and organizational rescue teams.

23.2.3.3. Assist in identification and selection of required equipment, to include PPE and full-face piece demand self-contained breathing apparatus (SCBA) certified by NIOSH for a minimum service life of 30 minutes or a combination full-face piece pressure supplied-air respirator (SAR) with auxiliary self-contained air supply, for organizational rescue teams.

23.2.3.4. Review and approve non-routine entry permits that are not contained in an organization MEP.

23.2.3.5. Evaluate confined spaces for oxygen-enriched atmosphere, flammability and toxicity when permitting entries that are covered by an MEP.

23.2.3.6. Be a CSPT member.

23.2.4. Installation Bioenvironmental Engineering (BE) will:

23.2.4.1. IAW AFOSH Standard 48-137, *Respiratory Protection Program*, is the OPR for the installation respiratory program and is the sole authority for selecting appropriate respiratory equipment and enrolling all personnel who may enter confined spaces into the installation respiratory protection program.

23.2.4.2. Ensure at least one BE representative on the CSPT is trained in confined space requirements. Each individual shall have attended a formal confined space course. Additionally, if required, BE shall request Defense Health Program (DHP) funds to maintain a fully trained individual on the CSPT.

23.2.4.3. Provide local training on the use, calibration (user) and care of atmosphere testing and monitoring equipment annually. Certify organizational personnel, as required, to test confined spaces. If unable to support this requirement, BE should assist in identifying a training resource. In isolated cases where organizational personnel are not available, provide appropriate atmospheric testing and monitoring for permit-required confined spaces operations. **Note:** BE shall not test or monitor a confined space for a contracted confined space operation. The contractor is required to conduct its own exposure monitoring during permit-required confined space operations.

23.2.4.4. Review and approve non-routine entry permits which are not contained in an organization MEP.

23.2.4.5. Assist in training personnel for confined space duties.

23.2.4.6. Evaluate potential worker exposure related to confined spaces IAW AFMAN 48-153, *Health Risk Assessment*.

23.2.4.7. Assist functional managers and entry supervisors in the selection of proper PPE.

23.2.4.8. Assist entry supervisors in the interpretation of monitoring results.

23.2.4.9. If certified organizational personnel are not available:

23.2.4.9.1. Evaluate confined spaces for hazardous atmospheres and Immediately Dangerous to Life and Health (IDLH) conditions as necessary to meet mission requirements.

23.2.4.9.2. Sample the atmosphere in the confined space as often as required to ensure changing conditions do not result in hazardous atmospheres.

23.2.4.10. Be a member of the CSPT.

23.2.5. Confined Space Program Team (CSPT). The primary purpose of the CSPT is to assist commanders and functional managers in developing and administering confined space programs. CSPT membership includes representatives from installation Ground Safety office, BE, FES Flight and the functional manager, commander or their designated representative. The CSPT will:

23.2.5.1. With the participation of the functional managers and commanders, assist in the identification, evaluation and classification of all confined spaces.

23.2.5.2. Develop and provide a CSPT train-the-trainer program for entry supervisors and personnel who perform confined space operations. If limited resources prohibit the CSPT from providing this program, the CSPT shall identify acceptable external training sources.

23.2.5.3. Assist in developing local controls and procedures for confined space entries.

23.2.5.4. Assist with developing a MEP when requested by the functional manager or commander. The MEP, a part of the overall written confined space program, will serve as approval for recurring entries having the same conditions and entry requirements when signed by representatives of installation Ground Safety office, FES Flight and BE. The MEP allows functional managers and commanders to designate entry supervisors to issue entry permits. Permits shall not be issued when unexpected conditions exist that have not been anticipated or allowed for in the MEP, unless the condition can be eliminated or controlled. If hazardous conditions develop after entry that cannot be eliminated or controlled, the entry shall be terminated, the permit revoked and retained for one year, and Ground Safety office, FES Flight and BE shall be contacted before proceeding. The MEP will:

23.2.5.4.1. Describe the acceptable entry conditions, including atmospheric conditions, under which permits may be issued.

23.2.5.4.2. Designate as many entry supervisors as needed for the organization.

23.2.5.4.3. Identify types and locations of spaces to be entered and types of tasks or operations to be performed.

23.2.5.4.4. List either by reference or direct statement in the MEP the procedures to be used for entry, e.g., shop OI that cover specific tasks.

23.2.5.4.5. Account for around-the-clock operations, when appropriate.

23.2.5.4.6. List PPE, monitoring and rescue equipment, and conditions under which it shall be used.

23.2.5.4.7. Designate frequency and type of atmospheric monitoring.

23.2.5.4.8. List other controls required, e.g., lockout and/or tagout, ventilation.



- 23.2.5.4.9. List chemicals and quantities authorized for use. List expected exposure levels based on air sampling results. Based on exposure levels, perform reassessments of the confined spaces IAW requirements in paragraph 23.2.5.4.7.
- 23.2.5.4.10. List conditions under which the space may be reclassified as described in paragraph 23.5.4.11.
- 23.2.5.4.11. Provide procedures for amending the MEP.
- 23.2.5.4.12. Require verification of the condition of all monitoring equipment and PPE.
- 23.2.5.4.13. Be maintained by the entry supervisor at the worksite.
- 23.2.5.4.14. Include provisions for entry during potential emergency situations.
- 23.2.5.4.15. Establish emergency rescue procedures for each permit-required confined space. Include provisions for entry during potential emergency situations to include IDLH conditions. Refer to paragraph 23.6 for additional guidance.
- 23.2.5.4.16. Establish communication procedures and identify communication equipment to be used during entries.
- 23.2.5.4.17. Require the ready availability of rescue, atmospheric testing and safety-related equipment such as lifting or retrieval devices, respiratory equipment and other equipment, as necessary, for the entry as determined by the permit system.
- 23.2.5.4.18. Require adequate attachment points outside the confined space for tying-off or otherwise securing retrieval lines for all authorized entrants.
- 23.2.5.4.19. Require an equivalent method for rescue when retrieval lines themselves may constitute an entanglement hazard or otherwise cannot be used.
- 23.2.5.4.20. Require availability of a rescue team. If the installation FES Flight is not available, verify availability of an organizational rescue team or other emergency rescue team. The operation shall be halted if the primary rescue team becomes unavailable until the primary team returns or a secondary trained and qualified team is available.
- 23.2.5.4.21. Require a reliable method, i.e., telephone, radio, etc., for summoning the rescue team and ensure it is operable, on hand or easily accessible.
- 23.2.5.4.22. Require functional manager or shop supervisor brief entry supervisor(s) on their duties prior to performing the operation.
- 23.2.5.5. Determine atmospheric monitoring requirements.
- 23.2.5.6. Evaluate and approve MEPs.
- 23.2.5.7. Review the installation confined space program at least annually. The review will include a review of all MEPs; an assessment of training, rescue procedures and qualifications of entry supervisors; a review of expired and/or revoked entry permits; and any changes to Air Force or MAJCOM confined spaces guidance. Additionally, a discussion shall be held regarding current Ground Safety, BE and FES Flight issues,

including surveillance and spot inspection findings for the last period, identifying any known vulnerabilities and establishing control measures for each.

23.2.5.8. Establish procedures with the contracting office to review all construction projects to identify, record and classify confined spaces. **Note:** This is only applicable if Air Force or DoD government civilian workers shall be entering or working in that confined space during construction.

23.2.5.9. Use **AF Form 1024**, *Confined Space Entry Permit*, or may authorize the use of an automated product or letter format for the MEP. Refer to **Figure 23.2** and paragraph **23.10** for additional information.

23.2.5.10. When possible, periodically monitor permit-required space entry operations.

23.2.5.11. Ensure non-permit required confined spaces are reviewed whenever entry is made IAW paragraph **23.5.6.2**

23.2.5.12. Discuss the installation's confined space program to include any changes to identified confined spaces (additions/deletions), unit MEPs, an assessment of training, rescue procedures, qualifications of entry supervisors, completed and revoked entry permits, organizational reviews of non-permit confined spaces and other issues/challenges of the program.

23.2.5.13. Provide the installation Ground Safety office an annual status report on the installation's confined space program. The report shall include, as a minimum, the number and type of confined spaces, the installation's major issues/challenges, the number of personnel trained on confined space operations and the number of entry permits and MEPs approved.

23.2.5.14. Meet at least annually to discuss the installation's confined space program.

23.2.5.15. As a minimum, all documents requiring CSPT approval will gain approval from the primary membership, as well as the appointed CSPT member from the owning unit.

23.2.5.16. If no Air Force personnel will enter installation confined spaces, the installation Ground Safety office may act in place of the installation CSPT (no CSPT required) provided they:

23.2.5.16.1. Maintain a current list of all installation confined spaces.

23.2.5.16.2. Ensure only contractor personnel are allowed to enter confined spaces.

23.2.6. Installation Wing Staff. Each organization that requires entry into confined spaces is responsible for its related portions of the confined space entry program, with assistance from the CSPT.

23.2.7. Commanders and/or Functional Managers will:

23.2.7.1. Ensure a written MEP and confined space program are developed, implemented and approved by the CSPT (only required for permit-required confined space programs). Serve as a member or designate a representative to the CSPT for management of confined spaces within the functional manager's control.

23.2.7.2. Ensure all personnel assigned duties and responsibilities that support permit-required confined space program tasks are properly trained, equipped and qualified. Training may be accomplished via the CBT CD-ROM, *Confined Space Series General Worker: Entrant, Attendant, Supervisor*, OSHA Course 226, *Permit-Required Confined Space Entry*, or equivalent, or by the installation CSPT. Ensure training is documented on an AF IMT 55 or an equivalent authorized computerized information management system. **Note:** Recommend personnel entering non-permit required confined spaces receive the same training as personnel entering permit required spaces, or at a minimum, confined spaces awareness training to recognize a confined space.

23.2.7.3. Ensure required equipment is procured to support entry into confined spaces. Equipment shall be available and properly maintained (operational).

23.2.7.4. Ensure a current list of all confined spaces, both permit-required and non-permit, under the control of the organization or function, is maintained.

23.2.7.5. Provide a copy of the list of all confined spaces, permit-required and non-permit, to the installation CSPT and Environmental Management office. The list shall include, at a minimum, the number of spaces (quantity), type (with every entry point uniquely identified and listed) and exact location (e.g., grid coordinates, GPS coordinates, if available, highlighted maps, if necessary).

23.2.7.6. Designate entry supervisors.

23.2.7.7. Ensure all non-permit required confined spaces under their control are reviewed whenever entry is made to ascertain that no changes occurred which would affect the original classification. If necessary, assistance may be obtained from the installation CSPT to reevaluate the confined spaces. If changes occur, provide an updated list to appropriate agencies.

23.2.7.8. Identify, evaluate and classify all the unit's confined spaces, with the participation of the installation CSPT.

23.2.7.9. Obtain BE approval for purchase of monitoring equipment for units requiring atmospheric testing and monitoring equipment. Each unit shall maintain a list of personnel trained and qualified to conduct atmospheric testing of confined spaces. BE testing and monitoring support does not apply to contractor confined space entries. Contractors shall conduct their own exposure monitoring during entry operations.

23.2.7.10. Ensure identified confined space program shortfalls, e.g., equipment, manning, funding, etc., are up-channeled and coordinated with the appropriate MAJCOM and higher headquarters.

23.2.8. Prior to start of entry, the operations Entry (On-site) Supervisor will:

23.2.8.1. Be responsible for authorizing entry, overseeing entry operations and for terminating entry if a change in conditions warrant.

23.2.8.1.1. Issue entry permits consistent with the MEP.

23.2.8.1.2. Revoke the permit and contact installation Ground Safety office when any entry condition is not consistent with the MEP.

23.2.8.2. Determine acceptable conditions are present at a permit-required space where entry is planned.

23.2.8.3. Ensure a qualified person (trained in the operation of direct-reading oxygen, flammability and toxicity monitoring equipment) evaluates and classifies the confined space IAW [Table 23.1](#)

23.2.8.4. Coordinate assistance from Ground Safety office, BE or FES Flight, as required.

23.2.8.5. Ensure workers are properly trained and qualified in safe operating and emergency procedures, use of protective equipment and how to egress. Ensure workers who are ill or are on medication that may affect their ability to safely perform assigned tasks are excused from the operation. Refer to paragraph [23.2.10.4](#).

23.2.8.6. Brief workers on hazards of entry, e.g., chemicals that were in the tank, effects of inhalation of vapors, safety and health hazards inherent in cleaning or internal confined space operations, etc.

23.2.8.7. Inspect work area, tools and equipment to identify and correct hazards.

23.2.8.8. Select appropriate PPE with help from Ground Safety office, FES Flight and BE. Ensure availability, condition and use of all protective clothing and other PPE necessary for safe entry. Ensure personnel working in a confined or enclosed workspace that contains exposed energized parts are provided and use protective shields, protective barriers or insulating materials as necessary to avoid inadvertent contact with these parts. Entry supervisor shall brief that doors, hinged panels and the like shall be secured to prevent their swinging into a worker and causing the worker to contact exposed energized parts. Refer to NFPA 70E, *Standard for Electrical Safety in the Workplace*, for additional guidance.

23.2.8.9. Ensure respiratory equipment is in safe operating condition and personnel are trained on proper procedures for use.

23.2.8.10. Ensure all valves are isolated, locked out and blinded or blanked to prevent anything from being accidentally pumped into the confined space.

23.2.8.11. Ensure all electrical power sources and electrical equipment meet safety requirements for the atmosphere in the confined space. Also, ensure all electrical power is de-energized, locked out and made electrically safe IAW AFI 32-1064, *Electrical Safe Practices*. Refer to ETL 06-9, *Arc Flash Personal Protective Equipment (PPE)*, for requirements on working on high-voltage overhead line work at 69kV (nominal) or less.

23.2.8.12. Establish emergency procedures to rescue persons incapacitated in the confined space. These will include:

23.2.8.12.1. Ensuring ready availability of rescue and safety-related equipment, such as lifting or retrieval devices, respiratory equipment and others necessary for the entry, as determined by the permit system.

23.2.8.12.2. Ensuring adequate attachment points outside the confined space for tying-off or otherwise securing retrieval lines for all authorized entrants.

23.2.8.12.3. Providing an equivalent method for rescue when retrieval lines themselves may constitute an entanglement hazard or otherwise cannot be used.

23.2.8.12.4. Determining availability of a rescue team. If the installation FES Flight is not available, verify availability of an organizational rescue team or other emergency rescue team. The operation shall be halted if the rescue team becomes unavailable. Ensure on-site standby of organizational rescue team for permit-required confined space entry that is IDLH.

23.2.8.12.5. Ensuring the means, i.e. telephone, radio, etc., for summoning the rescue team is operable, on hand or easily accessible.

23.2.8.13. Ensure qualified personnel conduct atmospheric monitoring prior to allowing entry. Ensure sample test readings are taken in the top third, middle third and lower third of the confined space. Ensure oxygen, LEL and toxicity are monitored as specified in paragraph [23.3.3.8](#).

23.2.8.14. Be the last person to sign the entry permit after all conditions are met. If necessary, perform entrant or attendant duties when properly trained. Be permitted to transfer duties of the entry supervisor to another qualified supervisor during the course of entry operations and ensure the new supervisor signs or initials the entry permit when transfer is complete. If space on the permit is not adequate, maintain a list of workers as a separate document and attach it to the entry permit form. Ensure the entry permit is maintained at the site where the entry is planned. **Note:** The entry permit shall be posted at entry portal of the permit-required confined space.

23.2.8.15. Provide an attendant for each permit entry as required by this instruction. The entry supervisor can authorize an attendant to cover more than one permit entry, provided the duties described in paragraph [23.2.9](#) are effectively performed for each permit space monitored and the attendant is within view of all spaces.

23.2.8.16. Ensure appropriate vehicle and pedestrian guards, barriers or other means to protect the entry party and attendants from traffic hazards and to protect non-entering personnel from confined space hazards are provided.

23.2.8.17. With assistance from Ground Safety, BE or FES Flight, as appropriate, determine and evaluate the source (e.g., removal of residue from the space, repair of leaking valve or pipe in the space, etc.) of any suspected atmospheric condition found at the time of entry. Make appropriate provisions in case the severity of this hazard could increase while workers are in the space.

23.2.8.18. Revoke the entry permit, terminate the entry and secure the site when becoming aware of a prohibited or unexpected condition. Ensure a new entry permit is processed through the CSPT prior to reentry.

23.2.8.19. Ensure workers entering a permit-required confined space are provided a harness and lifeline that does not hinder extracting the person from the space. They shall also ensure the lifeline is securely attached to the harness and adequate points outside the confined space are available and used to secure the other end of the lifeline. When use of a lifeline would present additional hazards, it shall not be used.

23.2.8.20. Ensure workers are aware that work on energized electrical equipment is prohibited unless approved by the installation CE IAW AFI 32-1064.

23.2.9. Confined Space Attendants will:

23.2.9.1. Maintain an accurate accounting of all entrants (name and number) in the permit-required space.

23.2.9.2. Remain outside the permit space and not attempt rescue involving entry until the rescue team has been notified and assistance has arrived. Make rescue efforts by means of the lifeline until assistance arrives.

23.2.9.3. Maintain continuous communication with all authorized entrants within the permit-required space by voice, radio, visual observation or other equally effective means. **Note:** If it is not possible for one attendant to maintain communications with each entrant because of the entrant's workstation in the space, the supervisor will make other arrangements to ensure the attendant is continuously aware of the location and condition of any entrant who is out of direct communication range.

23.2.9.4. Have authority to order entrants to exit the confined space at the first indication of a non-permitted condition, an unexpected hazard, indication of a toxic reaction (e.g., unusual conduct by the entrants) or if a situation outside the space could pose a hazard to the entrants.

23.2.9.5. Know the procedure and have the means to summon immediate emergency assistance, if required.

23.2.9.6. Remain at the attendant's post and not leave for any reason (except self-preservation) unless replaced by an equally qualified individual. Order the entrants to exit the space if the attendant must leave and there is no replacement.

23.2.9.7. Keep unauthorized persons from entering the permit-required space.

23.2.10. Confined Space Entrants will:

23.2.10.1. Be provided guidance and direction on all procedures, safeguards and emergency egress and/or rescue procedures associated with the entry.

23.2.10.2. Follow all safe work procedures required by supervisory personnel and installation Ground Safety office, BE and FES Flight.

23.2.10.3. Notify the entry supervisor when hazards exist that have not been previously identified and eliminated or reduced to an acceptable entry condition.

23.2.10.4. Notify the entry supervisor if they are ill or on medication of any type.

23.2.11. Shop Supervisor will:

23.2.11.1. Annually assess the section's or unit's known confined space workplace(s) to determine if hazards are present, or are likely to be present, which necessitate use of PPE.

23.2.11.2. Include specific confined spaces requirements and safety training in the Job Safety Lesson Plan and document training IAW AFI 91-202, *The U.S. Air Force Mishap Prevention Program*.

23.2.11.3. Ensure personnel are trained and certified in use, calibration (user) and care of atmospheric testing and monitoring equipment. Maintain a list of personnel trained and qualified to conduct continuous atmospheric testing of confined spaces. Refer to paragraph [23.3.8](#) for additional guidance.

### 23.3. General Requirements.

23.3.1. Confined Space Program Responsibility. The installation Ground Safety office is responsible for coordinating the installation confined space program. Each organization that requires entry into confined spaces under their control is primarily responsible for its related portions of the confined space entry program. This responsibility is accomplished in close coordination with the CSPT. Refer to paragraph [23.3.10](#) for additional guidance.

23.3.2. Identification of Confined Spaces. The functional manager or commander, in coordination with the CSPT, shall identify, evaluate, test and classify each confined space within the organization. If permit-required confined spaces are identified that workers and other personnel may enter, the functional manager or commander shall ensure a written confined space program consistent with requirements of this standard is implemented. Refer to [Figure 23.1](#), *Permit-Required Confined Space Decision Flow Chart*, for assistance in classifying confined spaces.

23.3.2.1. Entry into a confined space means the action by which a worker passes through an opening into a confined space. Entry occurs when any part of the entrant's body breaks the plane of an opening in the space. Refer to 29 CFR 1910.146., *Permit Required Confined Spaces*, for additional guidance.

23.3.2.2. Confined space means a space that meets all conditions in paragraphs [23.3.2.2.1](#) through [23.3.2.2.3](#) below:

23.3.2.2.1. Is large enough and so configured that a worker can bodily enter and perform assigned work.

23.3.2.2.2. Has limited or restricted means for entry or exit (for example: tanks, vessels, storage bins, hoppers, aircraft belly/lower lobe, vaults and pits are spaces that may have limited means of entry).

23.3.2.2.3. Is not designed for continuous worker occupancy.

23.3.3. Initial Testing and Evaluation of Confined Space Conditions. Functional managers and entry supervisors, in coordination with the CSPT, must test and evaluate prior to classifying a confined or enclosed space. **Note:** Obvious hazardous spaces, i.e., sanitary sewer manholes, could automatically be classified as permit required without the need for initial testing. Initial testing for classification of confined spaces shall be accomplished by a technically qualified individual. Classification documentation shall be maintained, as a minimum, by the shop supervisor. If the initial testing and evaluation documentation is lost, a retest shall be accomplished. Such evaluations will include, but not necessarily be limited to, the following considerations:

23.3.3.1. The contents or previous contents of the space that may result in the presence of flammables, toxic materials or oxygen-deficient or oxygen-enriched atmospheres.

23.3.3.2. The location and configuration of the space, including restricted access, obstructions, remoteness, etc., which may inhibit or interfere with movement (ability of entrants to self-rescue), ventilation, rescue efforts or firefighting efforts.

23.3.3.3. Potential hazards from the external environment, such as proximity of liquid oxygen (LOX) storage operations; petroleum, oil and lubricants (POL) storage areas; sewer and waste water treatment processes; and underground disposal sites, which could affect the atmosphere or other conditions within the confined space.

23.3.3.4. The types of operations conducted within the space, particularly those that produce toxic materials, flammables, oxygen depletion or enrichment or ignition sources.

23.3.3.5. Fixtures, devices or equipment within the space that may create or contribute to hazardous conditions including piping systems, conduits, ducts, machinery, pressurized lines, etc.

23.3.3.6. The presence of other hazards such as slippery surfaces, deteriorated or unstable ladders, irritant or caustic materials, etc., that may create a serious safety hazard in a confined space environment. Pay attention to the condition of permanently-installed ladders, such as those with metal rungs embedded into concrete walls of manholes or other structures.

23.3.3.7. The boundary spaces and their contents to ensure fire or explosion is not caused by the operation being conducted.

23.3.3.8. Initial testing shall be performed from outside the space. Testing of the space may be performed by drop tests or insertion of sample probes and hoses into the space. Testing shall be performed in the following sequence:

23.3.3.8.1. Oxygen Content. Combustible gases are tested after tests for oxygen content because the threat of fire or explosion is more immediate and more life threatening, in most cases, than exposure to toxic gases or vapors.

23.3.3.8.2. Flammable Hazard. Many combustible gas indicators and/or explosimeters (explosion meters) require oxygen for proper operation (generally 10- to 30-percent oxygen by volume). Corrections for known flammable components, if different from the calibration gas, shall be made IAW the manufacturer's instructions. For the detection of JP-8 and other kerosene-based fuels, a photo-ionization detector (PID) shall be used.

23.3.3.8.3. Toxic Materials. For the determination of initial confined space classification, chemical substances known or expected to be present shall be measured and evaluated for their potential to produce a hazardous atmosphere (as defined in [Attachment 1, Terms](#)). **Note 1:** If a chemical substance does not have an occupational and environmental exposure limit (OEEL), other sources of information, such as MSDS, National Institute for Occupational Safety and Health (NIOSH) documents consensus standards, Air Force documents, etc, may be used to establish an acceptable atmospheric concentration and any other atmospheric condition that is immediately dangerous. **Note 2:** Test results may vary from inside the space to the entry area of the confined space. To effectively determine the overall



status/classification of the space, consideration must be given to taking measurements to the fullest extent into the confined space without entering the space. **Note 3:** Testing Stratified Atmospheres. When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested a distance of approximately 4 feet (1.22 meters) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be slowed to accommodate the sampling speed and detector response.

23.3.4. Classification of Confined Spaces. Confined spaces are classified based on measurements of oxygen content, flammability and toxicity by testing. Refer to **Table 23.1** which is based upon existing or potential confined space hazards. Confined spaces are also classified relative to material contained in the space that could cause engulfment or are configured in a manner that could result in entrapment and/or asphyxiation. All personnel will assume confined spaces are permit-required until proven otherwise by means of testing, evaluation and/or inspection. A trained and qualified worker will conduct testing prior to any entry into permit-required confined spaces.

23.3.4.1. Permit-required confined spaces may contain hazards that are immediately dangerous to life or health (IDLH) or have a potential for or contain a hazardous atmosphere as defined in **Attachment 1, Terms**.

23.3.4.2. A non-permit confined space contains no hazardous atmosphere or potentially serious safety hazard, and entrants will not perform any work that could cause a hazardous atmosphere. The space does not have a potential for engulfment, is not configured in a way that would cause entrapment or asphyxiation, or does not contain any other serious safety hazard. Permits, signs and attendants are not required. **Note:** The use of special protective equipment and modified work procedures are not required by this standard, but may be required by other Air Force directives.

23.3.4.3. If permit-required confined spaces are identified and workers or other personnel have a need to enter, the commander or functional manager will ensure a written confined space program is developed and implemented consistent with the requirements of paragraph **23.3.10**. If the commander or functional manager determines that workers or other personnel will not enter permit-required confined spaces under his or her control, and they have been prohibited from entering, a written program is not required. In this case, the commander or functional manager must still ensure the requirements of paragraphs **23.3.2**, **23.3.3**, **23.3.5** and **23.8** are met.

23.3.5. Posting Signs. Where confined spaces are designated as permit-required and workers and other personnel could inadvertently enter, the supervisor will ensure personnel are informed of the existence, location and the danger of the permit space by posting danger signs. A sign stating, *DANGER — PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER* or a commercial equivalent that meets specifications and design established in **Chapter 29, Mishap Prevention Signs and Tags**, is appropriate. Confined spaces where personnel cannot inadvertently enter, such as those protected by heavy manhole covers, locks or that require tools to open, do not need to be posted.

23.3.6. Approved Equipment. Before purchasing equipment to support the confined space entry program, supervisors will coordinate with the appropriate member of the CSPT. The supervisor will ensure testing and monitoring equipment used in confined spaces is approved

for use in Class I, Division 1 and the appropriate group atmosphere, as defined in NFPA 70, *National Electrical Code*, Article 500, *Hazardous (Classified) Locations*. Only direct reading equipment with current calibration shall be used. The supervisor will also ensure equipment meets required standards as determined by an appropriate Nationally Recognized Testing Laboratory (NRTL) as listed in the OSHA NRTL Program—Underwriters Laboratories (UL), Factory Mutual Research Corporation (FMRC), etc. Group classifications are provided in NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*. Guidance is also provided in National Materials Advisory Board (NMAB) 353-5, *Classification of Gases, Liquids, and Volatile Solids Relative to Explosion-Proof Electrical Equipment*.

23.3.7. Testing of Confined Spaces. Verification testing shall be accomplished prior to entry into permit-required confined spaces. A trained and qualified individual will conduct testing prior to any entry into permit-required confined spaces. If a hazardous atmosphere is identified during pre-entry testing, use forced ventilation to try to clear the hazard for a period of not less than 15 minutes before testing again. If the hazardous atmosphere remains, repeat the process. If the hazard remains, use engineering controls to eliminate the hazard or make a determination about the need for entry under hazardous conditions. **Note:** Continuous forced ventilation is recommended when practical and when it will not interfere with work practices.

23.3.8. Calibration of Monitoring Equipment. Monitoring equipment used to evaluate confined spaces shall be calibrated by the Testing, Measurement, Diagnostic and Evaluation (TMDE) Lab at an interval established by manufacturer's instructions or technical orders. Some monitoring equipment, e.g., colorimetric tubes, does not require calibration. Equipment that comes with manufacturer-approved calibration devices and does not require TMDE calibration is also acceptable. Monitoring equipment that requires calibration, but cannot be calibrated by TMDE, shall be sent to the manufacturer for calibration. The user will field check and span-gas test equipment IAW the manufacturer's instructions immediately before testing the confined space. Workers will not use equipment that cannot be calibrated or which fails the field check or span-gas test, until it is repaired and the calibration and/or field check is successfully accomplished.

23.3.9. Atmospheric Monitoring. Many operations may generate hazardous conditions and may require atmospheric monitoring as the work progresses to ensure safe conditions are maintained. The frequency and types of testing are dependent upon prevailing conditions and the nature of the operations. No single rule can be established for all operations and conditions. The entry supervisor, with assistance from the CSPT, shall establish the frequency and type of tests for atmospheric monitoring and shall enter these requirements on the MEP and the entry permit. If isolation of a permit space is not possible because the space is large or is part of a continuous system (e.g., a sewer), pre-entry testing must be performed to the extent feasible and entry conditions must be continuously monitored in areas where authorized entrants are working. Additionally, continuous monitoring of oxygen levels, flammable vapor levels and toxicity levels shall be accomplished for all permit-required confined space operations. The entry supervisor, with appropriate assistance as stated above,

shall carefully evaluate the following types of operations for continuous atmospheric monitoring:

23.3.9.1. Work that may generate hazardous concentrations of toxic materials. (Examples: welding, cutting, brazing, soldering, etc.)

23.3.9.2. Application of preservatives, paints, epoxies, solvents, etc., which may involve hazardous concentrations of toxic or flammable vapors.

23.3.9.3. Cleaning operations, sludge removal, etc., which may produce or cause release of hazardous concentrations of toxic or flammable vapors.

23.3.9.4. Any other operations that may produce or release toxic, flammable or asphyxiating atmospheres or material into the space.

23.3.10. Written Permit-Required Space Program. Commanders or functional managers in organizations with confined spaces under their control that have been identified, evaluated and classified as permit-required will develop a written program. This document will include:

23.3.10.1. General operating and entry procedures applicable to all confined spaces within the organization, which will include the following elements:

23.3.10.1.1. Measures in place to prevent unauthorized entry (signs, method of training, etc.).

23.3.10.1.2. Methods used to identify and evaluate the hazards of permit spaces before personnel enter them (site visits, review of historical data, etc.). The entry permit shall list specific hazards and controls.

23.3.10.1.3. The requirements and procedures for safe permit space entry operations, including, but not limited to, specifying acceptable entry conditions; isolating the permit space; purging, inerting, flushing or ventilating the permit space as necessary to eliminate or control atmospheric hazards; providing pedestrian, vehicle or other barriers as necessary to protect entrants from external hazards; and verifying that conditions in the permit space are acceptable for entry throughout the duration of an authorized entry.

23.3.10.1.4. Required equipment, to include testing and monitoring, ventilating, communications, PPE, lighting, barriers or shields, egress ladders, rescue and emergency equipment, and any other equipment necessary for safe entry and rescue from permit spaces.

23.3.10.1.5. Procedures established to evaluate acceptable entry conditions through pre-entry and periodic testing and, if required, continuous monitoring.

23.3.10.1.6. Identify the persons by name, duty title and duty section who will have active roles as entrants, attendants, entry supervisors, organizational rescue team members and persons who test or monitor the atmosphere in a permit space.

23.3.10.1.7. Procedures for summoning rescue and emergency services, for rescuing entrants from permit spaces, for providing necessary emergency services to rescued employees and for preventing unauthorized personnel from attempting a rescue.

- 23.3.10.1.8. Procedures for the preparation, issuance, use and cancellation of entry permits for permit required spaces.
- 23.3.10.1.9. Procedures to coordinate entry operations when personnel assigned to different organizations or Air Force and contractor personnel are working simultaneously as authorized entrants in a permit space.
- 23.3.10.1.10. Procedures necessary for concluding the entry after entry operations have been completed, such as securing the permit space and canceling the permit.
- 23.3.10.1.11. Procedures to review entry operations when there is reason to believe that the measures taken under the permit space program may not protect personnel and revise the program to correct deficiencies found to exist before subsequent entries are authorized. Examples of circumstances requiring review of the permit space program are any unauthorized entry of a permit space, detection of a permit space hazard not covered by the permit, detection of a condition prohibited by the permit, the occurrence of an injury or near-miss during entry, a change in use or configuration of a permit space and worker complaints about program effectiveness.
- 23.3.10.1.12. Method to review the permit space program, using the completed and canceled permits, and to revise the program as necessary to ensure personnel are protected from permit space hazards.
- 23.3.10.2. If Air Force personnel will not enter the permit spaces, functional managers must still meet requirements of paragraphs [23.3.2](#), [23.3.3](#), [23.3.5](#) and [23.8](#).
- 23.3.11. Alternate entry procedures are not allowed in Air Force controlled facilities or operations.
- 23.3.12. Entry into telecommunications only controlled spaces are governed by [Chapter 30](#), *Communication Cable, Antenna and Communication Systems*. However, the requirements of this chapter (paragraphs [23.3](#) – [23.7](#)) also applies to telecommunications confined spaces.

**23.4. Confined Spaces Classification—Atmospheric Conditions (Reference [Table 23.1](#) below).** The presence of one or more of the conditions identified under Hazardous Atmosphere (second column below) constitutes a hazardous atmosphere, which, by itself, requires the confined space to be classified as permit-required. When all the conditions under Non-Hazardous Atmosphere (third column below) are met, the confined space does not contain a hazardous atmosphere and may be classified as a non-permit space as long as there is no condition in the space that could cause engulfment, a configuration that could result in entrapment or asphyxiation, or other serious safety hazard (reference permit-required confined space definition, [Attachment 1](#), Terms). Some test equipment, i.e., photo ionization detectors (PIDs), provide readings in parts per million (ppm), not as a percent of LEL. Personnel using such equipment shall be able to convert test data from ppm to percent of its LEL, and back, as required.

**Table 23.1. Confined Spaces Classification—Atmospheric Conditions.**

<b>Confined Spaces Classification—Atmospheric Conditions</b>		
<b>CONDITION</b>	<b>HAZARDOUS ATMOSPHERE</b>	<b>NON-HAZARDOUS ATMOSPHERE</b>
Flammability	1. Flammable gas, vapor or mist in excess of 10 percent of its lower explosive limit (LEL), or 2. Airborne combustible dust at a concentration that meets or exceeds its LEL. (See Note 1)	1. Flammable gas, vapor or mist less than or equal to 10 percent of its LEL, or 2. Airborne combustible dust at a concentration less than its LEL.
Oxygen	Atmospheric oxygen concentration less than 19.5 percent (148 mm Hg) or greater than 23.5 percent (greater than 179 mm Hg). (See Note 2)	Atmospheric oxygen concentration range from the minimum of 19.5 percent and the maximum of 23.5 percent (148–179 mm Hg).
Toxicity	An atmospheric concentration of any chemical substance which is capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to its health effects or which could result in an exposure or dose in excess of its occupational and environmental exposure limit (OEEL). (See Note 3)	An atmospheric concentration of any chemical substance which is not capable of causing death, incapacitation, injury, impairment of ability to self rescue or acute illness due to its health effects.
Other Condition	Any atmospheric condition that is immediately dangerous to life or health (IDLH) or local conditions that could be potentially hazardous or life threatening. (See Note 4)	No atmospheric IDLH condition present.

**Note 1:** This concentration may be approximated as a condition in which the dust obscures vision at a distance of five (5) feet or less.

**Note 2:** Based upon a total atmospheric pressure of 760mm Hg (sea level)

**Note 3:** Exposure at or above levels determined to be safe solely to prevent long-term adverse health effects is not considered a hazardous atmosphere on that basis alone and in itself would not constitute a permit-required confined space classification. However, other OSH standards, TOs, etc. may apply for exposure to chemical substances at levels greater than the OEEL.

**Note 4:** Immediately Dangerous to Life or Health – as referenced in National Institute for Occupational Safety and Health (NIOSH), *Registry of Toxic Effects of Chemical Substances*, Manufacturing Chemists data sheets or other recognized authorities. (Reference IDLH definition in **Attachment 1, Terms**). Local conditions could present potentially hazardous or life threatening situations such as extreme temperatures, noise, animals (rat droppings, potentially dangerous insects, wild animals, etc.). The installation CSPT will notify units of potentially hazardous or life threatening conditions in the local area.

### 23.5. Specific Requirements.

23.5.1. Entry Into Confined Spaces. Entry supervisors will ensure workers enter a permit-required confined space only after an **AF Form 1024**, *Confined Spaces Entry Permit*, or an approved entry permit which contains the minimum requirements of the AF permit has been obtained. The permit is an authorization and approval in writing that specifies the location and type of work to be accomplished. It certifies an evaluation of all existing hazards and the necessary protective measures have been taken to ensure the safety and health of each worker. Refer to **Figure 23.2** and paragraph **23.10** for additional information for **AF Form 1024**.

23.5.1.1. Rescue procedures and equipment are critical. Entrants shall be provided guidance and direction on confined space entry and rescue requirements, and the entry supervisor will sign the entry permit as the person responsible for the entry.

23.5.1.2. Each completed entry permit, including those canceled or revoked, shall be retained for one year by the organization responsible for the entry and be available for review. Any problems encountered during an entry operation shall be noted on the permit so necessary revisions can be made to the confined space program.

23.5.1.3. Entries into non-permit required confined spaces are allowed without attendants and entry permits. Even though the confined space is classified as a non-permit confined space, the space may contain other physical hazards, such as slippery surfaces or deteriorated pipe ladders, which may make self-rescue difficult for the entrant. In such cases, it may be appropriate for entrants to use a body harness to facilitate rescue operations, use a buddy system or use other special procedures developed to protect workers inside the space. Refer to Note in paragraph **23.5.6.1**.

23.5.2. Testing and Classification of Confined Spaces. Testing and classification of confined spaces shall be done by a qualified person trained and certified IAW requirements in paragraphs **23.3.3**, **23.3.4**, and **23.3.7**. Initial testing shall be performed from outside the space. Testing into the interior of the space may be performed by drop tests or insertion of sample probes and hoses into the space. Testing shall be performed in the sequence outlined in paragraph **23.3.3.8**.

23.5.3. Entry Into Known Immediately Dangerous to Life and Health (IDLH) Conditions Permit-Required Confined Spaces. Entry supervisors will not permit entry into and work in known IDLH spaces under normal operations. Continuous monitoring is required in a known IDLH space. Entry supervisors will authorize entry only when the following conditions are met:

23.5.3.1. Efforts to reduce the hazard within the confined space by isolation, ventilation or other techniques result in a lower classification of the confined space. If efforts to reduce the hazard to a lower classification are unsuccessful, entry into known IDLH spaces is authorized only in cases of extreme emergencies such as rescue efforts, emergency repairs, etc. The organizational rescue team shall be available at the scene for permit-required confined space entry under IDLH conditions.

23.5.3.2. The permit for entry into a known IDLH confined space is approved by the CSPT prior to space entry.

23.5.3.3. The permit authorizes entry into a specific confined space for a specific purpose, by specific work crews, and for a work period, which normally will not exceed a single shift. If multiple shifts are necessary, either a new entry permit shall be completed or the CSPT may approve a continuation of the initial permit with a new entry supervisor and crewmembers. Rescue team entry is exempt from this requirement.

23.5.3.4. Personnel entering confined spaces with known or suspected IDLH conditions will wear a positive pressure SCBA or a supplied-air respirator with escape SCBA. Additionally, personnel shall be equipped with a harness suitable for extraction of the person, which does not hinder extraction, a lifeline securely attached to the harness and other necessary PPE suitable for the conditions and exposures. **Note:** When use of a lifeline would present additional hazards, other alternatives must be considered. Refer to AFOSH Standard 48-137, *Respiratory Protection Program*, for additional respiratory guidance.

23.5.3.5. Emergency rescue personnel, equipped with the above-listed equipment and any additional equipment necessary for a rescue, are stationed immediately outside the entry to the confined or enclosed space.

23.5.3.6. Communications by sight or voice or both are established and maintained between the person entering the space and attendant personnel outside the space.

23.5.3.7. Only explosion-proof or intrinsically safe equipment is used where flammable or explosive atmospheres are present. Refer to NFPA 70, Article 504, *Intrinsically Safe Systems*, and Article 501, *Class I Locations*, for additional guidance.

23.5.3.8. A qualified BE or Ground Safety representative, based on the nature of the IDLH condition, shall be present during all known IDLH confined space entry and work periods and shall serve as safety consultant to the person in charge of entry.

23.5.3.9. A qualified on-site rescue team shall be present during all known IDLH space entries, where the atmosphere inside the space contains flammable or explosive contaminants or is oxygen-enriched.

23.5.4. Entry Into Permit-Required Confined Spaces. Permit-required confined spaces contain atmospheres or conditions that are, or may reasonably be expected to become, hazardous but are not IDLH. Refer to **Table 23.1** Flammables, toxic materials or deviations of oxygen levels within a permit-required space may be due to the materials and conditions within the space or result from operations in the space. Refer to paragraph **23.3.9** for additional guidance on atmospheric monitoring.

23.5.4.1. An entry permit must be approved by installation Ground Safety office, BE and FES Flight prior to entry, if not already identified on the MEP.

23.5.4.2. Permits, issued by an entry supervisor under a MEP, will permit entry into a specific confined space, for a specific purpose, by a specific work crew, for a period not to exceed a single shift or as determined jointly by the CSPT. Rescue team entry is exempt from this requirement.

23.5.4.3. Prior to entry into a contaminated space, the entry supervisor will identify the cause or source of the contamination and remove it to the maximum degree possible by

cleaning, ventilating or other such treatments. If the situation is not time critical, notify the installation CSPT immediately. Otherwise, notify the CSPT as soon as time permits.

23.5.4.4. Where operations conducted within the space introduce, or have the potential to introduce, additional hazards within the space, the entry supervisor will ensure these hazardous conditions and operations are covered by the permit and take action consistent with the nature of the operations to control the hazards and maintain safe conditions within the space. Refer to paragraph [23.3.9](#) for added guidance on atmospheric monitoring.

23.5.4.4.1. When an airborne exposure may exceed an allowable standard or toxic materials are present or may be introduced into the space, the entry supervisor will contact BE staff to determine necessity for respiratory protection equipment. The BE staff will provide assistance in selecting the appropriate NIOSH-approved equipment and any other PPE necessary to protect workers. Refer to AFOSH Standard 48-137 for additional guidance. **Note:** While the primary concern is the inhalation hazard, additional PPE may be required to protect against skin contact and absorption.

23.5.4.4.2. Entry supervisors will ensure only explosion-proof or intrinsically safe equipment is used where flammable or explosive atmospheres are present. Refer to NFPA 70, Articles 501, 504, and 513 for additional guidance.

23.5.4.5. Entry supervisors will ensure personnel entering a permit-required confined space are suited with a harness and lifeline that will not hinder extraction of the person from the space. They will also ensure the lifeline is securely attached to the harness and adequate attachment points outside the confined space are available and used. **Note:** When the space is so configured that use of a lifeline would present additional hazards, they shall not be used. However, continuous communication between the entry supervisor and all entrants within the confined space shall be maintained, i.e., via voice, radio, visual observation or other equally effective means. The entry supervisor is responsible for making the final decision about non-use of the lifeline. Contact the CSPT for additional guidance.

23.5.4.6. The entry supervisor will identify and notify an emergency rescue team, either organizational or the installation FES Flight, when an entry is planned. **Note:** Entry shall not be made until the emergency rescue team is notified and their availability has been verified. The entry will be immediately terminated and entry permit cancelled when the emergency rescue team, for any reason, becomes unavailable.

23.5.4.7. The entry supervisor will ensure an attendant is provided for all permit-required confined space entry operations. The attendant will remain outside the space and will establish and maintain communications with the entrants. The attendant will know the procedures and have the capability and means to contact the rescue team or summon emergency assistance if the rescue team is not stationed immediately outside the confined space.

23.5.4.8. When initial testing indicates ventilation is required to remove contaminants and/or provide adequate oxygen levels, the entry supervisor will ensure ventilation is provided during entry and occupancy of the space.



23.5.4.9. When operations conducted inside the confined space could cause an IDLH atmosphere without industrial ventilation, the entry supervisor will ensure ventilation (general dilution or local exhaust) is used to maintain the atmosphere within the limits specified on the entry permit.

23.5.4.10. For routine recurring tasks in permit-required confined spaces, such as sewers, lateral fuel pits, dikes, communication vaults, etc., where the spaces may be entered on a regular basis, a MEP will be developed and approved by the installation Ground Safety office, FES Flight and BE. All MEPs shall be reviewed by the above representatives and the organizational representatives at least annually, to ensure conditions have not changed. The entry supervisor will prepare an entry permit using the MEP as a guide. The entry supervisor will authorize entry into the confined space by signature on the entry permit and will ensure the following conditions are met:

23.5.4.10.1. There is no known potential for an IDLH atmosphere or an engulfment hazard.

23.5.4.10.2. Entrants are trained in routine recurring operations practices and procedures required for such entries.

23.5.4.10.3. Work operations are governed by TO, OI or similar directives, e.g., AFI 32-1064, *Electrical Safe Practices*, and UFC 3-560-01, *Electrical Safety O&M*.

23.5.4.10.4. The space is tested for atmospheric hazards and the results are properly recorded on the entry permit.

23.5.4.10.5. The permit is revoked if testing required by this section shows conditions in the space are more hazardous than contemplated under the permit. The entry supervisor will stop operations and ensure a new permit is issued. Retain the revoked permit for one year.

23.5.4.10.6. The permit is revoked when any conditions of the permit are not followed or enforced.

23.5.4.11. The entry supervisor may request the CSPT perform an evaluation to reclassify a permit-required confined space to a non-permit confined space at the time of a specific entry provided all hazards justifying the permit-required confined space classification have been totally eliminated. Control of a hazardous atmosphere, i.e., through forced ventilation, is not the same as its elimination. For example, a chemical tank that at one time contained a hazardous atmosphere, prior to draining it of its contents, purging any residual chemical content with water and venting the space after purging is complete, would be eligible for reclassification as long as the hazardous atmosphere remains totally eliminated. Entry into confined spaces, where a non-hazardous atmosphere is maintained through continuous forced ventilation, is a permit-required entry. The intent for reclassifying a permit-required confined space applies primarily to those spaces containing physical hazards, e.g., hazardous energy sources or engulfment hazards. Detailed provisions for reclassifying a space shall be addressed in the MEP, if one is in use. Such reclassification would allow entry without a permit, without personnel being suited with a harness and/or lifeline and without an attendant, provided:

- 23.5.4.11.1. Testing is accomplished prior to entry with the results showing the space is free of all hazards. **Note:** If entry is required to eliminate the hazards or perform verification testing in the permit space, the entry must be made with an entry permit IAW this standard. Once the hazards have been eliminated, the space may be reclassified as non-permit as long as the hazards remain eliminated. Elimination is achieved by completely protecting the space against the release of hazardous energy or material into the space.
- 23.5.4.11.2. That actual or potential atmospheric hazards are eliminated, and continuous monitoring is used to ensure the atmosphere remains free of hazards. That all hazards within the space are eliminated without entering the space at the time of testing, and any non-atmospheric hazards remain eliminated.
- 23.5.4.11.3. That during routine work, the entrant does not take tools or introduce material into the space that could themselves cause a hazard.
- 23.5.4.11.4. The entrant does not perform any work that would cause a hazardous condition.
- 23.5.4.11.5. The entry permit is revoked whenever any test, monitoring instrument or observation shows conditions are developing in the confined space more hazardous than allowed under the permit. When this occurs, the entry supervisor will remove entrants, secure the area and prevent entry until an approved entry permit is issued.
- 23.5.4.11.6. The entry supervisor documents the basis for the reclassification on a separate sheet, attaches it to the entry permit and signs or initials next to the statement. Refer to **Figure 23.2**. **Note:** Routine or repetitive entries for daily inspections of lateral fuel pits are examples of work tasks that may qualify for reclassification.
- 23.5.5. **AF Form 592, USAF Hot Work Permit.** Whenever workers perform hot riveting, welding, cutting or burning, or heating operations within a confined space, they will obtain an **AF Form 592** from the installation FES Flight. Refer to **Chapter 27, Welding, Cutting and Brazing, Figure 27.1** and **Table 27.2** for additional information. If hazards may be introduced into the confined space by the “hot work,” BE shall be contacted to evaluate the potential hazards and recommend ventilation procedures. Also, workers will:
- 23.5.5.1. Inspect, test, operate and maintain welding and cutting equipment such as hoses, connections, torches, etc., IAW provisions of **Chapter 27**, applicable TOs and manufacturers’ instructions.
- 23.5.5.2. Not take compressed gas cylinders or gas manifolds used in welding and cutting operations into a confined space.
- 23.5.5.3. Turn off gas supplies at the cylinder or manifold outside the space when equipment is unattended or unused for substantial periods of time, such as at breaks or lunch periods. At shift changes (30 minutes or more) or overnight, turn off gas supplies and remove torches and hoses from the space. Immediately remove open-ended hoses from the space when torches or other devices are removed from the hose.

23.5.5.4. Not take electric arc units or machines into a confined space. Place such units outside the space.

23.5.6. Entry Into Non-Permit Confined Spaces. These confined spaces are not considered hazardous and have no reasonable probability to become hazardous. These spaces are defined as confined because of design, may have limited openings for entry and exit, and may have limited space (lateral fuel pits under five [5] feet deep and dikes less than six [6] feet high around fuel storage tanks). **Note:** Recommend personnel entering non-permit required confined spaces receive the same training as personnel entering permit required spaces, or at a minimum, confined spaces awareness training to recognize a confined space.

23.5.6.1. Entries into non-permit required confined spaces are allowed without attendants and entry permits. **Note:** Even though the confined space is classified as a non-permit confined space when using typical criteria to evaluate hazards such as atmospheric, engulfment or entrapment, the space may contain other physical hazards. Hazards such as slippery surfaces or deteriorated pipe ladders may make self-rescue difficult for the entrant. Also, fuel pits less than five (5) feet deep with jet fuel accumulation due to line leaks may present a hazard to repair crews. In cases where no entry permit is required, it may still be appropriate for entrants to use a body harness to facilitate rescue operations, for an attendant to be assigned to monitor the entry process or other special procedures developed to protect entrants.

23.5.6.2. Non-permit confined spaces will be reviewed prior to each entry to determine if changed conditions in or around the space could have introduced a hazard that is immediately dangerous to life or health, thus changing the classification of the space to permit-required. Well-ventilated, frequently-entered non-permit confined spaces such as aircraft engine inlets/intakes/exhausts and avionics bays can normally rely on a visual review prior to each entry, unless a changed condition in or around those spaces could have introduced an atmospheric or other non-visual hazard, in which case, instrumented testing is warranted.

## **23.6. Emergency and Rescue Procedures.**

23.6.1. Responsibilities. The MEP or confined space entry permit will include emergency and rescue procedures consistent with each operation that requires entry into a permit-required confined space. The entry supervisor will coordinate with the installation Ground Safety office, BE and FES Flight when required to enter non-routine permit-required confined spaces not included in the MEP, and to establish emergency rescue procedures prior to entry. Means of rescue include: self-rescue, a centrally located rescue team (installation FES Flight or an installation established team) and an organizational rescue team. Aircraft fuel systems personnel will follow this standard and applicable technical data for responsibilities, qualifications, training and rescue procedure requirements for working in permit-required confined spaces.

23.6.1.1. Self-Rescue. Employees are trained to exit from the confined space IAW requirements in paragraph [23.7.2.2.3.1](#).

23.6.1.2. Centrally Located Rescue Team. The installation FES Flight provides emergency rescue services but will not normally provide on-site standby rescue services for entry into permit-required confined spaces on an Air Force installation as the FES

Flight is not manned to support these operations. The supervisor in charge of entry shall ensure a standby rescue team is in place prior to beginning operations in permit-required spaces that are IDLH. Additionally, this supervisor will contact the installation FES Flight prior to entering a permit-required confined space to coordinate emergency rescue assistance and ensure its availability within a reasonable period of time (normally within 5-7 minutes). The entry supervisor shall ensure these procedures are included during planning for permit-required confined space operations that are IDLH.

23.6.1.3. Organizational Rescue Team. When confined space permit-required work is performed outside the installation or the installation FES Flight is unable to support the operation, the entry supervisor/authority will ensure an organizational rescue team is available and, if not, the confined space work shall be rescheduled. For permit-required confined spaces that are IDLH, the organizational rescue team will standby on the scene of the operation. Organizational rescue teams shall consist of trained personnel equipped with appropriate PPE, including respiratory protection equipment necessary for entry into confined spaces, and with rescue and retrieval equipment suitable for the confined spaces involved. Installations/organizations may contract for rescue team support. **Note:** Within aircraft maintenance, the fuel systems shop/work center usually requires an organizational rescue team. Fuel systems personnel will conduct rescue efforts IAW MEP (Emergency and Rescue Procedures) approved by installation CSPT. Refer to paragraph [23.6.1](#) and TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks, and Fuel Cells*, for additional guidance.

23.6.1.3.1. Organizational rescue teams shall meet the same training requirements as FES Flight rescue teams. In addition, the entry supervisor will ensure they are locally trained in the correct performance of rescue functions assigned to them. Training received in technical school may suffice. Aircraft fuel systems personnel will follow requirements of TO 1-1-3. Training, as a minimum, will include use of retrieval and rescue equipment and proper wear and use of any PPE, including airline respirators or Self-Contained Breathing Apparatus (SCBA) that may be required during actual rescues. Refer to paragraph [23.7.3.2](#) for additional guidance.

23.6.1.3.2. During permit-required confined space entry operations, entry supervisors shall ensure all members of the rescue team are trained and current in cardiopulmonary resuscitation (CPR). The organizational rescue team shall be available at the scene for permit-required confined space entry under IDLH conditions.

23.6.1.3.3. The appropriate CSPT members will assist organizational rescue teams as required in the selection of equipment.

23.6.2. Inspection of Safety Equipment. Prior to a confined space operation, entry supervisors will ensure inspection, testing, maintenance and documentation of safety and rescue equipment is accomplished IAW [Chapter 14](#), *Personal Protective Equipment*, TO 00-25-245, *Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, and manufacturer's instructions.

23.6.3. Alternate entry procedures are not allowed in Air Force controlled facilities or operations.

## 23.7. TRAINING.

23.7.1. General Information. Each organization shall develop a structured and effective training program to include a hands-on portion that establishes safe work practices and techniques. A computer based training (CBT), titled *Confined Space Series General Worker: Entrant, Attendant, and Supervisor Course*, the OSHA Course 226, *Permit-Required Confined Space Entry* or other MAJCOM-approved CBTs are available for personnel who have not attended a formal training course. Each MAJCOM may develop and present training using methods (power point presentations, training plans, etc.) other than CBT, if approved by the Ground Safety office and BE. This will allow for type specific training for each weapons system. Personnel assigned duties as entry supervisors, attendants and entrants will complete general permit-required confined space program hands-on training in addition to AFCESA's CBT or OSHA Course 226, *Permit-Required Confined Space Entry*. Entry supervisors shall complete rescue training described in paragraph 23.7.3.2. All training associated with confined spaces shall consist of initial training and annual training thereafter. **Exception:** Training shall be conducted if an existing requirement changes and/or a new confined space or equipment is added. **Note:** Recommend personnel entering non-permit required confined spaces receive the same training as personnel entering permit required spaces, or at a minimum, confined spaces awareness training to recognize a confined space.

23.7.1.1. The installation or unit training program shall include the specific hazards to be encountered. The trainer shall obtain installation Ground Safety office, FES Flight and BE approval on all training lesson plans prior to their use and when changes are made to the plans. **Note:** The CBT listed in paragraph 23.7.1 may be included as part of the installation or unit training program.

23.7.1.2. Entry supervisors shall ensure all personnel authorized confined space entry or assigned as attendants or rescue personnel are trained. Entry supervisors shall ensure workers are aware of appropriate procedures and controls for entry and that unauthorized entry into such spaces is forbidden. **Warning:** Entry supervisors shall ensure personnel are aware/warned that unauthorized entry can be fatal. Many confined space hazards are impossible to detect without specially designed equipment. Refer to paragraph 23.7.5 for additional guidance on documenting training.

23.7.1.3. Each member shall be trained prior to being assigned permit-required confined space duties. For additional guidance refer to paragraph 23.7.2.

23.7.1.4. Additional training is required when workers have a change in assigned duties or when permit-required confined space operations present a hazard for which a worker has not previously been trained. Additional training is also required when there have been deviations from established entry procedures or when a worker displays inadequacies in the knowledge or use of these procedures.

### 23.7.2. General Confined Space Program Training Requirements.

23.7.2.1. Confined Space Program Team. CSPT members will perform the duties and responsibilities outlined in paragraph 23.2.5. At least one representative from the installation Ground Safety office, BE and FES Flight shall receive formal permit-required confined space training. These individuals shall make up the installation's CSPT. The Ground Safety office, BE, FES Flight and other installation units can train as many

personnel as they desire, but those designated as members of the CSPT must be trained. Completion of OSHA *Permit-Required Confined Space Entry*, Course 226/226A, or similar course taught by a recognized training organization, meets this requirement.

23.7.2.2. Entrants. Entrants will perform the duties and responsibilities outlined in paragraph [23.2.10](#). Entry supervisors will ensure all entrants are trained in the following subjects:

23.7.2.2.1. Hazard Recognition. Prior to entering a permit-required confined space containing a potentially hazardous environment, entrants shall be provided guidance and direction on the nature of the hazards, to include type, signs or symptoms, effects of exposure and the need to perform appropriate testing to determine if it is safe to enter.

23.7.2.2.2. Personal Protective Equipment (PPE). Entrants shall be trained and qualified on the proper use of all PPE and protective shields and barriers. Consult BE with questions or guidance on PPE.

23.7.2.2.3. Self-Rescue. Entrants will:

23.7.2.2.3.1. Exit from the confined space as rapidly as they can whenever an order to evacuate is given by the attendant, an automatic evacuation alarm is activated or workers recognize the warning signs of exposure to substances whose presence in the confined space is known or expected.

23.7.2.2.3.2. Recognize the toxic effects or symptoms of exposure to anticipated hazardous materials they are using.

23.7.2.2.3.3. Relay an alarm to their attendant and attempt self-rescue immediately on becoming aware of the effects discussed in paragraph [23.7.2.2.3.1](#). The entrants must communicate with the attendant as necessary to enable the attendant to monitor their exit.

23.7.2.2.4. Special Work Practices or Procedures. Entrants shall be provided guidance and directions on all modifications or alterations of normal work practices that are necessary for confined space work.

23.7.2.2.5. Equipment. Entrants shall be trained in the use and care of other equipment, such as monitoring, ventilating, lighting, communications, rescue and emergency equipment and like equipment used in and around confined spaces work areas.

23.7.2.3. Entry Supervisor. Entry (on-site) supervisors in charge of permit-required confined space operations and who authorize entry will meet entrant training requirements, in addition to the following:

23.7.2.3.1. Recognize effects of exposure to hazards reasonably expected to be present.

23.7.2.3.2. Perform duties and responsibilities outlined in paragraph [23.2.8](#).

23.7.2.4. Attendant. Entry supervisors will ensure the attendant is trained to perform the duties and responsibilities in paragraph 23.2.9 and on the same requirements as entrant or rescue personnel if the attendant is expected to perform those functions.

#### 23.7.3. Rescue.

23.7.3.1. All personnel with responsibility for rescue from confined spaces shall receive hands-on training initially (prior to assignment to rescue duties) and annually thereafter. This training will include removing simulated victims, such as dummies, mannequins or actual persons, from actual or representative confined space that have openings and portals similar to the types from which a rescue may be performed.

23.7.3.2. Entry supervisors will ensure all rescue team members are trained in all items listed in paragraph 23.7.2.2 for entrants, as well as: **Note:** The fire chief is responsible for the currency of the FES Flight's primary and secondary rescue teams' members.

23.7.3.2.1. Rescue duties and responsibilities.

23.7.3.2.2. Use of retrieval and rescue equipment.

23.7.3.2.3. Proper wear and use of PPE.

23.7.3.2.4. CPR and Self-Aid/Buddy Care.

23.7.4. Confined Space Tester and/or Monitor. The person designated to conduct tests of confined space atmospheric conditions must be trained in the operation, calibration and care of the specific testing equipment used. The person conducting the tests must be fully trained and certified as qualified to interpret the results. The tester shall meet the training requirements of an entrant if entry is required to conduct the tests.

23.7.5. Documentation of Training. All confined space training for entry supervisors, entrants, attendants, testers and/or monitors and rescue team members shall be certified, documented and kept up-to-date. The documentation shall contain each individual's name and dates of training or retraining and either the initials or signature of the trainer and/or instructor. Documentation will indicate the type of training conducted, e.g., general awareness, formal, rescue, attendant, entrant, entry supervisor or tester/monitor. Training shall be documented on an AF IMT 55, *Employee Safety and Health Record*, or an equivalent information technology system for safety related items such as CPR or respirator use, or on an authorized computerized information management system. Training records shall be available for review by the CSPT during annual program assessments or periodic reviews.

23.7.6. Annual Review. The installation CSPT will review and assess units' training programs and rescue team training at least annually. The review/assessment will include documentation, exercises, course material and training methodologies. The CSPT will provide a copy of the annual assessment to the user organization. Annual review may be incorporated into other annual reports conducted by members of the CSPT, i.e., annual safety reports.

### 23.8. Contractor Requirements.

23.8.1. General. When an organization arranges to have a contractor perform work that involves a permit-required confined space entry, the organization shall:

23.8.1.1. Notify the contractor that work will be performed in a permit-required confined space and ensure the information is included in the statement of work (SOW) or equivalent contracting tool. **Note:** IAW AFI 91-202, *The U.S. Air Force Mishap Prevention Program*, and AFFARS Clause 5352.223-9001, *Health and Safety on Government Installations*, the installation contracting officer shall ensure all required elements including safety and health are identified in the Performance Work Statement, SOW and/or other equivalent contracting tools. It is the contractor's sole responsibility for compliance with the OSHA (Public Law 91-956).

23.8.1.2. Ensure the fire chief coordinates on the confined space entry contract and either approves or disapproves use of the rescue team supplied by the installation FES Flight.

23.8.1.3. Brief the contractor on contents of the space and known hazards that make the space permit-required.

23.8.1.4. Brief the contractor on precautions and procedures implemented by the organization to protect Air Force workers.

23.8.1.5. Establish a procedure to ensure an after-action brief is completed with the contractor at the conclusion of the contract, where the contractor can provide information regarding hazards encountered or created in the space(s).

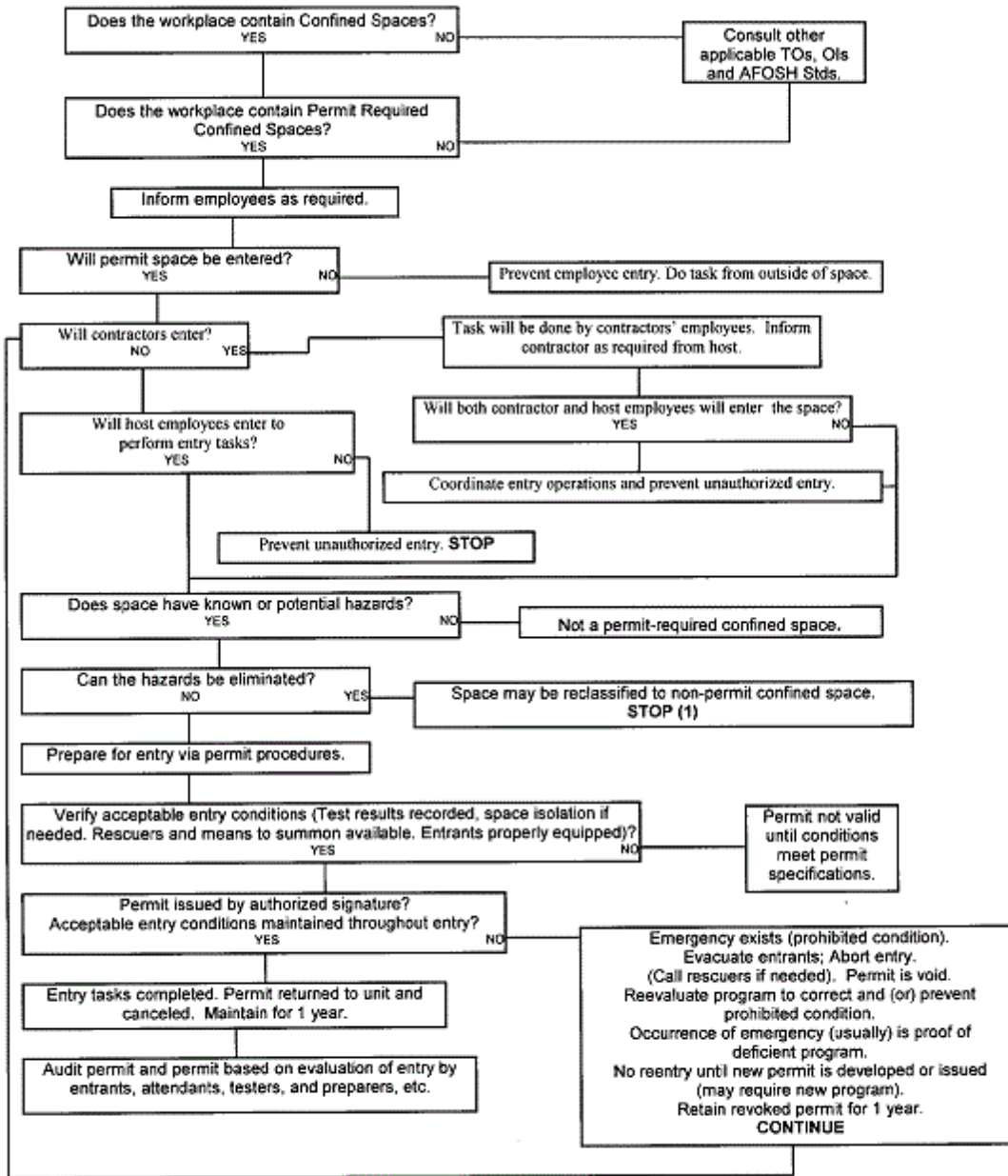
23.8.1.6. Contact the Administrative Contracting Officer (ACO) if an unsafe act or procedure is performed by the contractor.

23.8.2. Specific. Coordinate entry operations and procedures with the contractor and agree upon the permit space entry system to be used when both Air Force organizational and contractor personnel will be working in a permit-required confined space. **Note:** Contractor program must meet Air Force confined space program requirements, as a minimum, before Air Force personnel may enter a contractor permit-required confined space. The CSPT shall approve entry of Air Force personnel into contractor permit-required confined spaces.

23.8.3. If only contractor personnel will enter installation confined spaces, a CSPT may not be necessary. Refer to paragraph [23.2.5](#).



Figure 23.1. Permit-Required Confined Space Decision Flow Chart.



(1) Spaces may have to be evacuated if hazards arise during entry.

**23.9. MAJCOM Mandatory Aircraft Confined Spaces (Reference Table 23.2 below).** The following figure identifies confined spaces contained within each aircraft weapons system as defined by the MAJCOM Ground Safety office. This is not an all-inclusive list and is subject to change based on modifications in procedures and weapons system design. The all-inclusive list shall be maintained by each MAJCOM Ground Safety office for each installation under its purview and by the installation CSPT. **Note:** This list will also be posted on the AFSEC CoP website and maintained by each MAJCOM Ground Safety office. This table also specifies a minimum classification level established by the MAJCOM Ground Safety office. **Warning:**

Proper classification of a confined space depends heavily on the activity that occurs within the space. Therefore, while confined spaces with no hazards inherent within or introduced into the space are categorized as Non-Permit Required (NPR) in the table below, all have the potential to contain a hazard that could change the classification to Permit-Required (PR).

(a) If activity in the space introduces or generates any hazards, the installation CSPT must be notified to assess the classification. The installation CSPT may upgrade the classification to PR for that activity if there is potential to create a hazard.

(b) Some confined spaces contain fuel lines that are normally intact and not designed to release fuel into the space. In general, most of these spaces are classified as NPR in the table below on the basis that leaks of fuel are a rare event and the entrant would be able to detect the presence of fuel prior to entry. If there is any indication of fuel leakage (odor, visual evidence), the space must be upgraded to PR. Entrants are strongly encouraged to sample air for fuel vapor before entry into NPR confined spaces containing fuel lines as an additional means to verify no leakage has occurred. Check with BE for assistance in selecting fuel vapor detection equipment.

(c) In some confined spaces, lines containing nitrogen in liquid or gaseous form pass through the space. These lines are normally intact and not designed to intentionally release nitrogen into the space. In general, most of these spaces are classified as NPR in the table below on the basis that nitrogen leaks are a rare event and the entrant can verify the integrity of the nitrogen distribution system prior to entry. Any evidence of potential nitrogen leakage, e.g., pressure drops or maintenance history, drives an immediate upgrade of the space to PR. Additionally, due to the odorless and colorless properties of nitrogen, entrants into NPR confined spaces where nitrogen lines or bottles are present must continuously monitor for oxygen levels while in the space to verify no leakage has occurred. Refer to TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks, and Fuel Cells*, for additional guidance.

**Table 23.2. MAJCOM Mandatory Aircraft Confined Spaces.**

<b>MAJCOM Mandatory Aircraft Confined Spaces</b>	
<b>Aircraft Permit Required (PR) or Non-Permit Required (NPR) Confined Spaces</b>	
<b>Aircraft Type</b>	<b>Confined Spaces</b>
<b>A-10/OA-10</b>	Fuel Cell/Tanks (PR)
<b>B-1</b>	Aft Equipment Bay (NPR) Fuel Tanks (PR) Overwing Fairings (NPR)
<b>B-2</b>	Fuel Tanks (PR)
<b>B-52</b>	Fuel Tanks (PR) Wine Cellar (NPR)

<b>MAJCOM Mandatory Aircraft Confined Spaces</b>	
<b>Aircraft Permit Required (PR) or Non-Permit Required (NPR) Confined Spaces</b>	
<b>Aircraft Type</b>	<b>Confined Spaces</b>
<b>C-5</b>	<p>Cargo Compartment Underfloor/Bilge Area (NPR)</p> <p>Wing Dry Bays (NPR)</p> <p>Flap Pack Compartment (NPR)</p> <p>Fuel Tanks (PR)</p> <p>Power Transfer Unit Compartments (NPR)</p> <p>Center Wing Box (NPR)</p> <p>Radome Plug Access (NPR)</p> <p>T-Tail, Vertical Stabilizer (NPR)</p> <p>Wing Tip Box Beam (NPR)</p> <p>AFT Hayloft (NPR)Wing Leading Edges, Butt Line 120 to Outboard Pylon (NPR)</p> <p>Wing Root Dry Bay (NPR)</p> <p>In-Flight Refuel Manifold (RH W.S. 120 Dry Bay) (NPR)</p> <p>Forward SPR Pod/Access (PTU Compartment) (NPR)</p> <p>AFT Main Landing Gear Pod (left/right) (NPR)</p> <p>Horizontal Stabilizer (Box Access) (NPR)</p>

<b>MAJCOM Mandatory Aircraft Confined Spaces</b>	
<b>Aircraft Permit Required (PR) or Non-Permit Required (NPR) Confined Spaces</b>	
<b>Aircraft Type</b>	<b>Confined Spaces</b>
<b>C-17</b>	<p>Aft Main Landing Gear Pods, Left and Right (NPR)</p> <p>Cargo Ramp Maintenance Tunnel (NPR)</p> <p>Center Wing Dry Bay Area (PR)</p> <p>Fuel Tanks (PR)</p> <p>Fuselage and Wing Area (NPR)</p> <p>Horizontal Stabilizer Access (NPR)</p> <p>Under Floor Maintenance Tunnel (NPR)</p> <p>Uplock Assembly Area of Wheelwell (NPR)</p> <p>Vertical Stabilizer Area (NPR)</p>
<b>C-20</b>	Fuel Tanks (PR)
<b>C-21</b>	None listed
<b>C-32</b>	<p>E/E Bay, Forward of NLG (NPR)</p> <p>Fuel Tanks (PR)</p> <p>Main Entry Bay, Avionics Access Into Aircraft (NPR)</p> <p>Space Behind Aft Cargo Auxiliary Tank (NPR)</p> <p>Space Behind Forward Cargo Auxiliary Tank (NPR)</p> <p>Tail Cone Access Under Horizontal Stabilizer (NPR)</p>
<b>C-37</b>	Fuel tanks (PR)
<b>C-130</b>	<p>Fuel Tanks/Cells (PR)</p> <p>Wing Dry Bays (NPR)</p> <p>Benson Tanks (if installed) (PR)</p> <p>Avionics Bay (NPR)</p>

<b>MAJCOM Mandatory Aircraft Confined Spaces</b>	
<b>Aircraft Permit Required (PR) or Non-Permit Required (NPR) Confined Spaces</b>	
<b>Aircraft Type</b>	<b>Confined Spaces</b>
<b>C-135</b>	Center Wing Equipment Bay (NPR) Elevator Actuator Access (Hell Hole) (NPR) Fuel tanks (PR) Lower Nose Compartment (NPR) Water Tank (NPR)
<b>C-40</b>	Forward E/E Bay (NPR) Fuel Tanks (PR) Tail Access Area Above Stabilizer Jackscrew (NPR) Main EE Bay Access (NPR) Snake Pit Area (Air Dist Bay) (NPR)
<b>CT-43</b>	Aft Tail Cone Area (NPR) Fuel Tanks (PR) Forward E/E Bay (NPR)
<b>E-3C</b>	Aft Lower Lobe (NPR) Battery Compartment (NPR) Forward Lower Lobe (NPR) Fuel Tanks (PR) Rotor Dome (NPR)
<b>E-8C</b>	Fuel Tanks (PR)

<b>MAJCOM Mandatory Aircraft Confined Spaces</b>	
<b>Aircraft Permit Required (PR) or Non-Permit Required (NPR) Confined Spaces</b>	
<b>Aircraft Type</b>	<b>Confined Spaces</b>
<b>F-15 (C, D and E Models)</b>	#1 Cell Fuselage Tank (PR) #2 Cell Fuselage Tank (Feed Tank) (PR) #3A Cell (Feed Tank) (PR) Engine Intakes/Exhausts (NPR)
<b>F-16</b>	F-1 Fuel Cell (PR) Engine Intake/Exhaust (NPR)
<b>F-22A</b>	F-2 Fuel Cell (PR) F-1B Fuel Cell (PR) F-1A Fuel Cell (PR)
<b>HH-60</b>	External Door/Fuel Tanks (PR) Fuel Cell (PR)
<b>KC-10</b>	Aft Accessory Compartment (NPR) Aft Fuselage Compartment (NPR) ARO Compartment (NPR) Center Accessory Compartment (CAC) (NPR) Avionics Compartments (NPR) Bladder Fuel Cells (PR) Engine Inlets (NPR) Forward Accessory Compartment (FAC) (NPR) Forward Lower Compartment (Pool Room) (NPR) Integral Fuel Tanks (PR) Fuselage Tank Access Compartment (PR)

<b>MAJCOM Mandatory Aircraft Confined Spaces</b>	
<b>Aircraft Permit Required (PR) or Non-Permit Required (NPR) Confined Spaces</b>	
<b>Aircraft Type</b>	<b>Confined Spaces</b>
<b>QF-4</b>	Fuel Tanks (PR)
<b>T-38</b>	Fuel Cell (PR)
<b>U-2</b>	Aircraft Tailpipe (NPR)
<b>UH-1N</b>	Fuel Tanks (PR)
<b>VC-25</b>	Fuel tanks (PR)

**Figure 23.2. AF Form 1024, Confined Space Entry Permit.**

<b>CONFINED SPACE ENTRY PERMIT</b>		
<b>1. IS THIS ENTRY COVERED BY MEP</b> YES <input type="checkbox"/> NO <input type="checkbox"/>		
<b>2. GENERAL INFORMATION</b>		
LOCATION AND DESCRIPTION OF SPACE TO BE ENTERED		
PURPOSE OF ENTRY		
OPERATION COVERED BY TO OR OI		AUTHORIZED DURATION OF PERMIT
<input type="checkbox"/>	DATE:	FROM      TO
	TIME:	
<b>3. PERMIT SPACE HAZARDS (INDICATE PROBABLE HAZARDS)</b>		
<input type="checkbox"/>	OXYGEN DEFICIENT (< 19.5%)	<input type="checkbox"/>
<input type="checkbox"/>	OXYGEN ENRICHMENT (> 23.5%)	<input type="checkbox"/>
<input type="checkbox"/>	FLAMMABLE GASES OR VAPORS (> 10% LEL OR > 600 PPM)	<input type="checkbox"/>
<input type="checkbox"/>	AIRBORNE COMBUSTIBLE DUST (=>LEL OR OBSCURES VISION AT DISTANCE OF 5-FEET (1.52M))	<input type="checkbox"/>
<input type="checkbox"/>	MATERIAL HARMFUL TO SKIN	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<b>4. EQUIPMENT REQUIRED FOR ENTRY AND WORK</b> (SPECIFY SPECIFIC ITEMS REQUIRED TO INCLUDE MANUFACTURER AND PART NUMBER)		
PERSONAL PROTECTIVE EQUIPMENT		
RESPIRATORY PROTECTION		
ATMOSPHERIC TESTING/MONITORING		
COMMUNICATION		
RESCUE EQUIPMENT		
OTHER		
<b>5. RESCUE AND EMERGENCY SERVICE</b>		
NAME OF SERVICE	PHONE NUMBER	METHOD OF CONTACT
<b>6. AUTHORIZED</b>		





IS ADDITIONAL ENTRANT TIME INFORMATION ATTACHED? YES <input type="checkbox"/> NO <input type="checkbox"/>						
<b>11. REMARKS (ENTRY SUPERVISOR WILL RECORD PERMIT CLOSING TIME.)</b>						
<p>I certify that all precautions have been taken and necessary equipment is provided for safe entry and work in this confined space.</p>           <p>Work completed at: _____ Space normalized: _____</p> <p style="text-align: center;">THIS PERMIT MUST BE AVAILABLE ON JOB SITE DURING ENTRY; GOOD ONLY FOR TIME INDICATED MAINTAIN JOB SITE COPY ON FILE IN WORK CENTER FOR ONE YEAR</p>						

**23.10. INSTRUCTIONS FOR COMPLETING THE AF FORM 1024.** Paragraph **23.5.1, *Entry Into Confined Space***, requires entry supervisors ensure workers enter a permit-required confined space only after an **AF Form 1024, *Confined Spaces Entry Permit***, has been obtained. The following guidance shall be used to complete the **AF Form 1024** or equivalent.

**23.10.1. Section 1-Entry Information.** Mark the appropriate block indicating whether or not the entry permit was issued under a Master Entry Plan (MEP). If not, SEG, BE and CEF approval must be provided prior to space entry in Section 9.

**23.10.2. Section 2-General Information.** Enter the location of the confined space and indicate if the space is located on or off the installation. Include a description of the space to be entered, along with the purpose for entry. Check the block if the operation is covered by a technical order (TO) or an office instruction (OI) and identify the document. Enter the date and duration of the permit. **Note:** The entry supervisor is responsible for the following:

**23.10.2.1. Section 3-Permit Space Hazards.** Check hazard potential of the space. List hazards of the space on form; e.g., Oxygen-19 percent or Engulfment-Coal.

**23.10.2.2. Section 4-Equipment Required for Entry and Work.** List equipment by type and add any equipment not listed on the form.

**23.10.2.3. Section 5-Rescue and Emergency Service.** Identify and notify the rescue team. Include POC name, phone number and indicate the date and time when availability of the rescue service was confirmed.

**23.10.2.4. Section 6-Authorized.** List the names of all attendants and entrants for this entry. If the entry supervisor(s) will enter the permit-required space, list them as entrants. Attach an additional separate sheet if needed to list additional entrants. **Note:** Entrants are not required to sign or initial next to their names.

23.10.2.5. **Section 7-Preparation for Entry.** Identify required preparations prior to entering the permit-required confined space. Refer to the governing TO or OI as appropriate.

23.10.2.6. **Section 8-Atmospheric Testing and Monitoring Record.** The CSPT will determine the appropriate testing frequency, which shall be entered for each type hazard involved. Ensure each tester is qualified. Enter the make/model for all testing equipment along with its calibration date. Attach an additional sheet of paper if needed to record results of entry testing or monitoring of the space's atmosphere.

23.10.2.7. **Section 9-Authorized by Entry Supervisors.** The entry supervisor must sign each entry permit to validate the form. Entry permits issued from an approved MEP do not require SEG, BE or CEF representative signatures or initials. However, these representatives will review and approve all non-routine entry permits not covered by an MEP.

23.10.2.8. **Section 10-Entrant Time Log.** Enter the name of each entrant and the time of each individual's entry and exit. Check the box if additional sheets are used to track entrant data.

23.10.2.9. **Section 11-Remarks.** To aid on-site communication, include the phone number, radio call sign, etc., where the FES Flight rescue (if used) can contact the entry supervisor should rescue services become unavailable. The entry supervisor will include the permit closing time, or time and circumstances if the permit was revoked because a prohibited condition occurred.

**23.11. Confined Spaces Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

23.11.1. Has the commander and/or functional manager developed and implemented a written confined space program? Reference [23.2.7](#)

23.11.2. Does the commander and/or functional manager ensure personnel who support the permit-required confined space program are properly trained, equipped and qualified? Reference [23.2.7.2](#))

23.11.3. Does the commander and/or functional manager ensure required equipment is available and properly maintained? Reference [23.2.7.3](#)

23.11.4. Does the commander and/or functional manager maintain a current list of all confined spaces, both permit-required and non-permit, under the control of their organization? Reference [23.2.7.4](#)

23.11.5. Does the entry supervisor have a copy of the MEP? Reference [23.2.8.1](#)

23.11.6. Prior to the start of entry operations, does the entry supervisor ensure workers are properly trained and qualified in safe operating, emergency and egress procedures, and the use of PPE? Reference [23.2.8.5](#)

- 23.11.7. Prior to allowing entry to the confined space, does the entry supervisor brief workers on the hazards of the operation? Reference [23.2.8.6](#)
- 23.11.8. Does the confined space attendant maintain an accurate account of all entrants by name and time in and out of the permit-required space? Reference [23.2.9.1](#)
- 23.11.9. Does the attendant maintain continuous communication with all authorized entrants within the permit-required space via the most viable means of communication? Reference [23.2.9.3](#)
- 23.11.10. Does the attendant ensure unauthorized persons are not allowed in the permit-required space? Reference [23.2.9.7](#)
- 23.11.11. As appropriate, does the confined space entrant notify the entry supervisor when hazards existed that had not been previously identified? Reference [23.2.10.3](#)
- 23.11.12. Does the commander or functional manager identify all confined spaces within their organization, located both on and off the installation? Reference [23.3.2](#)
- 23.11.13. Do functional managers and entry supervisors ensure the organization's confined spaces are evaluated and tested prior to being classified? Reference [23.3.2](#)
- 23.11.14. Is initial testing of confined spaces accomplished by a technically qualified member of the installation CSPT prior to the space being classified? Reference [23.3.3](#)
- 23.11.15. Are danger signs posted at permit-required confined spaces, as appropriate? Reference [23.3.5](#)
- 23.11.16. Does the entry supervisor establish a frequency for atmospheric monitoring and the type of tests to monitor the tests, and ensures the requirements were entered on the MEP and entry permit? Reference [23.3.9](#)
- 23.11.17. Does the entry supervisor ensure workers obtain an **AF Form 1024, Confined Spaces Entry Permit**, prior to entering a permit-required confined space? Reference [23.5.1](#)
- 23.11.18. Are entry permits, including those canceled or revoked, retained on file for one year? Reference [23.5.1.2](#)
- 23.11.19. Does the entry supervisor ensure entry into known IDLH spaces are only authorized after the required conditions for IDLH are met? Reference [23.5.3](#)
- 23.11.20. Does the entry supervisor ensure workers entering IDLH spaces are equipped with proper PPE, including a positive pressure SCBA and a harness of a type suitable to permit extraction of the worker? Reference [23.5.3.4](#)
- 23.11.21. Does the entry supervisor ensure only explosion-proof or intrinsically safe equipment is used when flammable or explosive atmospheres are present for IDLH operations? Reference [23.5.3.7](#)
- 23.11.22. Does the entry supervisor ensure a qualified FES Flight specialist is present during all IDLH space operations? Reference [23.5.3.9](#)
- 23.11.23. When additional hazards are present or may be introduced in a permit-required operation, does the entry supervisor ensure the hazards are adequately addressed on the entry permit? Reference [23.5.4.4](#)

- 23.11.24. When toxic materials are present or may be introduced in a permit-required operation, does the entry supervisor contact BE to determine the necessity for respiratory protection equipment? Reference [23.5.4.4.1](#)
- 23.11.25. Does the organization have a MEP, as appropriate? Reference [23.5.4.10](#)
- 23.11.26. Are entry permits revoked whenever any testing in the space is not within established parameters in the MEP? Reference [23.5.4.10.5](#)
- 23.11.27. Is an **AF Form 592, USAF Welding, Cutting, and Brazing Permit**, obtained by workers prior to performing hot riveting, welding, cutting, burning or heating operations within a confined space? Reference [23.5.5](#)
- 23.11.28. Does the commander or functional manager ensure non-permit required confined spaces are reviewed periodically (but no less than annually)? Reference [23.5.6.2](#)
- 23.11.29. Does the MEP include emergency and rescue procedures consistent with the nature of each operation that requires entry into a permit-required confined space? Reference [23.6.1](#)
- 23.11.30. Does the entry supervisor ensure an organization rescue team is available when the installation FES Flight is unable to provide a team? Reference [23.6.1.3](#)
- 23.11.31. Does the entry supervisor ensure all members of the rescue team is trained and current in CPR and basic first aid during permit-required confined space entry operations? Reference [23.6.1.3.2](#)
- 23.11.32. Does the entry supervisor ensure the inspection, testing, maintenance and documentation of safety and rescue equipment are accomplished prior to an operation being performed? Reference [23.6.2](#)
- 23.11.33. Does the organization have an effective training program that incorporates safe work practices and techniques? Reference [23.7.1](#)
- 23.11.34. Does the organization ensure each member assigned permit-required confined space duties is trained prior to being assigned? Reference [23.7.1.3](#)
- 23.11.35. Does the organization ensure all individuals authorized and assigned permit-required confined space entry duties complete site-specific training? Reference [23.7.2](#)
- 23.11.36. Do all rescue team members receive initial and annual hands-on training in removing simulated victims from actual or representative confined spaces? Reference [23.7.3.1](#)
- 23.11.37. Does the installation CSPT periodically review and assess the rescue team training? Reference [23.7.5](#)
- 23.11.38. Is confined space training documented on an AF IMT 55, *Employee Safety and Health Record*, or an authorized computerized information management system? Reference [23.7.5](#)
- 23.11.39. Does the organization ensure all of the requirements are met prior to a contractor performing work that involves a permit-required confined space entry? Reference [23.8.1](#)

23.11.40. Does the organization coordinate entry operations and procedures with the contractor prior to both organizational and contractor personnel working in a permit-required confined space? Reference [23.8.2](#))

## Chapter 24

### AIRCRAFT FLIGHT LINE – GROUND OPERATIONS AND ACTIVITIES

#### 24.1. General Information.

##### 24.1.1. Hazards.

24.1.1.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on job safety analysis (JSA) and job safety lesson plan. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process. Example: TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

24.1.1.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance on these subjects.

24.1.2. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of industrial work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph **2.3** for additional information.

#### 24.2. Specific Requirements.

24.2.1. Guidance. Supervisors and managers shall follow AFI 91-202, aircraft-specific procedural TOs and other TOs and safety standards applicable to their areas of responsibility.

24.2.2. Fire Prevention. Aircraft servicing and maintenance facilities shall conform to Air Force design criteria or equivalent Air Force-approved engineering guidance to minimize fire and explosion hazards. Contractor aircraft maintenance facilities shall conform to this standard and National Fire Codes. Refer to paragraph **24.17** for additional guidance on contractor operations.

24.2.3. Cardiopulmonary Resuscitation (CPR)/Self-Aid Buddy Care (SABC). Aircraft maintenance and support shop workers exposed to electrical hazards from energized aircraft electrical systems, aircraft components or aircraft equipment shall be provided CPR and SABC training. This includes personnel who act as safety observers. CPR/SABC training shall include bleeding control (bloodborne pathogens training and disposal instructions), shock management and emergency care of open wounds and burns. **Note:** Universal precautions must be observed. Infection control requires the supervisor and worker to assume that all human blood and specified human body fluids are infectious for HBV, HIV and other bloodborne pathogens. Where differentiation of types of body fluids is difficult, all body fluids are to be considered as potentially infectious. Any person in the performance of their duties who could reasonably be expected to come in contact with blood or other potentially infectious materials must be trained IAW 29 CFR 1910.1030, *Bloodborne Pathogens*.

24.2.3.1. Installation unit maintenance commanders and supervisors may identify other job tasks that require CPR/SABC training based on hazards associated with tasks performed. Unit CPR instructors may be trained by host installation medical personnel or

certified through the American Red Cross or the American Heart Association. All personnel requiring CPR/SABC training shall receive refresher training at least every two (2) years.

24.2.3.2. AF IMT 55, *Employee Safety and Health Record*, or an equivalent record shall be used to document CPR/SABC training unless other documentation is specified elsewhere. Documentation shall be maintained by the work center supervisor.

24.2.4. Lifting Devices. Improper handling and lifting of heavy parts can injure personnel and damage aircraft components. Maintenance personnel shall be familiar with the directives and general safety standards for equipment they use. Engines and other heavy parts shall be handled with hoists, approved hoisting slings and similar equipment. Safe load capacities shall be stenciled on all hoists and strictly observed by operating personnel. Personnel shall not work under suspended loads. Inspect hoisting equipment IAW **Chapter 35**, *Materials Handling Equipment*, technical orders (TOs), ANSI standards and/or the manufacturer's manual(s). Defective hoists shall be locked and/or tagged out of service and shall remain out of service until repairs are complete. Weight testing of all lifting devices shall be IAW **Chapter 35** and/or applicable TOs.

24.2.5. Compressed Air. Only qualified, trained and authorized workers shall operate air compressors and/or repair or adjust pressure-regulating equipment. Compressed air shall not be used to clean workers or clothing while on their body. Compressed air used for breathing shall meet requirements of TO 42B-1-22, *Quality Control of Compressed and Liquid Breathing Air*, and AFOSH Standard 48-137, *Respiratory Protection Program*.

24.2.5.1. Compressed air shall not be used for cleaning purposes except when regulated to 30 psi or less, and then only when effective chip guarding, air diffuser and eye protection are used.

24.2.5.2. Before servicing any aircraft systems or components, e.g., aircraft tires, air bottles or landing gear struts, mechanics shall:

24.2.5.2.1. Inspect all chucks and valve stems for serviceability to ensure safe servicing.

24.2.5.2.2. Not over-inflate these components.

24.2.5.2.3. Install pressure regulators to prevent over-pressurization of components.

24.2.5.2.4. Wear proper PPE and eye protection IAW TO and local installation directives.

24.2.5.2.5. Ensure appropriate equipment has been calibrated, as required.

24.2.5.3. Air Lines and Fittings. Workers shall:

24.2.5.3.1. Avoid bending or kinking air hose lines.

24.2.5.3.2. Place air hose lines where they minimize a tripping hazard and are protected against damage caused by equipment or vehicles rolling over them.

24.2.5.3.3. Inspect air lines and fittings for defects before each use.

24.2.5.3.4. Ensure non-interchangeable chucks and connections are used on high- and low- pressure equipment to preclude servicing low-pressure systems with high-pressure equipment.

24.2.5.4. A drain pipe and valve shall be installed at the lowest point of the air receiver to remove accumulated oil and water. The air receiver drain valve, if not automatic, shall be opened and receiver completely drained daily to prevent accumulation of excess fluids.

24.2.6. Oxygen and Nitrogen (Liquid and Gaseous). Oxygen is not flammable, but supports combustion. Fire or explosion may result if oxygen contacts petroleum products, alcohol or other flammable or combustible materials. Oxygen systems subject to excessive pressures may result in rupture and explosion. Liquid oxygen (LOX) and liquid nitrogen (LN<sub>2</sub>) are extremely cold, can cause serious burns and can freeze skin upon contact. Nitrogen also depletes oxygen in unventilated, confined areas. Refer to **Chapter 43**, *Liquid Nitrogen (LN<sub>2</sub>), Oxygen (LOX) and Cryogen*, for additional guidance.

24.2.6.1. Personnel Training and Safety. Only fully trained and qualified personnel shall operate oxygen and nitrogen equipment or service aircraft systems. Servicing personnel shall understand the system being serviced, operation of their equipment and precautions and instructions for handling liquid or gaseous oxygen and nitrogen. A trainee may service only if directly supervised by a qualified supervisor or operator. Personnel engaged in oxygen handling and servicing operations shall strictly adhere to pertinent safety standards and TOs.

24.2.6.2. Mobile Servicing Units or Bottles. Mobile servicing units or bottles used to service aircraft or components shall be carefully positioned and not left unattended after hook-up or during servicing operations.

24.2.6.3. Aircraft oxygen systems (both gaseous and liquid) shall be emptied/drained prior to entering a major maintenance cycle at either an Air Logistics Center, Contract Repair Facility or Contract/Depot Field team location. Safeguards shall be taken while performing aircraft servicing or maintenance operations to prevent inherently or accidentally introducing ignition or combustible sources. Refer to TO 00-25-172 for additional guidance.

24.2.7. Aircraft arresting systems may pose hazards to aircraft and vehicle operations and shall follow guidance in AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arresting Systems*.

24.2.8. Confined Spaces. Supervisors shall ensure workers comply with requirements in **Chapter 23**, *Confined Spaces*, when entering confined spaces. Personnel will not enter confined spaces without training.

24.2.9. Red Ball. Red Ball situations require urgent and priority action to prevent late takeoffs and ground aborts. Their time-critical nature requires qualified maintenance personnel be immediately available, i.e., in a truck nearby on the flight line or standby in a shop, during aircraft launch and recovery operations to troubleshoot, isolate and repair system malfunctions. Maintenance personnel shall not deviate from authorized maintenance



procedures or violate any flight line requirements, i.e., flight line speed limits or safety requirements, during Red Balls.

24.2.9.1. TOs, tools, rags, parts, unused supplies and checklists shall be accounted for before the aircraft is allowed to taxi/takeoff.

24.2.9.2. Emphasis will be placed on FOD awareness/prevention during this critical maintenance operation.

24.2.9.3. If aircraft engines are operating, a safety observer (maintenance or aircrew member) shall maintain interphone communications or remain in full view of the flight crew and be positioned to maintain overall surveillance of the aircraft and personnel performing maintenance.

24.2.9.4. Weapons loaded aircraft shall be safed IAW applicable MDS and/or weapons specific technical data.

### **24.3. Flight Line Potentially Hazardous Areas and Operations.**

24.3.1. Flammable Fuel Vapor Areas. Supervisors shall ensure all personnel are aware of potentially flammable fuel vapor areas and the restriction against ignition sources in these areas. Fuel vapors are heavier than air, settle to ground level and will enter below-ground areas. These areas include, but are not limited to, fuel pits below ground level, areas within 10 feet of aircraft fuel vent systems and fuel spills, hydrant pump houses and fuels laboratories. Spark arresters are not required on general or special purpose vehicles driving on the flight line and around aircraft. However, these vehicles are not designed, certified or authorized to operate in flammable fuel vapor areas. Workers in flammable fuel vapor areas shall receive specialized training emphasizing hazards associated with these operations. Refer to AFMAN 91-201, *Explosive Safety Standards*, paragraph 8.34.2., for requirements for spark arresters on general or special purpose vehicles within or near structures containing exposed explosives. Not rated/approved equipment shall be turned off or removed from the area during refueling operations and fuel cell/tank work, unless permitted by TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells*. Only explosion-proof, intrinsically safe radios/equipment or equipment incapable of having sufficient energy to be an ignition source (approved by competent authority, e.g., HQ AFSEC, HQ AFMC, HQ AFCESA) shall be used in and around flammable fuel vapor areas. Refer to NFPA 70, Article 501, Class I Locations, for additional information.

24.3.2. Electrical Receptacles. Electrical receptacles on the flight line are protected from weather conditions and are not protected against explosive hazards. Aircraft fueling and defueling operations shall not be conducted where outside electrical receptacles are installed. If separation is not possible, receptacles in the immediate area of the fueling or defueling operations shall be deactivated, using lockout and tagout procedures (service/administrative lock procedures) IAW **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*.

24.3.3. Aircraft Maintenance Operations. Aircraft maintenance operations in hangars, shelters or docks (closed or semi-enclosed) on the flight line or outside maintenance areas, such as wash racks, shall be accomplished IAW Air Force guidance or recognized national consensus standards. MAJCOMs/units operating in overseas or remote areas may supplement this standard to meet international or host country safety requirements or unique working conditions.

24.3.3.1. Electrical Devices and Power Equipment. All fixed and installed electrical devices and fixed power equipment in hangars, shelters or docks shall comply with Air Force design criteria or equivalent Air Force-approved engineering guidance. Portable electrical equipment in Class I, Division 1 and Class I, Division 2 locations shall be explosion-proof or intrinsically safe and shall comply with NFPA 70, *National Electrical Code* or shall be approved by competent authority, e.g., HQ AFSEC, HQ AFMC, HQ AFCESA, to show that the equipment is incapable of having sufficient energy to be an ignition source. Items listed in TO 00-25-172, paragraph 3-9e, can be used in Class 1, Division 2 locations. Equipment not meeting this requirement may be temporarily approved by the installation fire chief prior to the use of the equipment. Approval shall be documented in writing, stating the area, nature, duration and the reason for the exception. If the working environment has been tested and contains flammable fuel vapors, all maintenance activities shall be stopped until the hazardous condition is eliminated and a safe work environment restored. Equipment in an area with a high potential for flammable fuel vapor release and that can be automatically energized when unattended shall be considered for explosion-proof or intrinsically-safe design.

24.3.3.2. Smoking. Smoking is prohibited in aircraft maintenance facilities, flight line areas and weapons storage and maintenance areas unless designated by the installation Fire Emergency Services (FES) Flight in coordination with the Maintenance Group Commander or equivalent, Airfield Manager and/or the functional manager.

24.3.3.3. Aircraft Fuels Management and Servicing. Fuel system maintenance and servicing operations shall be IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, [Chapter 36](#), *Hydrocarbon Fuels*, and other applicable TOs. Aircraft fuel cell and integral tank inspections and repairs shall be IAW TO 1-1-3.

24.3.3.4. Cleaning Parts. Parts shall be cleaned with approved high flashpoint or nonflammable solvents or compounds whenever possible. Do not clean aircraft parts, hangar floors, equipment or clothing with gasoline or unauthorized solvents. Operations requiring low flashpoint solvents shall be considered hazardous and performed in a facility or area compatible with the solvents.

24.3.3.4.1. Flammable liquids shall be kept in approved containers, marked to identify contents and stored in buildings/areas specifically approved by the installation FES Flight. Refer to [Chapter 22](#), *Flammable and Combustibles*, for additional guidance.

24.3.3.4.2. Wiping cloths, oily waste and other combustible materials shall be disposed of IAW paragraph [24.11.2.2](#).

24.3.3.4.3. Proper ventilation shall be maintained and proper protective clothing used when working with solvents. Refer to AFI 90-821, *Hazard Communication*, and [Chapter 35](#) when handling and using hazardous materials.

24.3.3.5. Welding on Aircraft. Welding on aircraft shall be done outside of hangars if possible. An **AF Form 592**, *USAF Hot Work Permit*, shall be issued prior to aircraft welding operations. Welding shall only be performed on aircraft system components IAW applicable aircraft technical data and [Chapter 27](#), *Welding, Cutting, and Brazing*.

Welding operations in hangars shall meet the requirements of NFPA 410, *Standard on Aircraft Maintenance*, **Chapter 6**. Refer to American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for industrial ventilation requirements during welding on aircraft.

24.3.3.6. Fire Extinguishers. Suitable fire extinguishers shall be placed throughout flight line and maintenance areas, within easy reach of the operator and close to ground power equipment. Refer to TO 00-25-172, Table 3-1, for flight line operations fire extinguisher requirements and **Chapter 6**, *Fire Protection and Prevention*, for additional information.

24.3.3.7. Nondestructive Inspection (NDI). NDI operations involving ionizing radiation (normally X-ray operations) shall be conducted IAW TO 33B-1-1, *Nondestructive Inspection Methods, Basic Theory*. The installation Ground Safety office, FES Flight and BE shall approve flight line X-ray procedures and locations.

24.3.4. Hazardous Noise. Personnel assigned to the flight line may be exposed to hazardous noise levels. Supervisors shall ensure assigned personnel adhere to engineering controls, administrative controls and properly wear PPE. Refer to AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, for additional guidance.

**24.4. Additional PPE Requirements.** The information below is specific to flight line operations and activities and is in addition to the PPE requirements of **Chapter 14**. Maintenance workers shall wear heat-resistant gloves and long-sleeve shirts to prevent burns when working around hot exhaust or tail pipes.

24.4.1. Head Apparel. Hats or caps shall not be worn on the flight line or in an engine intake danger zone (see specific aircraft TO) while engines are operating. Visitors or observers shall be briefed on removal of hats and carrying of objects on the flight line or near jet engines.

24.4.1.1. Bump caps may be worn when working in and around aircraft for protection from minor bumps and lacerations, but not during engine starts and run-ups unless engine inlet ducts are equipped with run-up screens. Bump caps shall not be substituted for hard hats.

24.4.1.2. Metal, plastic or leather hair fasteners and wigs shall not be worn during aircraft maintenance. A rubber band or hair net (with no metal parts) that holds the hair wrapped in a bun at the back of the head may be worn. Umbrellas are not permitted on the operational flight line except when assisting passengers on or off aircraft during inclement weather. Criteria in **Chapter 14**, *Personal Protective Equipment (PPE)*, shall be used when aircraft or equipment TOs do not provide specific PPE guidance. When in doubt, consult the installation Ground Safety office and BE. **Note:** Helmets to protect workers from impact and flying objects must meet requirements in **Chapter 14**.

24.4.1.3. For flight line operations, in extreme cold weather regions, where the temperature dips below freezing (32° F), the wear of a thick knit hat, "beanie" (skull cap) or appropriate headwear approved by the Maintenance Group Commander in coordination with the Ground Safety office is authorized.

24.4.2. Footwear. Protective footwear shall be provided and worn when there is a reasonable possibility of foot injuries. Metallic shoe cleats and taps can generate sparks and create

foreign object damage (FOD) hazards and shall not be worn on the flight line. **Exception:** In areas subject to heavy to severe snow/ice conditions, organizations, with approval from their MAJCOM or higher headquarters Chief of Safety, may permit use of removable metallic shoe cleats to improve traction on ice/snow covered surfaces and prevent worker slips and falls. Organizations shall define the type(s) of footwear to be worn, the conditions and locations where such footwear may be worn, and procedures/controls to prevent cleats/spikes/studs becoming a FOD hazard. Refer to [Chapter 14](#) for additional guidance. **Note:** Cleats will not be worn working on or inside aircraft, near fueling, defueling or fuel cell repair type operations, or operations using flammable solvents, paints, etc.

24.4.3. Jewelry. Refer to [Chapter 14](#), *Jewelry*, for detail and additional guidance.

24.4.4. Reflective Materials.

24.4.4.1. Vehicle and Equipment Marking. Vehicles, ground servicing and ground powered equipment shall be marked with reflective materials to the maximum extent authorized by appropriate TOs, such as TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenance*, and TO 35-1-3, *Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE)*. Fire extinguishers and all hazardous obstacles on or adjacent to the flight line shall be marked with reflective material.

24.4.4.2. Bicycles. All bicycles (Air Force and privately owned) operated on the flight line during the hours of darkness shall be equipped with a suitable headlight (turned on and provides adequate illumination) and reflective markings front and rear. Also see paragraph [24.13.5.3](#).

24.4.5. Jet Intakes. Mechanics entering jet intake sections shall wear appropriate PPE. A pocket-less, zipper-less, button-less bunny-suit, cloth over-boots or stocking feet, boots removed, for intakes only, shall be worn whenever physical entry into an aircraft intake or exhaust is required. To minimize heat stress during high heat/humidity conditions, i.e., air temperatures above 85° F, workers in engine intakes may wear half-bunny suits and garments designed for use over trousers. When worn with a pocket-less T-shirt, these items provide the same level of FOD protection as a full bunny suit. Units using half-bunny suits shall have procedures in place to control use.

24.4.6. LOX/LN<sub>2</sub> Transfers.

24.4.6.1. When transferring LOX, personnel shall wear the following PPE (all items shall be clean and free of grease, oil and fuel):

24.4.6.1.1. Head covering.

24.4.6.1.2. Eye protection (goggles).

24.4.6.1.3. Face shield (NSN 4240-00-542-2048) or locally purchased hard hat face shield combination. **Note:** Face shield is secondary eye protection and must be worn in conjunction with primary eye protection (goggles).

24.4.6.1.4. Gloves (loose fitting), leather, welder's gauntlet cuff (DLA-A-50022) (NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (DLA-A-55213) (NSN 8415-00-964-4760), medium as an insert; or

24.4.6.1.5. Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673) or equivalent.

24.4.6.1.6. Apron (NSN 8415-00-082-6108).

24.4.6.1.7. Coveralls, cotton white (mandatory) (NSN 8405-00-037-9274).

24.4.6.1.8. Cuff-less trousers.

24.4.6.1.9. Long sleeve shirt.

24.4.6.1.10. Jacket (optional).

24.4.6.1.11. Shoes, which fit closely around the top, with rubber soles and heels.

24.4.6.2. When transferring LN<sub>2</sub>, personnel shall wear the following protective clothing and equipment (all items shall be clean and free of grease, oil and fuel):

24.4.6.2.1. Head covering.

24.4.6.2.2. Eye protection (goggles).

24.4.6.2.3. Face shield (NSN 4240-00-542-2048).

24.4.6.2.4. Gloves (loose fitting), leather, welder's gauntlet cuff (Federal Specification KKG486, Type II, NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (MIL G-1057E) (NSN 8415-00-964-4760), medium as an insert; or

24.4.6.2.5. Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673).

24.4.6.2.6. Apron (NSN 8415-00-082-6108).

24.4.6.2.7. Coveralls, cotton white (mandatory) (NSN 8405-00-037-9274), or

24.4.6.2.8. Jacket.

24.4.6.2.9. Cuff-less trousers.

24.4.6.2.10. Long sleeve shirt.

24.4.6.2.11. Shoes, which fit closely around the top, with rubber soles and heels.

**Note 1:** The above NSN data is for gloves, size "medium." Other sizes may be ordered as required, but all sizes must meet the criteria of the federal and military specifications identified above.

**Note 2:** The wool glove insert and cotton knit cloth work gloves used as inserts can be used interchangeably with either welder's gauntlet cuff leather gloves or leather gloves specified above.

**Note 3:** A leather boot approximately eight (8) inches in height with close fitting top and rubber soles and heel is recommended, since LOX spills normally subject one's foot area to a freeze burn exposure hazard. This type footwear when equipped with a hard protective toe area is generally classified as a safety shoe or boot.

## 24.5. Aircraft Parking Requirements.

24.5.1. Strict adherence to standards ensures the safety of parked aircraft. Specific parking locations shall be designated for each aircraft IAW AFH 32-1084, *Facility Requirements*. Generally, distances between parked aircraft, wingtip to wingtip, shall allow immediate access of emergency vehicles and permit free movement of equipment and materials. Refer to AFH 32-1084 for specific aircraft wingtip distances. Also see UFC 3-260-01, *Airfield and Heliport Planning and Design*. Refer to AFMAN 91-201, *Explosive Safety Standards*, and TO 11A-1-33, *Handling and Maintenance of Explosives Loaded Aircraft*, for parking explosives loaded aircraft.

24.5.2. Temporary Parking. A qualified ground observer shall be used to warn oncoming traffic when temporarily parked aircraft extend into an active taxiway. A suitable flag will suffice in daytime; however, when dark, a high-visibility reflective vest and red warning light shall be used. A ground observer shall remain with the aircraft until moved to a safe location. Vehicles parked on the flight line shall be parked with the driver's side door facing aircraft, ignition turned off, keys in the ignition and the gear lever in reverse (manual transmission) or park position (automatic transmission) and the brake set. Chock all powered vehicles and all equipment mounted on wheels that do not have an integral braking system when left unattended on the flight line. Chocks will be placed in front of and behind a rear wheel, or one chock placed between the tandem wheels of dual (tandem) axle vehicles.

24.5.3. Wheel Chocking. Aircraft wheel chocks, fabricated IAW MIL-PRF-32058, *Chock, Wheel-Track-Aviation, Adjustable Rope Type*, and/or the aircraft Dash 2 TO, shall be placed fore and aft of the main landing gear or as specified in applicable aircraft TOs. Vehicle chocks shall meet Commercial Item Specification A-A-52475 or be made IAW TO 00-25-172.

24.5.4. Clean Parking Areas. Maintenance equipment, workstands, loose aircraft parts and materials not actually required for work in progress or planned, shall be moved from the aircraft parking area to designated storage locations. Equipment stored outside buildings shall be tied down and/or chocked or brakes applied to prevent movement by wind or engine blast. Mobile work platforms and stands shall be moored/tied down when in designated storage locations to prevent collision with aircraft, vehicles or other equipment. Designated flight line support equipment storage areas shall be determined by the AGE Flight Commander and Airfield Manager and approved by the Maintenance Group Commander or equivalent in coordination with the installation Ground Safety office.

24.5.5. Taxi/Tow Lines. Taxi/tow lines shall be painted on ramp, taxiway and hangar parking areas to aid safe movement of aircraft and vehicle traffic. Parking lines will have spots painted where the nose or forward wheel of the aircraft shall be positioned. Hangars used for parking helicopters shall have parking lines and rotor blade lines painted on the floor to prevent the blades contacting hangar walls. Lines are not required if: numerous types of aircraft use the same facility and multiple paint lines would be confusing, fixed objects are marked and identified, an aircraft parking plan is established, wing and tail walkers are used during hangaring operations and streamers are placed on rotors or wingtips. **Exception:** Under emergency conditions, streamers on helicopters when hangaring are not required. Nose docks or other maintenance facilities shall have spots painted where each aircraft wheel (forward, aft and outrigger) shall be positioned to prevent aircraft striking the building during

docking and undocking. Taxi/tow lines shall be painted on wash rack pavement to help position aircraft.

24.5.6. Mooring or Tie-Down of Aircraft. Follow applicable aircraft TOs and use designated fittings on aircraft. Normally, square or bowline knots shall be used to provide secure rope fastenings. Allow sufficient slack to prevent excessive stress on wings, fittings and rope from tire or strut expansion or deflation and contraction of tie-down ropes when wet. Aircraft mooring points shall be placed directly over ground mooring points, or as close as possible.

24.5.7. Aircraft Emergency Removal. Emergency procedures shall be developed to remove endangered aircraft in the event of fire, adverse weather or other emergency situations on the flight line or in hangars. Refer to paragraph [24.14.15](#).

24.5.8. C-130 Aircraft. Personnel will not enter the plane of rotation of the propellers except by walking around the outside (number 1 or number 4) propeller arcs. **Exception:** If bleed air is not supplied to the aircraft, personnel may enter the plane of rotation for preflight inspections and maintenance actions.

#### 24.6. Adverse Weather Conditions.

24.6.1. IAW [Chapter 11](#), *Weather Safety*, each Air Force installation shall develop local procedures to notify key personnel and agencies with high risk activities IAW the installation weather support document, and establish a lightning safety program with a two-tiered notification system to minimize exposure to lightning hazards. Refer to [Chapter 11](#) for further guidance.

24.6.2. The local base weather organization may, IAW the weather support document, initiate notification of adverse weather conditions (includes strong surface winds, heavy rain, freezing precipitation, thunderstorms, lightning and hail) to predetermined support agencies. Notification may also be initiated by a supporting operational weather squadron/flight providing meteorological watch duties for the installation.

24.6.3. Safeguarding Aircraft. Winds of 20 knots or greater can damage aircraft. When possible, aircraft shall be evacuated to safe weather areas when tornadoes, hurricanes or winds in excess of 50 knots are forecasted. Local high wind and severe weather safety plans shall be developed to include an evacuation plan and hangaring of installation and transient aircraft. The option to evacuate is the installation commander's decision in coordination with the appropriate MAJCOM.

24.6.3.1. Taxiing Aircraft. Avoid taxiing aircraft during unusually high winds (defined by local weather support document). Taxi only at the discretion of the wing commander when the action will lessen the possibility of aircraft damage.

24.6.3.2. Outside Parking. If possible, park aircraft inside hangars. Light aircraft shall be given priority over heavy aircraft for parking inside hangars. Aircraft parked outside shall be faced into the wind and tied down. Wing spoilers shall be used when necessary to reduce airfoil lift. Transient aircraft shall be parked inside hangars, if space permits, or tied down as directed by the Maintenance Group Commander or equivalent.

24.6.3.3. When To Tow Aircraft. Light aircraft in docks or extending outside hangars shall be towed clear and parked IAW applicable aircraft TOs when winds exceed 30 knots (sustained or gusts). Medium or heavy aircraft in docks or extending outside

hangars shall be towed clear and parked IAW applicable aircraft TOs when winds exceed 50 knots (sustained or gusts). Refer to [Table 24.1](#) for additional information.

24.6.3.4. Working Materials. All maintenance equipment, workstands, loose aircraft parts, flight line fire extinguishers and materials not in use shall be removed from aircraft parking areas and stored in a safe area. Equipment remaining outside shall be secured against wind movement.

24.6.3.5. Personnel. When winds reach velocities greater than 40 knots, activities other than those required to safeguard the aircraft shall be suspended and avoided.

24.6.4. C-5 and Wide-body Staircases. Caution is required when using C-5 staircase trucks during high wind conditions. Wide-body and C-5 staircases are designed to withstand a maximum wind velocity of 60 mph/52 knots. Wide-body staircase trucks may be used to upload/download passengers whenever wind velocity (including gusts) on the ramp area is at or below 40 mph/35 knots. C-5 staircase trucks may be used to upload/download passengers whenever wind velocity (including gusts) on the ramp area is at or below 29 mph/25 knots. If wind velocity (including gusts) on the ramp area exceeds 40 mph/35 knots, ATOC senior controller/superintendent shall decide on a case-by-case basis whether the wide-body staircase will be used and then so direct. C-5 staircases will not be used to upload/download passengers whenever wind velocity (including gusts) on the ramp area exceeds 29 mph/25 knots. This standard applies whenever a wide-body or C-5 staircase truck is used on any aircraft.

**Table 24.1. Adverse Weather High Wind Safeguards.**

<b>Adverse Weather High Wind Safeguards</b>			
	<b>Winds 20-30 Knots</b>	<b>Winds 31-50 Knots</b>	<b>Winds Over 50 Knots</b>
Required Actions Personnel will adhere to locally established high wind safety precautions, plans, and checklists developed by each functional area and observed along with the guidance presented. Criteria for advisories varies from state to state; local procedures shall consider these factors.	Ensure all aircraft precautionary actions are taken IAW applicable TOs, Directives and Publications.	In addition to high wind precautions secure all materials and maintenance equipment.	In addition to high wind precautions, have all nonessential personnel move to shelter or remain in their duty section. <b>WARNING:</b> Do not open canopy hatch or any access door or remove any covers when winds are in excess of 50 knots.
	Ensure all non-essential AGE and other loose equipment is removed from the flight line and secured (except fire extinguishers)	Hangar all aircraft with less than 15,000 pounds gross weight (i.e. engines removed, no fuel)	ALL AGE must be removed from flight line. Maximum number of aircraft shall be hangared.



<b>Adverse Weather High Wind Safeguards</b>			
	<b>Winds 20-30 Knots</b>	<b>Winds 31-50 Knots</b>	<b>Winds Over 50 Knots</b>
	If aircraft is not being worked, ensure all RADOMES, canopies and access panels/doors are closed and secured.	Hangar all aircraft with canopies and/or RADOMES removed.	All non-essential personnel shall seek shelter or remain inside their duty sections.
	Ensure all protective covers are installed on aircraft.	Aircraft should be triple chocked and laced.	For winds in excess of 70 knots, moor aircraft IAW applicable TOs; clear ramp.
		Secure all equipment.	Consider evacuation of aircraft.

**Note 1:** This table shall be used as a guide in tying down, hangaring or evacuating aircraft.

**Note 2:** Installation Commander is the governing authority on the evacuation of installation aircraft.

#### **24.7. Towing and Taxiing Aircraft.**

24.7.1. Towing Operations. Refer to AFI 21-101, *Aircraft and Equipment Maintenance Management*, for vehicle operator's aircraft towing responsibilities and qualifications. A tow operation will consist of trained and qualified workers, thoroughly familiar with aircraft towing responsibilities including TO and local procedures and conditions, such as inclined ramps, emergencies, other local limitations and weather conditions. For maximum safety, tow team workers shall not place themselves in the direct path of aircraft wheels nor ride on any external portion of an aircraft or tow vehicle. When connecting a tow bar to the tow vehicle, workers shall stand clear until the backing tow vehicle is in close proximity to the tow bar. When connecting a tow vehicle to the aircraft, workers shall watch for any sudden tow vehicle movement. Avoid backing aircraft when possible. MAJCOMs may authorize movement of aircraft into hardened aircraft shelters (HAS) while the aircraft engines are operating, provided a System Safety Engineering Analysis (SSEA) has been conducted. An SSEA shall be conducted for each type or generation shelter and type of aircraft to be moved into the shelter. **Note:** Technical data takes precedence over this standard when differences exist in towing procedures.

24.7.2. Qualified Personnel. All aircraft tow team members shall be familiar with all published towing procedures for the aircraft being towed. Supervisors shall conduct written proficiency tests on local procedures and an operating standards review at least annually. Newly assigned aircraft maintenance specialists shall pass a proficiency test on the types of aircraft towed after completing supervised on-the-job training (OJT). Wing and tail walkers shall be familiar with all published towing procedures for the aircraft being towed but do not require annual proficiency training if their duties are restricted to these positions during towing operations. Tow team supervisors shall ensure all team members are qualified per requirements above and shall clearly define duties and responsibilities at the time of the pre-

tow briefing. Refer to paragraphs [24.7.2.3](#), [24.7.2.4](#), [24.7.2.5](#) and [24.7.2.7](#) for additional information.

24.7.2.1. Tow Team Supervisor. The tow team supervisor shall be in complete command and will take a position that will ensure surveillance of the towing procedures and performance of other team members. Normally, this will be the position of nose walker. The supervisor shall use a checklist covering safe movement of the towed aircraft. Checklist steps shall be completed and towing personnel briefed before the aircraft is moved. Only the supervisor shall be authorized to give the “all clear to move” order. The supervisor will determine the safe distance, based on aircraft type and amount of allowable space to maneuver the aircraft; the tow vehicle operator can back the aircraft into its final position. Hangaring aircraft is considered final positioning, which includes final entry. Refer to paragraph [24.7.2.8](#) for additional guidance on hangaring aircraft. Wing walkers shall be required when backing aircraft. Refer to paragraph [24.7.18](#) for additional guidance.

24.7.2.2. Towing Team Assignments. Tow team size and where they are stationed shall be IAW applicable aircraft TO procedures. Each shall have a tow team supervisor. **Note:** Tail and wing walkers are not required when towing aircraft on unobstructed, established taxiways and runways or parking ramps where taxi or towing lanes are marked with guide lines.

24.7.2.3. Brake Person in Cockpit. A qualified person, authorized by the supervisor, shall be in the pilot’s seat to operate aircraft brakes and follow the supervisor’s signals. If the brake operator is unable to maintain hydraulic pressure, another qualified person shall be stationed to watch and maintain the pressure. The supervisor shall terminate the towing operation if brake pressure drops below safe operating limits.

24.7.2.4. Tow Vehicle Operator. An authorized and qualified vehicle operator shall control the tow vehicle at all times during aircraft movement, operate the vehicle in a safe manner, follow team supervisor’s instructions, obey any emergency stop instructions and stop the tow vehicle upon losing sight of or communication with the tow supervisor. The vehicle operator shall face the direction of travel while seated and not look over his or her shoulder to face the direction of travel except while making minor changes during final positioning. Hangaring aircraft is considered final positioning (includes final entry) so minor changes are allowed. Positioning the aircraft an appropriate distance from hangar doors and backing the aircraft into the hangar is acceptable. The towing supervisor shall determine final positioning, based on aircraft type and maneuverability, and brief the towing crew.

24.7.2.5. Wing Walker. A wing walker shall be stationed at each wingtip to ensure adequate aircraft clearance of any obstruction and shall signal the supervisor whenever the aircraft is in danger of colliding with an obstruction. In such cases, towing shall be stopped until clearance is personally checked by the supervisor. Wing walkers are not required when towing helicopters with rotor blades in parallel position (H-1 type helicopters parallel rotor blades in a fore and aft trail position). Wing walkers shall be familiar with all published towing procedures for the aircraft being towed but do not require annual proficiency training if their duties are restricted to these positions during

towing operations. Thorough pre-tow briefings by a qualified towing supervisor satisfy the training requirement. **Note:** When differences exist in towing procedures prescribed in this standard and applicable technical data for the specific aircraft, the technical data will take precedence.

24.7.2.6. **Nose Walker.** The tow team supervisor also serves as the nose walker and shall maintain a safe position in front of the towing vehicle and have a clear view of both wing walkers, the vehicle operator and the person in the cockpit. The nose walker shall have direct contact with the person in the cockpit by interphone or communications media specified in applicable aircraft TOs. When tail and wing walkers are not required, the nose walker may ride in the tow vehicle cab if he can observe the path to be traversed and direct actions of the cockpit brake person and vehicle operator.

24.7.2.7. **Tail Walker.** A tail walker shall be used when the aircraft is turned sharply or backed into position. A tail walker is required when backing aircraft into a HAS with permanent chocks installed. Tail walkers shall be familiar with all published towing procedures for the aircraft being towed but do not require annual proficiency training if their duties are restricted to these positions during towing operations. Thorough pre-tow briefings by a qualified towing supervisor satisfy the training requirement. **Note:** The tow team supervisor may eliminate the tail walker when moving small aircraft or in third generation HAS. Earlier generation HAS do not have sufficient clearance to allow eliminating the tail walker.

24.7.2.8. **Final Positioning (Hangaring Aircraft).** Some aircraft have MDS Specific TOs that address final positioning of hangaring aircraft. For aircraft not addressed in MDS Specific TOs, final positioning of hangaring aircraft is considered to be the last act of positioning the aircraft in its parking spot in a designated hangar. Final positioning may begin at the door of the hangar but is not considered complete until the aircraft is parked in its assigned parking spot for maintenance, training, etc. (final position).

24.7.2.8.1. There is no distance requirement for final positioning of an aircraft, i.e., the final two or three feet do not constitute final positioning. For smaller aircraft, the process may be simple and fairly quick. For bigger aircraft, that process may be a more arduous task. Also the amount of aircraft already hangared may play a major role in hangaring additional aircraft.

24.7.2.8.2. The tow team will consist of the team identified in paragraphs [24.7.2.1](#) through [24.7.2.7](#) for final positioning.

24.7.3. **Steerable Gear.** Steerable landing gear, including outriggers, shall be set in tow position before the aircraft is moved and returned to original position after tow bar removal. The tow supervisor shall instruct cockpit personnel to allow the nose gear steering wheel to turn freely and not attempt to steer or turn the nose wheel when the tow bar is connected to the aircraft.

24.7.4. **Workers Riding or Walking.** Workers shall not cross a tow bar connected to both the aircraft and the tow vehicle, nor ride on the outside of a moving aircraft, tow bar or on the outside of tow vehicles unless an authorized seat is provided. No one will try to board or leave a moving aircraft or tow vehicle. The tow supervisor shall brief this information prior to towing.

24.7.5. Night Crew Signals. Two luminous wands shall be issued to tow team members who require wands. Tow team supervisors should use wands even if aircraft interphone contact is established with tow vehicle operator and cockpit brake person. Wands or wingtip lights shall be used by other tow team members, as needed, to warn approaching aircraft traffic. Refer to AFI 11-218, *Aircraft Operations and Movement on the Ground*, for night crew signaling practices. **Note:** Many units have established local policy on night crew signaling procedures. Local policy shall be written IAW the tenets of AFI 11-218.

24.7.6. Control Tower Clearance. The tow team supervisor shall obtain control tower clearance before towing aircraft on or across a taxiway or runway, maintain radio contact with tower and inform the tower when tow is complete. The primary means of communication shall be the aircraft radio, but, if not feasible, a radio-equipped escort vehicle, in direct radio contact with the control tower, shall accompany the aircraft throughout the towing operation.

24.7.7. Towing Speed. Towing speed shall not exceed the walking speed of team members, with a maximum of five (5) miles per hour.

24.7.8. Brakes. To prevent serious mishaps, aircraft brake systems shall be charged before each towing operation, and towing shall be stopped immediately if brake pressure drops below safe operating limits. Aircraft with inoperative brakes will follow MDS-specific guidance procedures. Aircraft without MDS-specific guidance for towing with inoperative brakes will comply with the following procedures:

24.7.8.1. Obtain Maintenance Group Commander or designated representative approval prior to each tow.

24.7.8.2. Maintain radio communication throughout entire towing operation.

24.7.8.3. Additional personnel will chock walk the aircraft, positioned outboard of each landing gear strut requiring chocks. **Note 1:** The aircraft maintenance organization will develop local procedures for aircraft without MDS-specific guidance and publish them in a local OI or supplement. Procedures shall include main landing gear chock walk requirements. **Note 2:** The same procedures above shall be followed when towing aircraft with inoperative brakes from a repair facility, i.e., to allow repairs on higher priority aircraft.

24.7.9. Tow Bars. Only authorized equipment in good condition shall be used in towing operations. Before moving any aircraft, the tow vehicle, tow bars and connections and other associated equipment shall be inspected for defects by the tow team supervisor.

24.7.10. Chocks. Chocks shall be maintained near the tow vehicle or aircraft for emergency use throughout the towing operation and shall be properly placed before the tow vehicle is unhooked. Chocks or other support equipment shall not be placed on or hung from any part of the aircraft exterior during towing or repositioning operations.

24.7.10.1. During inclement weather conditions, when towing or parking aircraft with snow, ice or frost present anywhere on the parking ramp or towing surface, use the heaviest tow vehicle authorized per aircraft technical data to prevent loss of aircraft or

tow vehicle control during tow operations. Also, equip the tow vehicle with chains to maintain traction.

24.7.10.2. Conduct an ORM assessment of proposed tow operation based on current runway and taxiway condition readings from local Airfield Management. The decision to proceed shall be approved by appropriate squadron command levels.

24.7.11. Starts and Stops. Tow vehicle operators shall not stop and start suddenly when moving aircraft. Aircraft brakes shall only be applied upon direction from tow supervisor. Chocks shall be properly placed and the aircraft's brakes set before the towing vehicle is unhooked from the aircraft,

24.7.12. Equipment, Stands and Similar Materials. The supervisor shall ensure all equipment, workstands, loose aircraft parts, fire extinguishers and all other materials are removed from the vicinity of an aircraft and properly stored. Equipment or materials left outside shall be secured to prevent accidental movement by wind or jet or propeller blast.

24.7.13. Entrance Doors, Ladders and Down Locks. Aircraft entrance doors shall be closed, ladders retracted or removed, and landing gear down locks installed to prevent possible worker injury and aircraft damage during towing operations, unless permitted by specific aircraft TOs.

24.7.14. Struts and Tires. Towing team members will check nose and main landing gear struts and tires for proper inflation prior to towing any aircraft. A visual check of tires and struts shall be adequate for towing purposes unless the applicable TO requires a gauge check.

24.7.15. Docks. The following precautions shall be taken when moving multi-engine aircraft with propellers (particularly into and out of docks):

24.7.15.1. Ensure ramps are clear of snow and ice at least 100 feet in front of dock doors and far enough on each side to accommodate all landing gear wheels.

24.7.15.2. Open hangar doors enough to allow complete passage of the aircraft, both in width and height, with at least 10 foot wingtip clearance on either side. Inflate or deflate tires as necessary to provide required clearances, but do not exceed minimum or maximum pressures. If hangar construction does not permit such clearance, the doors shall be opened to the maximum limit. Wing walkers shall be used when an aircraft is placed in a hangar. Also see paragraph [24.14.8.4](#). Under normal conditions, powered hangar or shelter doors shall be opened at least 10 feet. Refer to [Chapter 21, Hazardous Energy Control \(Lockout and Tagout\)](#), for lockout requirements.

24.7.15.3. Maintain landing gear strut extension suitable for the aircraft and dock involved.

24.7.15.4. Place propellers in an "X" position or position suitable for the aircraft and dock combination.

24.7.15.5. Keep hydraulic brake pressure at or above safe minimum values in applicable TOs.

24.7.15.6. Station two (2) team members to observe the top clearance of propeller blades.

24.7.16. Towing Vehicle Inspections. Tow vehicle operators shall inspect all towing equipment to ensure it is serviceable and functioning properly before starting any tow operation. Inspection shall be documented on AF Form 1800, *Operator's Inspection Guide and Trouble Report*. The tow team supervisor is responsible for the entire towing operation and shall ensure the tow vehicle is free of defects or extraneous material that may interfere with safe operation before the tow bar is hooked to the aircraft. The unit vehicle control plan shall ensure a qualified operator inspects each tow vehicle designated for emergency response use each shift to ensure the cab and bed are clear of extraneous materials and the vehicle is safe for use. All other tow vehicles shall be inspected using the same criteria prior to use. Towing connections shall be inspected before each use. Pintle assemblies and towing connections shall be secured with a pintle hook safety or cotter pin that will positively lock towing connections. Tow vehicles with safety defects shall be removed from service until repaired.

24.7.17. Approach of Towing Vehicle. The tow vehicle driver will stop at least 50 feet from the aircraft to be moved and shall proceed only when directed by the tow team supervisor.

24.7.18. Towing Clearance. The tow vehicle shall remain at least 50 feet from other aircraft or vehicles and at least 150 feet when towing aircraft with faulty brakes. **Caution:** The wingtip path on sweptback wing aircraft extends beyond the straight line wingtip path during turns, based on the degree of turn and the degree of sweep on the wings. In some cases the aircraft tail path may also exceed wingtip path. Equipment, vehicles and other aircraft may appear to be clear of the intended path, while actually impeding it. Refer to [Figure 24.1](#) for additional guidance.

24.7.19. Towing Aircraft Without Cockpit Access. Chocks shall be immediately available for emergency use when moving cocooned aircraft without seat, brakes or with closed and sealed canopies.

24.7.20. Engine Operation. As a general rule, aircraft shall not be towed with engines operating. However, civilian contract air carrier jet engine transport aircraft may be towed or pushed short distances with engines operating IAW Federal Aviation Administration-approved procedures in operations and maintenance handbooks. Copies of these procedures shall be carried on the aircraft. Air Force aircraft may only be pushed back with engines running during non-routine or abnormal operational requirements using push-back procedures supported by engineering analysis and the aircraft Dash 1 TO.

24.7.21. Taxiing Operations. A marshaller shall be used. Personnel shall remain clear of taxiing aircraft until the aircraft has come to a complete stop. Aircraft shall not be taxied closer than 100 feet to an active runway where aircraft are operated unless taxiing on an established taxiway. Wing walkers shall be used when taxiing within 25 feet of obstructions. Wing Commanders may waive this provision for locally based aircraft if taxi lines and permanent obstructions are marked or other aircraft are parked on parking spots or lines. Aircraft shall not be taxied within 10 feet of an obstruction, except during contingency operations when compliance would restrict the mission; or from alert, readiness or protective shelters. A plainly visible centerline shall be painted along the exit path and a marshaller shall be used; or when operating locally based aircraft from parking spots specifically designed for those aircraft. Parking spots shall have a minimum 10-foot wingtip clearance between

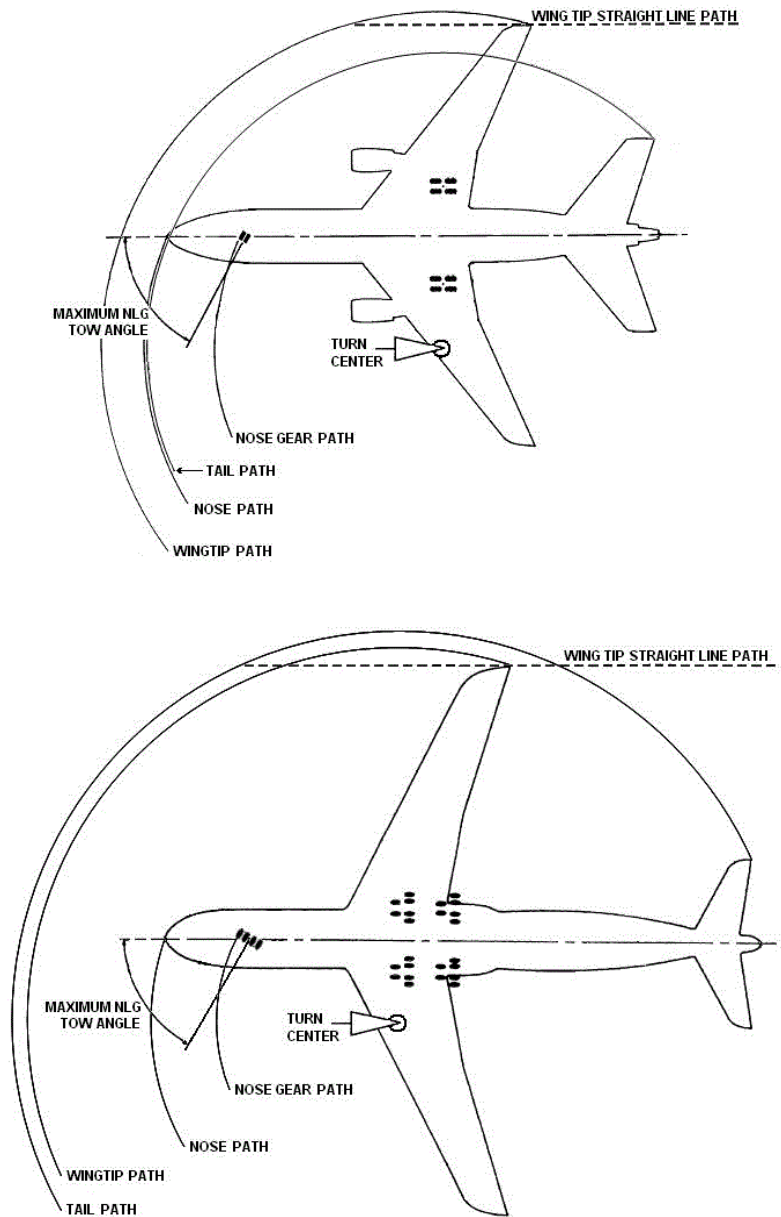
aircraft, taxi routes clearly marked and support equipment placed in designated locations. **Caution:** The wingtip path on swept-back wing aircraft extends beyond the straight line wingtip path during turns, based on the degree of turn and the degree of sweep on the wings. Equipment, vehicles and other aircraft may appear to be clear of the intended path while actually impeding it. Refer to **Figure 24.1**

24.7.21.1. Aircraft Taxiing Requirements. Aircraft canopy and windshield shall be clean before aircraft taxi and position lights ON from before engine start until engine shutdown. T-38 and C-21 aircraft and aircraft in approved sound suppressors are exempt during daylight hours. **Note:** Exercise care not to blind ground crew members when taxiing with landing lights on. Refer to AFI 11-218, *Aircraft Operations and Movement on the Ground*, for further guidance.

24.7.21.1.1. Doors and Hatches. Unless a specific requirement exists, no aircraft shall be taxied with open doors or hatches. Personnel shall secure doors and hatches IAW operating instructions and checklists before starting engines, taxiing or actual flight. Aircraft commanders shall brief all personnel on board not to leave or enter the aircraft while it is moving. If a door warning light comes on during taxiing, the aircraft shall be completely stopped, if operational or airfield constraints allow, and the cause determined.

24.7.21.1.2. Communications. Aircraft shall not be taxied without clearance. Radio contact shall be maintained with the control tower throughout taxi operations. Taxi speeds in uncongested areas shall be reasonable, with aircraft and personnel safety the determining factors. Follow guidance in Dash 1 handbooks for taxi operations under varying wind conditions.

Figure 24.1. Swept Wing Aircraft Hazard.



**Note:** Illustrates how wingtip path on swept-back wing aircraft extends beyond the straight line path during turns based on the degree of turn and the degree of sweep on the wings.

24.7.21.2. Crossing Behind Aircraft. Personnel, vehicles and towed aircraft shall remain clear of taxiing traffic and will not pass within 200 feet behind aircraft with engines running.

24.7.21.3. Ramp Areas. Aircraft parked in ramp areas shall be taxied only after an "ALL CLEAR" signal is given by the ramp supervisor.



24.7.21.4. Signaling at Night. At night, ground crewmembers shall use two illuminated wands for signaling taxiing aircraft IAW paragraph 24.7.5. Refer to AFI 11-218 for further guidance.

24.7.21.5. Taxiing Near Other Aircraft. Pilots and taxi-qualified technicians shall use minimum power when leaving a row of parked aircraft and taxi in a way that prevents propeller or exhaust blast endangering personnel, parked aircraft or property. The minimum safe distance behind a jet aircraft at 100 percent power setting is where the jet blast does not exceed 35 miles per hour and 38° C / 100° F. Refer to applicable aircraft TOs for the recommended safe distance.

24.7.21.6. Jet Run-up Areas. Caution signs, constructed IAW **Chapter 29, Mishap Prevention Signs and Tags**, shall be posted at entrances, gates and approaches to jet run-up areas.

## **24.8. Aircraft Jacking Operations.**

### 24.8.1. General Requirements:

24.8.1.1. All personnel involved in jacking operations shall be thoroughly familiar with TOs and handbooks for the aircraft involved and follow procedures in these publications. Jacks shall be: operated, maintained, inspected and tested IAW applicable TOs or handbooks; inspected before use to verify lifting capacity, proper functioning of safety locks, conditions of pins and general serviceability; and inspected with documentation maintained by work section supervisor. If integrity of jack is questionable, the jack shall be removed from service and the supervisor notified.

24.8.1.2. Workers shall follow specific aircraft TO jacking procedures. Non-essential workstands and equipment shall be removed from under the aircraft before jacking. If the aircraft weight-and-balance condition has been affected by removing heavy items, weight shall be added to reestablish the proper center of gravity before jacking. Workers shall not remain in aircraft being raised or lowered, unless directed by TO (i.e., to observe leveling instruments). TO prescribed jack pads, jack pad fittings and correct jack screw adapters and extensions shall be installed prior to jacking. Chocks shall be removed and brakes released before the aircraft is raised or lowered,.

24.8.1.3. Safety stands of suitable capacity shall be installed under aircraft wings and tail after the aircraft is jacked and leveled if equipment failure or an unbalanced condition could occur.

24.8.1.4. Personnel shall not pass under, climb or walk on any portion of the aircraft when the entire aircraft is supported by jacks, except to support jacking activities or when operationally necessary to perform maintenance. The area around jacked aircraft shall be secured and warning signs posted. Personnel not directly involved in jacking operations or performing maintenance on jacked aircraft shall remain outside the posted area. Depot maintenance facilities may post signs at work area, hangar and flight line entrances in lieu of securing and signing individual aircraft

24.8.1.5. Engines and other major components, such as wing panels and stabilizers, that affect aircraft center of gravity or are identified as stress areas, shall not be changed or

removed on jacked aircraft with landing gear clear of the ramp or floor except IAW aircraft TOs.

24.8.1.6. The ram locknut will lower under its own weight or be turned down by hand as the ram is extended and shall remain against the lift tube cylinder during jacking procedures. Other types of jacks, if equipped with locking pins or nuts, shall be set immediately after jacking is complete. Refer to TO 35A2-1-1, *General Inspection Procedures and Overhaul Instructions – For Hydraulic Jacks*, for specific instructions.

#### 24.8.2. Specific Requirements:

24.8.2.1. Outside Jacking. Aircraft may be jacked outside hangars when wind conditions permit. When aircraft wind velocity specifications are not available, 13 knots (15 miles per hour) shall be used as a safe maximum velocity for outside jacking. Jacking shall be done on a level surface. High tail surfaces of some aircraft require special consideration when exposed to even moderate wind. Maintenance workers shall be familiar with appropriate aircraft TOs before jacking.

24.8.2.2. Hangar-Dock Jacking. Hydraulic pumping units for aircraft jacks shall not be operated in aircraft hangars unless authorized by the Maintenance Group Commander or equivalent, ground safety representative and installation fire chief. When authorized, hydraulic pumping unit design shall ensure all electrical equipment, sparking contacts, hot surfaces and other possible ignition sources are at least 18 inches above floor level. Refer to NFPA 410, *Standard on Aircraft Maintenance*, and NFPA 70, *National Electrical Code*, for additional guidance. Hydraulic pumping units shall be placed at least 25 feet from the aircraft in an area free of combustible material and the pumping unit engine properly grounded.

24.8.2.3. Releasing Jacks. Maintenance workers shall ensure the area beneath the aircraft is clear of equipment, cribbing and personnel, and verify the aircraft is ready for lowering before releasing jack pressure and lowering the aircraft. Workers shall ensure the landing gear is completely down and locked in position with all ground locking devices installed. Only workers required to operate jacks and free the struts will remain near the aircraft while lowering. The aircraft shall be lowered slowly and evenly to the surface. Workers should exercise care when removing jacks to prevent aircraft skin or structure damage. Jacks shall be removed by first turning down the jack screw extension then depressing the ram into the cylinder. Personnel will not place any part of their hands on top of the ram to avoid injury while depressing the ram.

24.8.2.4. Landing Gear Retraction Tests. Landing gear retraction tests shall be directed orally, using an interphone system for communication between a ground observer outside the aircraft and the landing gear operator. Use of hand signals is acceptable if the interphone system is inoperable and the ground observer maintains direct visual contact with both the wheel well/gear swing areas and the landing gear operator at all times. The ground observer will ensure the wheel well and gear swing areas are clear of personnel and equipment prior to and during all testing.

24.8.2.5. Fire Fighting Equipment. Maintenance workers will ensure suitable portable firefighting equipment is readily available and properly positioned. After aircraft

departure, fire extinguishers used to support that aircraft shall be removed from the ramp. Refer to **Chapter 6**, *Fire Protection and Prevention*, and TO 00-25-172, for additional guidance.

#### **24.9. Aircraft Engine Operations.**

24.9.1. Engine starts and run-ups present hazards to personnel and other aircraft. Personnel near an engine start or run-up shall wear, at a minimum, hearing protection as prescribed by BE. Eye protection shall be required if conditions exist where flying debris is present, i.e., unimproved/austere runways or aircraft backing maneuvers. The fire hazard is high because fuel vapors may be ignited by exhaust flames. Rotating propellers are dangerous to personnel and can cause extensive equipment damage. Except for turboprop aircraft, personnel will not hand-pull the propeller of a recently operated engine. The ignition switch for reciprocating or electric start engines shall be in the OFF position when engines are not operating and the master battery switch shall be turned off when no longer required. For C-130 aircraft, personnel will not enter the plane of rotation of the propellers except by walking around the outside (number 1 or number 4) propeller arcs. (**Exception:** If bleed air is not supplied to the aircraft, personnel may enter the plane of rotation for preflight inspections and maintenance actions.) Personnel shall not stand in line with the stripe that designates the plane of propeller operation. Radio contact with the control tower shall be maintained during engine operation or taxiing or with job control during engine runs when the control tower is not operating. Maintenance Operations Center (MOC) shall be prepared to request FES Flight or medical services assistance as needed.

24.9.2. Aircraft Chocks. Aircraft shall be properly chocked and parked IAW applicable TOs and job guides before starting engines. Functional managers will ensure only chocks approved by MIL-PRF-30258 and/or the specific aircraft Dash 2 TOs are used. When aircraft engines are in operation, chocks shall be removed with the utmost caution after the proper signal has been given. Workers will approach the aircraft from the safest direction, considering location of propellers, jet intakes and exhausts.

24.9.3. Personnel on Exterior Portions of Aircraft. Personnel shall not be allowed on external portions of an aircraft during engine start or when taxiing. Qualified workers may stand on TO designated areas only during instruction on ground operation procedures and necessary adjustments. Qualified workers may service hydraulic fluid and engine oil or make minor adjustments on multi-engine aircraft with engines operating if engines on the wing being worked are shut down and engines on the opposite wing are in idle. Interphone or radio contact shall be maintained with the cockpit operator, if possible, or the workers shall be under direct observation of another crewmember, team member or fire guard with direct cockpit communication. Aircraft wing and formation lights shall be on to warn personnel of engine operation IAW AFI 11-218.

24.9.4. Fire Guard. A qualified (trained) fire guard (need not be a certified firefighter) shall be positioned by the fire bottle(s), if required by the aircraft TO, prior to starting aircraft engines. This individual shall remain stand by in readiness until all engines are operating and fire danger is past; i.e., crew chief or team leader can release fire guard once engines are started and no fire danger exists. If no fire guard is required by aircraft TO:

24.9.4.1. Aircraft with internal fire fighting capability shall have a ground observer in position on interphone to monitor and report any problems, e.g., fire, fuel leaks, aircraft

movement, and shall remain in position until released by the individual operating the engine.

24.9.4.2. Aircraft without interphone capability shall have a fire guard stationed to observe the engine start process. After start, the fire guard will remain in clear view of cockpit personnel and observe aircraft and area during engine operation. **Warning:** Use extreme caution to ensure all personnel remain clear of propeller arc and/or jet intakes/exhaust during ground operation. **Exception:** Aero Club or similar aircraft used by CAP-USAF or Civil Air Patrol may be started/operated without a fire guard if fire extinguishers are readily accessible during engine starts, aircraft maintenance and refueling, and if it does not violate manufacturer's operating handbook procedures.

24.9.5. Qualified Personnel. Only personnel trained and certified IAW AFI 11-218 shall be authorized to start and run-up aircraft engines. The engine run supervisor is responsible for inspecting the surrounding area to ensure it is clear of equipment, personnel and materials that might cause or be subject to FOD. Equipment or materials subject to engine blasts or being blown into other equipment shall be repositioned or secured. Refer to AFI 21-101, *Aircraft and Equipment Maintenance Management*, for additional information.

24.9.6. Jet Engine Start Observers. A ground crewmember, in contact by interphone at all times with the person operating the engine control, shall be stationed in front and to one side of the engine being started. On aircraft without interphone capability, a ground crewmember shall be stationed to observe the start and give necessary signals to the person in the cockpit.

24.9.7. Cockpit Checklist. Workers starting, operating and testing aircraft engines shall use the appropriate cockpit checklist before, during and after the operation.

24.9.8. Jet Engine FOD. Damage caused to jet engines by foreign objects and debris sucked through inlet ducts can be reduced by use of inlet duct run-up screens on certain aircraft types. Operational needs may require installation and removal of screens while engines are running. Ensure engine inlet run-up screens and anti-personnel guards are used IAW applicable system TOs. Refer to AFI 21-101 for additional information on FOD prevention and FOD prevention programs.

24.9.9. Hearing Protection Devices. Crew and maintenance personnel shall wear approved hearing protection in noise hazard areas to prevent permanent hearing loss. BE will determine noise hazard areas, protection requirements and adequacy of hearing protection.

24.9.10. Rotary Wing Aircraft.

24.9.10.1. The collective pitch stick shall be locked in the full low position during engine run-up by ground workers. Personnel and equipment shall be kept clear of rotary wing aircraft at least a distance equal to its length, to prevent injury and damage if a quick excessive throttle start swings the tail.

24.9.10.2. Main rotor blades shall be tracked only with an experienced pilot at the controls. Engine run-up shall not be attempted by fewer workers than specified in specific aircraft TOs. Personnel shall exercise caution when approaching the plane of rotation of main rotor blades because they droop at decreased speeds.

24.9.10.3. All personnel shall remain in full view of the pilot or helicopter operator and keep a crouched position approaching or leaving a helicopter with rotating blades. Personnel shall avoid the area from cockpit or cabin rearward unless authorized by helicopter operator to work in this location. Keep unauthorized personnel at least 50 feet from helicopters with turning rotor blades.

24.9.10.4. Personnel shall use extreme caution to stay clear of main and stabilizing rotors when visibility is reduced by dust or other conditions. Protective goggles shall be worn by all personnel and other precautions taken as needed to minimize problems from reduced visibility.

24.9.10.5. Adequate precautions shall be taken to protect personnel from flying objects caused by rotor downwash. All loose gear within 100 feet of the area susceptible to rotor downwash shall be secured or removed.

#### **24.10. Jet Aircraft Requirements.**

24.10.1. General safety standards for conventional powered aircraft also apply to jet aircraft, and ground handling of jet aircraft involves hazards not common to conventional types. Engine inlet suction and exhaust blast pose hazards to maintenance, support and flight crew personnel.

24.10.2. Reserved.

24.10.3. Suction Effect. Jet engine suction can ingest personnel, causing loss of life. Additionally, ingestion of tools or personal articles may cause extensive engine damage. Unless required by TO, crewmembers, maintenance workers and other personnel shall not approach closer than 5 feet from the side or rear or 25 feet from the front of engine intake ducts of running engines. Personnel may approach multi-engine aircraft, e.g., F-15, from the opposite direction of the running engine, but shall use extreme caution to prevent ingestion. Maintenance and aircrew personnel who work on or near running jet engines will not wear loose clothing, hats or carry objects that might be sucked in the engine. All objects shall be removed from in front of or within intake ducts prior to starting engines. Visiting personnel or observers shall be briefed on removing hats and carrying objects near jet engines. Refer to paragraph 24.4 for additional information. Maintenance workers will not place hands or fingers on auxiliary air inlet doors as they operate automatically and may close. If open, access doors shall be secured or removed as they may be forced closed by engine suction.

24.10.4. Exhaust Blast. Jet engine exhaust blast is hazardous to personnel and property. Local procedures shall be established to prevent personnel, vehicles and aircraft passing behind engines operating above idle speed or through hazardous jet blast areas IAW applicable aircraft TOs. A ground or flight crew member shall be stationed alongside the operating engine to warn personnel and traffic to remain clear at least 25 feet in front and 200 feet to the rear of the aircraft, depending on the aircraft involved or as prescribed IAW applicable aircraft TOs and handbooks. A blast fence shall be installed where needed to protect personnel and equipment from exhaust blast. Tools, spare parts and other objects shall be removed from blast areas before any jet engine is started. Refer to ETL 07-3, *Jet Engine Thrust Standoff Requirements for Airfield Asphalt Edge Pavements*, for mandatory standoff distance required to prevent uplift forces from causing catastrophic failure of asphalt edge pavements.

24.10.5. Ejection Seats and Canopies. Accidental discharge of ejection seats, cockpit canopies and jettisonable hatches (i.e., A-10, B-2, and F-16) is hazardous to workers. Extreme heat or unintentional movement of actuating mechanisms can fire the ejection seat catapult or canopy remover. The following precautions will reduce accidental seat or canopy ejections for aircraft on the ground. **Note:** Anyone entering a cockpit or flight deck equipped with escape system components shall have aircraft cockpit and flight deck familiarization training prior to entry IAW AFI 21-101. **Exception:** C-17 Aircraft, Flotation Equipment Deployment Systems (FEDS) – Electro-Environmental workers with task qualification training and annual explosive safety training for time change compliance related to FEDS meets the intent of paragraphs [24.10.5](#), [24.10.5.1](#) and [24.10.5.3](#).

24.10.5.1. Normal Procedure. Ground safety pins shall be installed by aircrew or maintenance workers immediately after an aircraft is parked and the engine shut down or by egress workers after maintenance requiring removal of the pins is complete. Care shall be exercised to ensure safety pins are removed before the next flight. Only qualified egress maintenance workers will remove or install canopy or ejection seat discharge mechanisms. Emergency rescue personnel will train only with ejection seats certified safe (disarmed) by a qualified egress technician. FES Flight personnel shall be trained to safe (disarm) ejection seats and canopy actuators before removing crew members from aircraft. Rescue efforts shall follow TO 00-105E-9, *Aerospace Emergency Rescue and Mishap Response Information (Emergency Services)*, procedures. Maintenance workers will avoid accidental arming and firing when working near ejection seat catapults and ejection seat or canopy remover controls. They will not carry combs, screwdrivers, pens, pencils, etc., protruding from pockets or clothing that may cause accidental or inadvertent arming and firing of ejection seat or canopy controls. Only qualified egress and munitions workers shall be authorized to handle and maintain ejection system explosive items.

24.10.5.2. Crash Landings. Care shall be exercised to avoid snagging arming and firing mechanisms when removing crewmembers from crashed aircraft. Cook-off, inadvertent actuation or residual pressure stored in lines and tubes of explosive egress components may pose hazards during rescue attempts.

24.10.5.3. Salvage Operations. Explosive ordnance disposal (EOD) workers will ensure explosive devices are removed before any aircraft salvage operations begin. Only qualified and certified egress workers will remove escape and/or egress system explosive components. These items include cartridge-actuated devices (CAD) and propellant-actuated devices (PAD), such as initiators, catapults, canopy removers, rocket packs, divergence rockets, gas generators, shielded mild detonating cord (SMDC) and flexible linear shape charges (FLSC).

24.10.5.4. Transient Checklists. Transient alert organizations shall develop local checklists to ask pilots about explosive egress systems for aircraft not normally processed through their installations and shall follow specific TO procedures for aircraft being serviced.

24.10.6. Pressure Testing. Cockpit pressure-testing shall not exceed TO allowed pressures.

24.10.7. Sharp Edges. Some jet aircraft control surfaces have sharp edges. Mechanics shall use caution when working on or near these edges. During prolonged maintenance periods,

sharp edges or corners of aircraft parts or equipment shall have suitable protective covers, where practical, or tape placed over them and red streamers attached to indicate the danger area.

24.10.8. Entering Tail Pipe. IAW **Chapter 23**, *Confined Spaces*, based on the determination of the CSPT, workers will evaluate the condition of tail pipes prior to entering, i.e., to inspect engine turbine wheel assembly. This evaluation will include an atmospheric test prior to entry. If the tail pipe was deemed to be a permit-required confined space, appropriate measures shall be taken before entry IAW **Chapter 23**, including use of a BE approved respirator. If the space was deemed non-permit required, the space shall be checked IAW **Table 23.1** to ensure the space is safe to enter prior to any work being started in the tail pipe. A responsible individual shall be positioned adjacent to the tail pipe or entrance of the aircraft to prevent anyone entering the cockpit and to maintain communication with the person in the tail pipe.

24.10.9. Handling Hydrazine. Fire fighting and transient maintenance personnel may be exposed to hydrazine. Workers shall be trained IAW **Chapter 14**, *Personal Protective Equipment (PPE)*, AFI 90-821, *Hazardous Communication*, and TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. Training shall be documented IAW AFI 91-202 and on AF IMT 55, *Employee Safety and Health Record*.

## **24.11. Aircraft Cleaning.**

24.11.1. General Requirements. To prevent falls, workers shall not climb or walk on wet aircraft surfaces. Separate elevated work platforms and long-handle brushes shall be used to the maximum extent possible. If absolutely necessary to walk on aircraft TO designated areas during washing, extreme care shall be exercised, and locally designed systems, such as sky-lines (horizontal life lines) and personal fall arrest systems, shall be used. Refer to paragraph **24.16**. Workers will wear PPE identified by BE to include, but not limited to, chemical-splash goggles, when using brightening agents, caustics, acids, phenolic compounds or other chemicals. Only authorized cleaning agents shall be used. Appropriate footwear shall be worn to prevent falls from wet surfaces. Refer to **Chapter 14** for additional PPE guidance. All PPE use, including respirators, shall be coordinated with BE. Refer to AFI 90-821 for hazard communication requirements.

24.11.1.1. Flammable Solvents. Aircraft shall be cleaned with nonflammable nontoxic solvents IAW TO 1-1-691, *Cleaning and Corrosion Prevention and Control, Aerospace and Non-Aerospace Equipment*. Flammable solvents may be used only if authorized by TOs or other guidance and shall be a coordinated, approved and well-planned operation involving the Maintenance Group Commander, or equivalent, and the installation Ground Safety office, FES Flight and BE. All potential sources of ignition shall be prohibited within 50 feet of the operation and warning signs shall be posted. Suitable auxiliary firefighting equipment shall be kept close at hand as determined by the installation FES Flight. The aircraft shall be grounded at all times to prevent collection of static charges. When an aircraft is washed or cleaned with flammable solvents and thunderstorms are within 5 nm or less, the operation shall be suspended unless inside a facility with an approved lightning protection system. Refer to paragraph **24.6** for additional information on adverse weather requirements.

24.11.1.2. Cleaning Material or Solvent Spills. The installation FES Flight shall be notified immediately of any flammable solvent spill and pollution control procedures IAW installation spill prevention control and reporting plans.

#### 24.11.2. Aircraft Cleaning Operations.

24.11.2.1. Maintenance personnel shall not clean aircraft parts, hangar floors, equipment or clothing with unauthorized solvents, e.g., gasoline, diesel, petroleum-based liquids, etc. Use approved high flashpoint or nonflammable substances or liquids whenever possible. Store flammable liquids IAW **Chapter 22, *Flammables and Combustibles***. See paragraph **24.3.3.4** for additional information on cleaning aircraft parts.

24.11.2.2. Wiping cloths, oily waste and other flammable materials shall be placed in suitable, self-closing metal containers in the work area. At the end of each day or shift, these containers shall be emptied or removed to an approved location outside the shop for pickup and disposal. Contact the installation Environmental Management office for waste disposal guidance. **Caution:** To prevent spontaneous combustion due to heat buildup, do not put soiled rags in sealed plastic bags. **Note:** Flammable and combustible wastes may be stored in vapor tight containers if required by the installation Environmental Management office.

24.11.2.3. Store small amounts of flammable solvents with adequate ventilation and fire extinguishers readily available. Keep storage areas cool (55° to 80° F) and free of spark or heat-producing equipment. Absorbent material should be available to clean up spills. Refer to paragraph **24.15.3.3.1** for additional guidance.

24.11.2.4. Flammable and toxic vapors are common hazards with solvents. Electrically bond containers (metal to metal contact) when transferring flammable solvent.

24.11.2.5. Safe spill handling materials control the hazard. Vapor absorbent materials absorb vapors and flammable liquids so even if an ignition source is present, the spill will not burn.

24.11.3. Fire Control. Use Class B extinguishers for flammable solvents. In no case shall water be used. Workers using flammable solvents shall be trained and proficient in extinguisher use. Extinguishers shall be sized for possible fires. A gallon of spilled solvent can cover 25 to 50 square feet, but a small extinguisher may only extinguish 2 square feet. The FES Flight shall be consulted to ensure extinguishers with proper capacity are obtained. Workers shall remain vigilant after a fire is extinguished because flammable solvent may still be present beneath the extinguishing material. If an ignition source is present, the vapors can re-ignite. Safety cans and solvent storage cabinets shall have flash arresters to prevent flame from entering the container.

#### 24.12. Aircraft Tire Mounting and Servicing Operations.

24.12.1. Maintenance workers shall use tire dollies or mechanical devices when mounting, servicing or removing heavy aircraft tires. Sufficient personnel are also necessary, in addition to mechanical aids, to safely handle heavy tires and wheels. **Note:** The risk of personal injury and equipment damage increases greatly when workers do not use tire cage guards or tire inflation equipment properly, i.e., over-inflate a tire, use un-calibrated equipment, etc.



24.12.2. Tire cages shall be used when inflating tires in the shop to prevent injury to workers. Extreme caution shall be used to avoid over-inflating tires. Nitrogen or dry air supply lines shall be equipped with regulators to prevent over pressurizing the tire. Consult TO 4T-1-3, *Inspection, Maintenance Instructions, Storage, and Disposition of Aircraft Tires and Inner Tubes*, when using a remote tire inflator assembly kit.

24.12.3. Only authorized safety tire inflation equipment shall be used for flight line or hangar tire inflation. The relief valve shall be set at 100 psi (with a 10 percent tolerance) for tires with a maximum tire pressure (MTP) under 80 psi. Tires with an MTP over 80 psi shall have the relief valve set at 20 psi over the MTP (with a 10 percent tolerance). For pressures exceeding 50 psi, inflator equipment servicing hose shall be a minimum of 10 feet in length. This allows personnel to be positioned forward or aft of the tire and clear of potential wheel failure fragments.

24.12.3.1. The pressure supply source, especially when using high pressure gas cylinders, shall include a pressure reducing regulator set not more than 50 percent over the required tire pressure or a maximum inlet pressure of 600 psi, whichever is less.

24.12.3.2. Only qualified precision measurement equipment laboratory (PMEL) personnel will adjust and/or calibrate tire inflation equipment. Applicable equipment TOs shall be referenced for time requirements.

24.12.4. Tire temperatures become more critical on faster and heavier aircraft. Nitrogen gas is preferred for inflating tires because oxygen in compressed air reacts with tire rubber at high temperatures and pressures. This causes deterioration, decreased tire life, and creates a blowout hazard. If compressed air is used, it shall be oil- and water-free. Hose material shall be compatible with the servicing agent (air or nitrogen) used. Two types of gaseous nitrogen are available in the Air Force supply system: oil-free nitrogen and oil-tolerant nitrogen.

24.12.4.1. Only oil-free nitrogen, also called water-pumped nitrogen, shall be used to inflate aircraft tires. Guidance for portable, nitrogen (converter) supply system cart (PN AO40111000) shall be consulted. **Warning:** Never inflate tires with nitrogen directly from supply cylinders.

24.12.4.2. Use local procedures to ensure oil-tolerant nitrogen, or oil-pumped nitrogen, is not used to inflate tires to prevent oil soaking the rubber. If compressed air (a legal alternative) is later used to inflate the tire, a combustible mixture will form on contact with the oil.

24.12.5. Aircraft Wheel Removal. Deflation is not required prior to removal if the tire will be reinstalled immediately following the maintenance task. All other removal actions require deflation prior to tire removal. Refer to TO 4T-1-3 for aircraft wheel removal task procedures.

24.12.6. Employee Training. Supervisors shall ensure workers servicing wheels are trained on procedures for each type of wheel serviced and will not allow untrained workers to service wheels. See OSHA 3086, *Servicing Single Piece and Multi-Piece Rim Wheels*, a comprehensive pamphlet on servicing wheels at <http://www.osha.gov/Publications/osha3086.pdf>, and 29 CFR 1910.177, *Servicing Multi-piece and Single Piece Rim Wheels*, for additional requirements.

24.12.6.1. The supervisor shall ensure each worker demonstrates and maintains the ability to service aircraft wheels safely. A worker is considered qualified and trained after completing the installation or unit's training program.

24.12.6.2. IAW 29 CFR 1910.177 and applicable TOs, the following tasks are required for worker qualification:

24.12.6.2.1. Deflation and demounting of tires.

24.12.6.2.2. Inspection and identification of wheel components.

24.12.6.2.3. Mounting and inflation of tires.

24.12.6.2.4. Use of tire cages and other tire mounting and servicing equipment.

24.12.6.2.5. Handling aircraft wheels.

24.12.6.2.6. Inflation of tire when wheel is mounted on aircraft or during in-shop maintenance.

24.12.6.2.7. Understanding the need to stand outside the trajectory of fragments in the event of an explosive separation during or immediately following inflation.

24.12.6.2.8. Installation and removal of wheels.

24.12.6.2.9. Use of appropriate PPE, e.g., goggles and/or face shield during tire inflation.

24.12.7. The supervisor shall evaluate each worker's ability to perform tasks safely and provide additional training as necessary to ensure each worker maintains proficiency.

24.12.8. Tire Servicing Equipment. The supervisor shall ensure a restraining device is available for inflating tires on wheels. The restraining device shall withstand the maximum force from a wheel separation at 150 percent of the maximum tire specification pressure for the type of wheel being serviced. Restraining devices shall also prevent wheel components being thrown outside or beyond the device for any wheel positioned within or behind the device. Restraining devices shall be visually inspected prior to use each day and after any separation of wheel components or sudden release of contained air. Inspections shall be annotated on AFTO Form 244, *Industrial/ Support Equipment Record*, or MAJCOM Safety Office approved substitute. Restraining devices exhibiting defects listed below shall be removed from service and an **AF Form 979**, *Danger*, tag attached until repaired and re-inspected:

24.12.8.1. Cracks at welds, or cracked or broken components. Validate any suspected cracks at welds using NDI methods.

24.12.8.2. Bent or sprung components from mishandling, abuse, tire explosion or wheel separation.

24.12.8.3. Pitting of components due to corrosion.

24.12.8.4. Other structural damage which would decrease restraining device effectiveness.

24.12.9. Accomplish a one-time NDI on all welds on locally manufactured restraining devices or commercially procured devices when integrity of welds has not been documented. Also, conduct NDI of welds whenever a tire/wheel failure in a restraining device causes visible or suspected damage, when a weld is found to be severely rusted or the integrity of a weld is in question.

24.12.10. Hoses shall be inspected periodically and replaced as required.

24.12.11. Restraining devices requiring structural repair, component replacement or re-welding shall be removed from service until certified by the manufacturer or registered professional engineer as meeting TO strength requirements.

24.12.12. The supervisor shall ensure an air line assembly with the following components is used for inflating tires:

24.12.12.1. Specified service chuck.

24.12.12.2. In-line valve with pressure gauge or pre-settable regulator (low/medium/high inflator/deflator kit).

24.12.12.3. Air hose, at least 10 feet long, between clip-on chuck and in-line valve so worker can stand outside fragment trajectory.

24.12.13. Current charts, TOs or manuals containing instructions for types of wheels being serviced shall be available in the service area.

24.12.14. The supervisor shall ensure only tools recommended in the TO or manual for the type of aircraft wheel being serviced are used.

### **24.13. Flight Line Vehicle Operations.**

24.13.1. General Requirements. Persons assigned flight line or related activities shall be knowledgeable of and comply with these requirements. Carelessness, haste and disregard for safety standards are primary causes of incidents and near misses, aircraft and vehicle mishaps and personnel injuries on the flight line.

24.13.2. Responsibilities. Supervisors will monitor and evaluate their personnel to ensure compliance with this standard, DoD and Air Force directives, installation directives and other established guidelines. Refer to AFMAN 24-306 (IP), *Manual for the Wheeled Operator*, AFI 13-213, *Airfield Driving*, and AFI 31-204, *Air Force Motor Vehicle Traffic Supervision*, for additional guidance and information.

24.13.2.1. Security Forces. The Chief of Security Forces shall monitor flight line vehicle operations for compliance with this standard, DoD and Air Force directives, and installation directives. Safe driving practices are the responsibility of all personnel who work and/or operate a vehicle on the flight line. Security Forces is responsible for enforcing safe and secure driving practices and procedures on the flight line. Only operators and vehicles designated by the wing commander or Airfield Manager, as prescribed in AFMAN 24-306 and AFI 13-213, shall be granted access to the flight line.

24.13.2.2. Acquisition Management Division. The chief of acquisition management (contracting division) shall: ensure contractors understand and comply with regulations, and inform Security Forces and airfield management of contractors who need to operate

vehicles on or work around the flight line including jobs that may impact airfield operations.

24.13.2.3. Safety. The Ground Safety office shall, in coordination with Airfield Management, brief temporary duty (TDY) groups, i.e., exercise participant, inspection teams, etc., on driving and conditions peculiar to the installation on-base and off-base environment and vehicle operations. The Ground Safety office will coordinate on lesson plans and tests for local flight line vehicle operations, as applicable, local directives or operating instructions for flight line traffic flow patterns and parking plans, and ensure vehicle operator briefings include flight line traffic rules and hazards.

24.13.2.4. Airfield Management. The Airfield Manager shall ensure eligible personnel are trained before granting privileges to drive on installation airfield/flight line; endorse the AF Form 483, *Certificate of Competency*; develop lesson plans and tests for installation flight line vehicle operations; train unit Flight line Driving Program Managers on flight line driving requirements; ensure training is provided to non-Air Force and contractor operators before allowing them to drive on the flight line; provide information to train personnel operating vehicles on the installation flight line; brief TDY personnel on local flight line procedures, if applicable; and IAW AFI 13-213, develop a program to control and identify privately-owned vehicles authorized access to the flight line.

24.13.2.5. Unit Commanders. Commanders with personnel authorized to operate motor vehicles on the flight line will ensure their operators are qualified and trained on the type vehicle and task assigned; review individuals' AF Form 110, *Individual Incident Reference Record*, to ensure their qualifications before permitting them to operate vehicles and/or equipment on the flight line; and ensure unit Vehicle Control Officers (VCOs), Vehicle Control NCOs (VCNCOs) and designated flight line driving instructors give day and night check rides to new operators before allowing them to drive on flight line. Check rides will include routes, limitations, runway and taxiway crossing and other local procedures for flight line driving. Additionally, the Commander shall suspend a vehicle operator's driving privileges if that person develops physical and/or mental problems that may impair driving, cause personnel injury or damage to equipment.

24.13.3. Operating Standards. The following vehicle traffic standards shall be observed when vehicles (including motorcycles, mopeds, bicycles or tricycles) are operated on the flight line.

24.13.3.1. Speed Limits. No vehicle shall be operated at a speed in excess of that deemed reasonable and prudent for existing traffic, road and weather conditions. Emergency vehicles will not automatically assume the right of way. AFMAN 24-306 lists the following flight line speed limits: **Note:** Vehicles responding to Red Balls (emergency flight line scenarios), exercises and precautionary landings are not authorized to exceed these limits. Refer to AFI 21-101, *Aircraft and Equipment Maintenance Management*, and paragraph [24.2.9](#) for additional guidance on Red Balls.

24.13.3.1.1. General purpose vehicles – 15 mph.

24.13.3.1.2. Special purpose vehicles, i.e., tractors, tugs, forklifts, sweepers, etc. – 10 mph.

24.13.3.1.3. Vehicles in close proximity to aircraft (within 50 feet) – 5 mph.

24.13.3.1.4. During reduced visibility or when snow and ice are present on paved surfaces, reduce speed to 10 mph maximum. Defer vehicle operation when possible and limit to mission essential.

24.13.3.1.5. Snow and ice removal vehicles will operate at a speed commensurate with safety during snow and ice control operations.

24.13.3.1.6. “Follow Me” vehicles are permitted to exceed the normal 15 mph speed limit to accommodate aircraft taxiing speed.

24.13.3.1.7. During emergencies, all emergency response vehicles, i.e., aerospace rescue firefighting equipment, ambulances, Airfield Management and Security Forces, may exceed speed limits only with due regard for the safety of persons and property.

24.13.4. Aircraft, Equipment and Trailer Towing. Limit towing speed to 5 miles per hour for all aircraft and when towing 2 or more maintenance stands, and 10 miles per hour with one stand or equipment with solid wheels and/or castors. Limit tow speed for AGE, such as compressors, ground power units, oxygen carts and similar equipment to 15 miles per hour. Refer to paragraph [24.15.4](#) for additional information on AGE. Up to four type B1, B4, B5 and similar small stands may be towed as two sets of two in tandem on a double hitch or two in tandem on a single hitch. Type B3, J7 and similar large stands shall be towed singly on a center mounted hitch. Four-wheeled units shall not be towed behind two-wheeled units. Large AGE, when towed in tandem, shall not block the driver’s vision of the last item being towed. Safety locking devices or cotter pins shall be used to secure pintle hooks and trailer hitches. Vehicle operators will not approach within 50 feet of an aircraft being towed.

24.13.5. Flight Line Driving.

24.13.5.1. Private Motor Vehicles (PMV). The operator shall possess a valid state driver’s license, an AF Form 483, with flight line endorsement and authorization (PMV pass/cone) from the Airfield Manager. Airfield Management will ensure flight line training is provided to contractor personnel requiring flight line access.

24.13.5.2. Motorcycles. Motorcycles, mopeds or scooters may be operated on the flight line. If authorized, PPE IAW AFI 91-207, *The US Air Force Traffic Safety Program*, shall be worn when operating a motorcycle. No passengers are allowed. The operator shall complete a Motorcycle Safety Foundation Course IAW AFI 91-207. Motorcycles shall have headlights on at all times, unless shining toward a moving aircraft at night or during reduced visibility, when it shall be turned off immediately so the pilot is not blinded or night vision affected. Mopeds and scooters will have an operating headlamp and front and rear reflectors if authorized for night use.

24.13.5.3. Bicycles and Tricycles. Bicycle or tricycle operators shall know requirements in this chapter and local directives. Tricycles parked on the flight line will have a braking device engaged to prevent inadvertent movement. For night use, bicycles and tricycles shall be equipped with an operating headlight and reflectors or reflective tape. Bicycles and tricycles parked on the flight line at night shall be placed so they will not impede aircraft or traffic flow.

24.13.5.4. Other Vehicles. Vehicles identified in AFI 91-207 include Government Vehicles Other (GVO), Low-Speed Vehicles (LSV) and Off-Road Vehicles (ORV). If authorized to operate on the flight line, electrical, gas or gasoline-powered GVO, LSV and ORVs will follow AFI 91-207 PPE and training requirements, and all rules established for general and special purpose vehicles. GVO, LSV and ORVs shall have forward and rear lamps if operated at night.

24.13.6. Entering or Leaving Flight line Driving Areas. All vehicles, except emergency and alert vehicles responding to an alert or emergency, shall stop prior to entering the flight line and accomplish an FOD check. FOD Check signs shall be positioned at every entrance to ramp areas and flight line. This is a mandatory requirement. **Note:** This may be waived by the Installation Commander. Traffic lanes on aircraft parking ramps are normally to the right of the aircraft. Unless prevented by local procedures, traffic flow on aircraft parking ramps shall be parallel to the noses of parked aircraft with the driver's side toward the aircraft. Vehicles shall not be driven diagonally across the parking ramp, but at 90-degree angles to the driving lanes.

24.13.7. Vehicle Parking. Vehicles shall not be backed or parked within 25 feet of any aircraft, unless authorized for operations such as loading or unloading, servicing or towing. A spotter shall be posted when backing a vehicle towards an aircraft. Prepositioned wheel chocks shall be used to prevent vehicles backing into aircraft. Prepositioning of chocks during backing of tow vehicle to tow bar (for the express purpose of towing the aircraft) is not required as long as all requirements of paragraph 24.7 are followed. Vehicle chocks shall be constructed IAW Commercial Item Specification A-A-52475 or locally manufactured IAW TO 00-25-172.

24.13.7.1. Unattended vehicles shall be parked with the driver's side facing the aircraft and so it will not interfere with aircraft being towed or taxied. Ignition shall be turned off; keys left in the ignition; and the gear lever put in reverse gear for manual transmissions, and in 'park' for automatic transmissions. All vehicles parked and left unattended will have brakes set or chocks placed in front of and behind a rear wheel, or one chock placed between the tandem wheels of dual (tandem) axle vehicles. Only alert and emergency vehicles responding to an alert or emergency are exempt from these requirements. **Note:** AGE towing vehicles may be placed in "neutral or park" with parking brake set and engine left running during equipment hitching and unhitching operations. AGE towing vehicles must be turned off when the driver seat is vacated for any other purpose.

24.13.7.2. Wheeled AGE/maintenance equipment shall have brakes set, if available, or chocked.

24.13.7.3. Vehicles shall not be parked or driven less than 25 feet in front or 200 feet behind aircraft with running engines, unless prescribed in applicable aircraft handbooks. Vehicles parked next to aircraft shall be clear of wingtips and clearly visible to personnel in cockpit.

24.13.8. Passengers in Vehicle. Passengers shall be limited to the designed seating capacity of the vehicle during routine operations. This includes pickup trucks and cargo vans with passenger seats as well as sedans, station-wagons and buses. When exigent circumstances or contingency requirements exceed the capability of available vehicles, commanders may,

through appropriate written and documented risk assessments and compliance with installation/host installation guidelines, determine the appropriate means of transportation for existing vehicles. Passengers shall use available seat belts when the vehicle is in motion. If deemed operationally necessary by the unit commander to ride in the bed of pickup trucks, occupants will sit only on the floor, not on wheel wells, with their backs against the cab and remain seated while vehicle is moving (see **Note** below). Passengers in vans will remain seated, keep their arms and legs within the vehicle body, and keep side doors closed while the van is moving. Passengers will not ride in doorways or sit on engine covers in metro vans/step vans. Door nets shall be used when transporting passengers with rear doors open. Panel van and metro vehicle (bread truck) sliding passenger doors may remain open while the vehicle is in motion if a cargo net is installed to restrain the passengers. **Note:** Personnel jumping or descending from the bed of pickup and stake bed trucks have caused a large number of injuries and the practice of riding in the bed of these type vehicles is highly discouraged. However, commanders should identify in writing vehicles approved for transporting personnel in the bed of pickup or stake bed vehicles.

24.13.9. Restricted Visibility or Night Operations. Flashing or parking lights shall be used at night when vehicles are temporarily parked on any part of the aircraft ramp. This does not apply to vehicles parked in a designated parking area. Refueling and explosive loaded (laden) vehicles shall not be operated when visibility is less than 300 feet unless directed by wing or installation commander. PMVs and flight line vehicles, except emergency and alert vehicles, shall not be operated on the flight line with visibility less than 100 feet. A walking guide with a flashing or luminescent wand shall be used during emergency movement of alert vehicles when visibility is under 50 feet. Vehicle operators shall ensure headlights do not point toward taxiing aircraft or towing operations to prevent blinding aircraft or tow vehicle operators.

24.13.10. Control Tower Signs. For units based at an Air Force installation, AFVA 11-240, *Airport Signs and Markings* (**Figure 24.2**), shall be displayed where maintenance and flight-related operations take place. Suitable locations include, but are not limited to, maintenance work areas, flight operations, flight line buildings frequented by ground and aircrew personnel, vehicles operated on Air Force airfields, etc. Refer to AFI 13-213, *Airfield Driving*, for additional guidance. AFVA 11-240 is available at <http://www.e-publishing.af.mil>. AFVA 13-221, *Control Tower Light Signals* (**Figure 24.3**), may be used in conjunction with AFVA 11-240. Units located at contingency or foreign airfields shall use the visual aid (FAA or USAF) that most clearly depicts the actual markings on the airfield. Vehicle operators will know and comply with the following signals:

24.13.10.1. Steady Green Light: "Clear to cross."

24.13.10.2. Steady Red Light: "STOP! Vehicle shall not be moved."

24.13.10.3. Flashing Red Light: "Clear active runway/taxiway."

24.13.10.4. Flashing White Light: "Return to starting point."

24.13.10.5. Red and Green Light: "General warning. Exercise extreme caution." **Note:** During alerts and emergency conditions, all non-essential personnel will withdraw to an appropriate location IAW installation guidelines, Airfield Management or their Work Control Center until the emergency is terminated. Contractor withdrawal due to alerts and



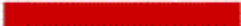



emergency conditions shall be determined on a case-by-case basis by Airfield Management.

Figure 24.2. AFVA 11-240, *Airport Signs and Markings*.

Airport Signs - Action and Purpose	ATCT LIGHT GUN SIGNALS	Airport Markings
<p><b>16-SS</b> TWY/RWY HOLD POSITION: Hold short of Runway on Taxiway</p> <p>ALSO... RWY/RWY HOLD POSITION: Hold short of Intersecting Runway</p> <p><b>16-APCH</b> RWY APCH HOLD POSITION: Hold short of Act on Approach</p> <p><b>INST</b> INST HOLD POSITION: Hold short of INST Critical Area</p> <p><b>NO ENTRY:</b> Identify Paved Areas Where Aircraft Entry is Prohibited</p> <p><b>A</b> TAXIWAY LOCATION: Identify Taxi on Which Vehicle/Aircraft is Located</p> <p><b>16</b> RUNWAY LOCATION: Identify Runway on Which Vehicle/Aircraft is Located</p> <p><b>VFR HOLD POSITION BOUNDARY:</b> Exit Boundary of Rwy Protected Area</p> <p><b>INSTRUMENT AREA BOUNDARY:</b> Instrument Hold Position</p> <p><b>TWY DIRECTION:</b> Defines Direction &amp; Designation of Intersecting Taxiway(s)</p> <p><b>RWY EXIT:</b> Defines Direction &amp; Designation of Exit Taxi from Runway</p> <p><b>15 I</b> OUTBOUND DESTINATION: Define Direction to Take-Off Runways</p> <p><b>MIL</b> INBOUND DESTINATION: Define Direction for Arriving Aircraft</p>	<p><b>STEADY GREEN</b> → Cleared to cross, Proceed or Go</p> <p><b>FLASHING GREEN</b> → Not Applicable</p> <p><b>STEADY RED</b> → STOP</p> <p><b>FLASHING RED</b> → Clear the Taxiway/Runway</p> <p><b>FLASHING WHITE</b> → Return to Starting Point on Airport</p> <p><b>ALTERNATING RED/GREEN</b> → Exercise Extreme Caution</p>	<p><b>VFR HOLD POSITION:</b> Hold Short of Rwy</p> <p><b>ALTERNATE RUNWAY HOLD POSITION:</b> Hold Short of Runway</p> <p><b>INSTRUMENT HOLD POSITION:</b> Hold Short During IMC Conditions</p> <p><b>TAXIWAY/TAXIWAY HOLDING POSITION:</b> Hold Short of Intersecting Taxiway When Directed by ATC</p> <p><b>TAXIWAY EDGE:</b> Defines Edge of Usable Full Strength Taxiway Pavement. Adjoining Pavement NOT Usable</p> <p><b>DASHED TAXIWAY EDGE:</b> Defines Edge of Taxiway Where Adjoining Pavement or Apron IS Available for Taxi</p>
<p><b>TOWER FREQUENCY</b></p> <p>Reference: AFI 11-218 Aircraft Operations and Movement on the Ground</p>	<p><b>16-SS</b> VFR Hold Position</p> <p><b>INST</b> INST Critical Area Markings</p>	<p><b>GROUND FREQUENCY</b></p> <p>AFVA 11-240 USAF Airport Signs and Markings</p> <p><small>AFVA 11-240, 3 June 2004 Prepared by AFVA 11-240 1816, HQ AFVA/ASSTC 2400, AFVA/Signs and Markings 2400, AFVA/Signs and Markings 2400, AFVA/Signs and Markings</small></p>



Figure 24.3. AFVA 13-221, *Control Tower Light Signals*.

CONTROL TOWER LIGHT SIGNALS		
SIGNAL	FOR AIRCRAFT	FOR VEHICLES
STEADY GREEN 	CLEARED TO LAND CLEARED FOR TAKEOFF	CLEARED TO CROSS
FLASHING GREEN 	RETURN FOR LANDING CLEARED TO TAXI	NOT APPLICABLE
STEADY RED 	GIVE WAY TO AIRCRAFT STOP	STOP
FLASHING RED 	AIRPORT UNSAFE CLEAR RUNWAY	CLEAR RUNWAY
FLASHING WHITE 	RETURN TO STARTING POINT ON AIRPORT	
ALTERNATING RED & GREEN 	GENERAL WARNING SIGNAL EXERCISE EXTREME CAUTION	
AFVA 13-221, 1 November 2001      Distribution: F Prescribed by AFI 13-203		

24.13.11. Taxiing Aircraft. Except for *Follow Me* vehicles, vehicles shall not be parked in front of, driven into the path of taxiing aircraft or driven between a taxiing aircraft and its *Follow Me* guide vehicle or aircraft marshaler. All drivers operating vehicles on taxiways and parking ramps shall give way to taxiing aircraft. Vehicles will exit taxiways by the shortest route. Only as a last resort will the vehicle be driven off prepared surfaces to ensure adequate clearances for aircraft. A FOD check shall be accomplished when the vehicle is back on the taxiway.

24.13.11.1. Vehicle headlights shining towards a moving aircraft at night shall be turned off immediately to prevent affecting the pilot’s night vision and will remain off until the aircraft is out of range. However, vehicle parking lights or emergency flashers shall be turned on so its position is known. Headlights shall be turned ON prior to moving the vehicle. **Note:** Vehicles with daytime running lights will park in a safe location with ignition off, parking brake set and emergency flashers on.

24.13.11.2. Taxiing aircraft shall be alerted when a vehicle cannot operate under its own power. As a minimum, the vehicle operator will leave the vehicle parking lights or emergency flashers on during hours of darkness. Vehicles’ two-way radio shall transmit: “All parties *BREAK, BREAK – This is (call sign) with an emergency for Airfield Management, Tower and Maintenance Operations Center.*” Then state the problem and vehicle position on the airfield. Operators of other radio-equipped vehicles (security

forces, CE, Logistics Readiness, etc.) will contact their control center to relay the information to the Airfield Management Dispatcher and tower. For vehicles without a radio, stay with the vehicle and try to get attention of the taxiing aircraft.

24.13.12. *Follow Me Vehicles.* *Follow Me* vehicles for guiding aircraft shall be equipped with signs, easily visible at night, reading “*Stop*” and “*Follow Me.*” They shall have two-way radio communication on control tower frequencies. When approaching the parking spot, the *Follow Me* vehicle operator should illuminate the “*Stop*” signal, move the vehicle from the intended path of aircraft travel, and position it laterally — clear of the aircraft wingtip. The marshaller, who may be the vehicle operator, will guide the aircraft to the parking spot using approved marshaling signals. *Follow Me* vehicles may exceed the 15 mph flight line speed limit when necessary to accommodate the safe taxiing speed of aircraft. Tugs shall not be used as *Follow Me* vehicles. Refer to AFMAN 24-306 (IP), *Manual for the Wheeled Operator*, for additional information on *Follow Me* vehicles.

24.13.13. FOD Prevention. Rocks, bolts, screws, trash, nails, etc., may become lodged between dual wheels and gravel may stick in tire treads when vehicles are operated off paved surfaces. Before entering ramp areas or flight line, except responding emergency and alert vehicles, operators will stop, visually check and remove foreign materials from the tires, bumpers, pickup beds, tailgate area, etc. FOD Check signs shall be positioned at every entrance to ramp areas and flight line. This is a mandatory requirement. **Note:** This may be waived by the Installation Vice Wing Commander. Refer to AFI 21-101, *Aircraft and Equipment Maintenance Management*, AFMAN 91-201, *Explosive Safety Standards*, and AFMAN 24-306 (IP), for additional guidance. Vehicle operators shall ensure all equipment on their vehicles is properly stowed and secured and inspect their vehicles for objects that could damage aircraft before operating on the airfield.

24.13.14. Forklift and Hi-Lift Truck Operation Around Aircraft. Forklifts and hi-lift trucks are used to move cargo to/from aircraft and for raising/lowering cargo/equipment between ground and aircraft. Only licensed drivers shall operate forklifts and hi-lift trucks. Training and licensing shall be IAW AFI 24-301, *Vehicle Operations*. Forklift or hi-lift truck operators shall not exceed 10 mph on ramps or 5 mph within 50 feet of any aircraft. Hi-lift truck operators require special training, a responsibility of the using organization. Refer to **Chapter 35**, *Materials Handling Equipment*, and AFMAN 91-201 for additional information.

24.13.14.1. Maneuvering Forklifts and Hi-Lift Trucks. A spotter shall assist operators in determining safe clearances when maneuvering close to aircraft. Bumper blocks or vehicle chocks placed on ramps shall be used to prevent backing into aircraft. Spotters shall also assist operators when necessary to back the vehicle. The driver and spotter shall be able to communicate at all times. The spotter shall use luminous wands or flashlights to relay signals to the hi-lift operator during the night unless supplemental lighting is used. Spotters shall be used any time the cargo bed is raised or lowered. Forklifts shall be completely stopped before lifting or lowering a load, and forklift drivers shall not raise or lower a load while in motion. Forklifts shall never be driven under an aircraft except when required by the aircraft involved. When traveling long distances and/or when carrying bulky loads, the forklift shall be driven in reverse as the operator’s field of vision is less obstructed. Forks of parked forklifts shall be lowered flat on the ground to

prevent injury to personnel working or walking in the area. Parked and unattended forklifts shall have operating levers placed in neutral, ignition switched off and handbrake set.

24.13.14.2. Crating. Large unwieldy crates shall be equipped with rings for attaching tag lines. Tag lines make handling safer and provide a means of securing crates in open areas. Tag lines shall be of sufficient length to permit the person holding the rope to stand clear of the load and avoid standing under the load.

24.13.14.3. Stacking. Forklift drivers will not stack empty pallets higher than eye level. Pallets stacked on forklift tines higher than eye level cause an unsteady load and are a potential source of injury or property damage. Forklift operators will have a spotter available when stacking cargo on trailers and 463L (pallet) equipment if vision is obstructed.

24.13.14.4. Lift-Truck Forks. Forklifts shall not be used to tow trailers or push equipment unless designed for that operation by the manufacturer and technical data is followed. Forklifts shall be equipped with operating horns and lights, when needed for safe operation.

24.13.14.5. Hi-Lift Truck Cargo Bed Hydraulic System. The driver shall completely stop the truck before operating the cargo bed hydraulic system. The truck shall be at least five (5) feet from the aircraft, before the bed is raised or lowered, to ensure adequate clearance.

24.13.15. Hand Pallet Trucks Inside Aircraft. Hand pallet trucks are hydraulically-operated material handling devices used for moving heavy objects inside aircraft. Since hand pallet trucks do not have brakes, at least two (2) persons will operate this piece of equipment. 1-inch by 12-inch shoring or equivalent protection shall be used to prevent floor damage when moving extremely heavy loads inside aircraft. Care shall be taken to avoid damaging aircraft ceilings and sidewalls.

24.13.16. Stowing Cargo on Aircraft. Cargo shall be loaded IAW aircraft loading TOs and handbooks to avoid exceeding weight and balance limits.

24.13.17. Roller Pry Bar Use Inside Aircraft. When using roller pry bars to position heavy cargo inside aircraft, personnel shall be careful not to exceed maximum allowable floor strengths.

24.13.18. Floor Load. Consult aircraft TOs to determine maximum allowable floor loads. Shoring shall be used when a load is expected to exceed the published limit.

24.13.19. K-loaders and Roller-Equipped Trailers Around Aircraft. Guides/spotters shall assist the operator when approaching an aircraft to load or off-load cargo. The operator shall bring the loader to a complete stop, set the brakes and place the cab transmission selector in neutral before operating the cargo deck hydraulic system. To ensure adequate clearance, the loader shall be stopped or moved at least five (5) feet from the aircraft for preliminary deck alignment using the hydraulic system. The operator shall maintain a 5 to 8-inch clearance between the rubber bumpers and the aircraft for further deck adjustments during on- or off-loading.

24.13.20. Air Cargo Storing and Warehousing. Storage and warehousing of air cargo is similar to normal warehousing procedures. General safety standards for warehousing also apply to air cargo storage. Refer to **Chapter 35** for additional information.

24.13.21. Tractor Operations. Tractors with small flatbed warehousing trailers and airlift palletized cargo shall not exceed five (5) mph. All tractor-trailer combinations shall be equipped with lights when operating at night or during low visibility. Signs reading “*Slow Moving Vehicle*” or the triangular slow moving vehicle emblem shall be displayed on these vehicles. Passengers shall not be allowed to ride on tractors unless adequate seats are installed.

24.13.21.1. Trailers. No more than four (4) trailers, loaded or empty, shall be pulled by any tractor. To avoid jackknifing, trailer trains shall be arranged with the most heavily loaded trailer next to the towing vehicle, the next heaviest second in line, etc. **Exception:** Six A/M-3H-6 palletized cargo trailers may be moved behind one prime mover.

24.13.21.2. Couplings. Tractor operators shall ensure couplings are secure before moving a trailer or train. Pintle assemblies and towing connections shall be secured with a pintle hook safety locking device or cotter pin that will positively lock towing connections.

24.13.22. Deicing Operations. Conduct deicing operations IAW TO 42C-1-2, *Anti-icing, Deicing and Defrosting of Parked Aircraft*, and aircraft-specific deicing TO guidance. Also, only licensed drivers shall operate deicing trucks. Deicing basket operators shall act as vehicle spotter and remain in constant radio or interphone contact with the driver throughout the deicing operation. Basket operators shall continually monitor clearances. A ground spotter shall be used if the basket operator cannot adequately monitor clearances. Pre-position chocks when using a deicer truck to perform maintenance and inspections, when backing towards aircraft or as directed by local procedures or aircraft TOs.

#### **24.14. Aircraft Hangar Operations.**

24.14.1. Hangaring Aircraft. The Maintenance Group Commander or equivalent shall ensure detailed local operating procedures for hangaring aircraft, including safety precautions, are prepared and coordinated with the installation Ground Safety Office and FES Flight. Include installation Weapons Safety Office coordination if hangaring weapons-loaded aircraft.

24.14.2. Aircraft Hangar, Shelter and Dock Facility Design Guidance. Consult NFPA 70, Article 513, *Aircraft Hangars*, NFPA 409, *Standard on Aircraft Hangars*, NFPA 410, *Standard on Aircraft Maintenance*, Unified Facilities Criteria (UFC) 3-600-01, *Fire Protection Engineering for Facilities*, and associated engineering technical letters (ETL) for detailed design guidance. ETLs supplement UFC 3-600-01. Compliance with ETLs is required per AFI 32-1023, *Designing and Constructing Military Construction Projects*. ETLs take precedence in conflicts with national fire codes, building codes or UFC 3-600-01. The installation Ground Safety office, FES Flight and BE will evaluate facilities, equipment, processes, etc., and provide recommendations to ensure safety, fire and health hazards are properly mitigated and/or controlled.

24.14.2.1. Fixed electrical equipment approved for Class I, Division 1 locations may be used in Class I, Division 2 locations of the same class and compatibility group.

Equipment not meeting these guidelines shall be de-energized or disabled and locked out until special operations are complete and hazardous conditions permanently eliminated. Refer to paragraph [24.3.3.1](#) for additional guidance.

24.14.2.2. Keep portable electrical equipment out of hangars during special hazardous procedures unless it meets requirements in paragraph [24.14.2.1](#) and is marked accordingly.

24.14.3. All openings from occupied areas into hangars shall be protected by ramps, curbs or drains to prevent entry of liquids. All areas normally occupied by personnel shall have an exit route to the outside of the hangar that does not require entering locations occupied by aircraft. Refer to NFPA 409 for additional information. Each means of egress from mezzanines shall lead directly to a properly enclosed stairwell, directly to the exterior, or to outside stairs.

24.14.4. Hangar, Nose Dock and Shelter Door Design and Operation Guidance. Eliminate hazards through engineering design or redesign. Install barriers such as chains and fencing to restrict personnel from hazardous areas. Ensure mechanical safeguards are in place such as installing limit switches and doorstops where necessary to limit unnecessary door travel. Doors not in compliance shall be assigned an RAC by the installation Ground Safety office. A JSA shall be performed and appropriate controls put in place until doors are compliant.

24.14.4.1. Identification. Establish a clear zone, i.e., five (5) feet if space allows, around all hazardous areas. Hazardous areas include crush and pinch points between structural beams and hangar doors. Highlight hazardous areas such as crush and pinch points that cannot be eliminated by engineering controls or mechanical safeguards with colored paint and signs. Mark these clear zones with solid yellow or yellow and black stripes IAW [Chapter 7, Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders](#).

24.14.4.2. All sides visible when approaching a hazard area shall have a 14 by 20 inch or larger "DANGER" sign painted on the floor just outside the clear zone IAW [Figure 29.1](#) and [Table 29.3](#). Place the sign so it can be read when approaching the hazard area. The word "DANGER" shall be printed on top with white letters with a message below stating: "HAZARDOUS AREA – STAND CLEAR DURING DOOR OPERATIONS."

24.14.4.3. Place a "DANGER" sign next to all hangar door controls. Sign size (at least 7 by 10 inches) and lettering shall be IAW [Figure 29.1](#) and [Table 29.3](#). The word "DANGER" shall be printed on top in white letters with a message below stating: "ONLY QUALIFIED PERSONNEL AUTHORIZED BY THE SQUADRON COMMANDER MAY OPERATE HANGAR DOORS." The bottom of the sign shall reference paragraph [24.14.8.3](#).

24.14.4.4. Safety signs shall be printed in English and the predominant language of non-English reading workers. Established symbols should also be considered. Workers unable to read posted signs shall be informed of hazardous areas and instructions printed on the signs.

24.14.5. Training. Workers who routinely work in hangars or require access through hangar doors shall receive Hangar Door Awareness Training, both an initial training program and annual refresher course. Courses shall include, at a minimum, door hazards, emergency

procedures (including manual door operation) and safe operation. Training shall be documented on worker's AF IMT 55, *Employee Safety and Health Record* (or equivalent product), AF Form 623, *Individual Training Record Folder*, or MAJCOM authorized substitute (paper or electronic format acceptable).

24.14.6. Operating Condition. Hangar doors shall be maintained in safe working condition. Door paths shall be free of obstructions with door tracks and track-ways in good condition and free of debris. A visual inspection shall be made prior to operation and discrepancies corrected before operation. Hangar doors shall be on a preventative maintenance schedule and only qualified workers shall perform hangar door maintenance.

24.14.7. Door Pockets. Hangar door pockets and recessed areas shall not be used for storage and shall be adequately illuminated so the door operator can see any obstructions or personnel in the door path.

24.14.8. Powered Hangar Doors:

24.14.8.1. Alarm/Warning Lights. To prevent confusion, powered hangar doors shall have an alarm device with a sound distinguishable from the facility fire alarm and audible above normal noise levels. The warning device shall automatically signal at least 5 seconds before any door section movement, continuously while the door is operated and shall reset immediately after movement stops. Additionally, warning lights are required in high noise areas if the audible alarm is difficult to hear, but use caution to avoid stroboscopic effects.

24.14.8.2. Door Controls. Controls shall not place the operator in harm's way. Controls shall be installed where they prevent the operator entering hazardous areas and shall provide the operator a clear view of door travel. The door shall stop movement if the operator removes pressure on the door switch. For all center door switch operations, the word "OPEN" shall be placed at the top position and the switches shall be wired so the doors open when "OPEN" is selected. A hinged cover or other device shall be installed over the "CLOSE" switch or button to prevent inadvertent activation. Fold-up, counterbalanced and similar doors shall have control switches located with a clear view of the door opening. Where feasible, place limit switches in appropriate locations to keep the operator away from hazardous areas. Also see Air Force design criteria or equivalent Air Force-approved engineering guidance.

24.14.8.2.1. All markings on or near controls and doors shall be easily understood and excessive markings avoided to eliminate confusion.

24.14.8.2.2. Directional arrows shall be present and understandable. Luminescent or reflective directional arrows shall be placed adjacent to each switch and on horizontal sliding doors to indicate direction of door travel for each corresponding switch.

24.14.8.3. Only qualified personnel, approved by the squadron commander or designated representative, shall be authorized to operate hangar doors. Operators shall be thoroughly familiar with operating instructions and precautions necessary for safe operation. Written operating procedures outlining all safety precautions to operate the doors shall be posted next to all operating controls. Qualified personnel will be documented in writing by the squadron commander or designated representative.

24.14.8.4. Overhead hangar doors shall be fully opened before moving aircraft through the door entrance. Horizontal sliding doors shall be opened to permit a minimum 10-foot clearance at each wingtip. If hangar construction does not permit such clearance, the doors shall be opened to the maximum limit. Wing walkers shall be used when an aircraft is placed in a hangar. (Also see paragraph [24.7.2.5](#)) Under normal conditions, powered hangar or shelter doors shall be opened at least 10 feet. For special operations, such as during extreme weather conditions, the door may be opened less than 10 feet only if the door control switch is locked off or out until the door can be opened to 10 feet or more, or be closed. Refer to [Chapter 21](#), *Hazardous Energy Control (Lockout and Tagout)*, for lockout requirements.

24.14.8.5. Personnel Access Doors. Personnel shall not enter through a personnel door while the hangar door is moving. Hangar doors with personnel access doors shall have safety switches installed to prevent inadvertent entry while the door is moving.

24.14.8.6. Signs. Where hazards cannot be eliminated, place danger/caution/warning signs describing the hazardous condition in conspicuous locations IAW [Chapter 29](#).

24.14.8.7. Operational Checkout of Doors and Safety Features. Facility managers shall conduct monthly inspections of hangar door operational and safety features. CE and Airfield Management shall be notified immediately of any discrepancies.

24.14.9. Manual and Roll-up Hangar Doors. Manual hangar doors shall be maintained in good operating condition with door tracks free of debris and obstructions to allow smooth operation. Operators shall conduct a visual inspection of door path and track-way and correct any discrepancies before operating door. Individuals shall remain clear of door path while door is in motion. Hangar auxiliary service roll-up doors, to include tow vehicle exit doors, shall meet the following requirements:

24.14.9.1. Be able to open a minimum of 8 feet or 70 percent of maximum opening height.

24.14.9.2. Crush sensor on the bottom of the door shall be installed and operational.

24.14.9.3. Controls for the door shall be located so there is an unobstructed view during door operation.

24.14.9.4. Open and close motion shall be no faster than nine (9) inches per second.

24.14.9.5. Prior to entering or exiting the hangar with a vehicle through these doors, vehicle drivers will sound their horn to alert personnel.

24.14.9.6. Motion alarm will sound on the closing cycle of the door.

24.14.10. Clear Space Requirements Around Hangars. Maintain a clear zone of at least 50 feet around all sides of a hangar, shelter or nose dock. Do not store or park aircraft, position concentrations of combustible materials or erect buildings of any kind within the clear zone. Refer to NFPA 409 for additional information.

24.14.11. Vehicle Operations. Vehicles pose a traffic hazard and an ignition source for fuel vapors from aircraft fuel vents or a fuel spill. The Maintenance Group Commander or equivalent shall ensure local procedures are established to control these hazards. While Air Force general or special purpose vehicles do not require spark arresters, vehicle ignition and

power systems are not designed for operation in hazardous atmospheres and shall not be driven within 25 feet of fuel spills. Also, vehicles or equipment with metal wheels or studded tires may be prohibited from operations in hangars. Vehicles shall not be parked unattended in front of hangar doors while aircraft are parked inside. When mission requirements or weather conditions create a need to park vehicles inside hangars, a plan for an isolated parking area shall be developed and approved by the Maintenance Group Commander or equivalent in coordination with the installation Ground Safety office, FES Flight and BE. This special parking area shall be outside of any potential hazard area and ventilated as required by the BE OEH risk assessment. Traffic patterns shall be separated from parked aircraft. **Note:** Vehicles shall not be parked unattended in front of hangar doors if aircraft are in that hangar bay. Vehicles may be parked in front of any hangar door that is not used for the egress or ingress of aircraft operations.

24.14.12. Heaters. Combustion heaters installed in aircraft shall not be operated in a hangar. Portable engine and cabin heaters shall be removed and stored immediately after each use or when no longer required. Engine and shelter heaters shall be placed as far from the aircraft as ducting permits. No portable heater shall be left operating unattended. Only heaters approved for operation inside hangars and that do not give off unacceptable levels of carbon monoxide (CO) shall be used. Heaters and the processes for which they are used shall be evaluated by BE to ensure adequate ventilation is provided and that health threats (e.g., CO) are effectively controlled (e.g., CO alarms are installed) to prevent harmful exposures.

24.14.13. Electric Wiring, Power Cords and Maintenance. Temporary or makeshift wiring in hangars is prohibited. Only properly installed and maintained service extensions shall be used. Overloading electric circuits shall be avoided. All hangar electrical systems and subsystems shall be protected by circuit breakers or switches with lockout capabilities and shall be de-energized and locked out prior to beginning maintenance. Refer to **Chapter 21, Hazardous Energy Control (Lockout and Tagout)**, for additional information. Portable lamps shall have three wire grounded cords long enough for the task. All electric cords shall be inspected before each use and repaired or replaced as necessary. Wall receptacles of different voltages and frequencies shall be configured as required by NFPA 70, *National Electric Code*. Metal ladders or stands shall not be used when servicing electrical equipment and systems. All cables/cords shall be de-energized (turned off), disconnected and stored when not in use. Refer to **Chapter 8, Electrical Safety**, and UFC 3-560-01, *Electrical Safety, O & M*, for additional information.

24.14.14. Ground Power Generators. Generators shall not be positioned within 10 feet of aircraft fuel system vents. Generator design shall ensure all electrical equipment, sparking contacts, hot surfaces and other possible ignition sources are at least 18 inches above floor level. Generators shall not be refueled inside hangars. Place engine powered equipment so the exhaust does not pose a hazard to workers.

24.14.15. Aircraft Emergency Removal. The aircraft maintenance officer, designated by the Maintenance Group Commander or equivalent, shall establish emergency procedures to remove aircraft from hangars in case of fire, severe weather or other hazards. Workers shall be trained on emergency procedures to eliminate confusion and ensure timely evacuation of aircraft. Snatch blocks and/or harnesses laid out on hangar floors shall be attached to the aircraft when in-progress work permits.



24.14.16. Conduct aircraft refueling and defueling operations in facilities designated and approved for aircraft fuel system maintenance (fuel cell repair) operations. Refer to TO 1-1-3, *Inspection and Repair of Aircraft Integral Tank and Fuel Cells*, for aircraft fuel system maintenance facility requirements. For operations other than aircraft fuel systems maintenance, aircraft shall only be fueled or defueled in facilities approved through a System Safety Engineering Analysis (SSEA) conducted IAW instructions in TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. SSEA-approved facilities include TAB VEE shelters, modified TAB VEE, 2nd and 3rd generation aircraft shelters, flow-through revetments and B-2 maintenance facilities at Whiteman AFB, MO.

#### **24.15. Aircraft Shop and Flight Line Maintenance Operations.**

24.15.1. General Requirements. Plan layout of aircraft shops and the flight line operations and facilities in relation to lighting, ventilation, aisle way and work space for safe and efficient production. Provide mechanical safeguards to prevent injury from equipment failure or unsafe use. Locate hazardous operations in isolated areas less likely to endanger workers. Shop supervisors shall brief aircraft shop and the flight line workers on hazards of poor housekeeping, personal safety, occupational health, shop machinery, loose clothes and finger rings.

24.15.1.1. Machine Safeguarding and Shop Layout. Machinery shall be procured with built-in safeguards for operator protection without interfering with normal equipment operation. Suitable enclosures or barricades shall be installed on unguarded machinery or power-transmission equipment. Firmly secure machines and equipment to floors, bases or stands located so the operator need not stand in an aisle. Provide the operator sufficient space to handle materials and conduct routine job and maintenance tasks, including cleaning and housekeeping, without interfering with other operations. Refer to **Chapter 18**, *Machinery*, and **Chapter 7**, *Walking Surfaces*, for additional information.

24.15.1.2. Tool Safety. Unsafe use of hand and power tools can injure workers or damage equipment. Supervisors shall enforce strict tool control procedures. Use of personally owned hand and power tools shall be prohibited. Tools shall be kept in suitable containers when not in use. Appropriate PPE, such as goggles, face shields, hard hats, gloves, respirators and safety-toe shoes, shall be provided to workers and use enforced. Refer to TO 32-1-101, *Use and Care of Hand Tools and Measuring Tools*, and TO 32-1-2, *Use of Hand Tools (International Business Machines)*, and paragraph **24.15.8** for battery-powered tool use.

24.15.1.3. Compressed Air Systems. Workers shall wear appropriate PPE, such as gloves and wrap-around face shields or goggles, when using compressed air for cleaning. All shop and aircraft maintenance personnel authorized to use air compressors shall be trained in operation and maintenance of air compressors. Compressed air for general cleaning purposes shall be limited to less than 30 psi. Effective chip guarding shall be provided and have a finger-actuated press (on)/release (off) control. Compressed air shall not be used for cleaning benches, floors, work areas, aircraft interiors, clothing or exposed body surfaces. Aircraft pitot-static systems shall not be cleaned with compressed air to prevent instrument diaphragm damage. Refer to paragraph **24.2.5** for additional information on cleaning with compressed air.

24.15.1.4. Compressed Gases. Compressed gas cylinders, full or empty, shall be handled with care at all times. When not in use, caps shall be placed over the valves and the cylinder secured. All compressed gas cylinders shall be stored in their compatibility groups and not co-mingled. Flammable gases, such as acetylene, shall be stored separately and in an upright position. Storage areas shall be clean and dry to prevent corrosion and away from heat sources and oxygen. Only approved regulators with anti-flashback devices shall be used with flammable compressed gases. Refer to TO 42B-5-1-2, *Gas Cylinders (Storage Type) – Use, Handling, and Maintenance*, for additional information.

24.15.1.5. Housekeeping. Floors shall be cleaned at all times to provide safe walking and working surfaces. Spills shall be cleaned as they occur. Electrical cords and air hoses shall be stored when not in use. All flammables and combustibles shall be properly stored or removed from the shop and disposed of.

24.15.1.6. Personal Safety. Loose fitting clothing or other apparel that may be caught in moving machinery shall not be worn. Finger rings shall not be worn when they may catch on equipment or a vehicle while performing job tasks. Conductive articles of jewelry and clothing such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear or metal frame glasses, shall not be worn when they present an electrical hazard from contact with exposed live parts.

24.15.1.7. Occupational Health. Aircraft maintenance operations on the flight line, in shops, aircraft shelters, hangars and maintenance facilities pose many chemical and physical hazards. These hazards shall be evaluated, the level of risk established and controls incorporated where necessary. AFI 48-145, *Occupational and Environmental Health Program*, provides guidance for these evaluations. Physical hazards, such as high noise levels, shall be evaluated for design or administrative changes to abate the hazard, e.g., engineering controls and administrative controls. Where administrative and engineering controls are not feasible to implement or adequate to control the exposure, the unit will provide BE-approved PPE to the workers and ensure they comply with the care and the use of such PPE. Work with chemicals may require additional ventilation, the use of PPE or a change in process to protect exposed workers. A reevaluation shall be performed if a process is changed, altered or new chemicals are introduced after the initial evaluation and abatement actions. BE performs these evaluations upon request. However, the functional manager or supervisor shall contact BE to arrange an evaluation if a potential health hazard is identified or if a process changes.

24.15.2. Aircraft Electrical System Maintenance. Potential hazards involving aircraft electrical maintenance tasks include overloading, poor electrical contacts and wiring shorts.

24.15.2.1. Electrical systems shall be de-energized whenever possible. If the approved procedure requires work on an energized circuit, approved technical data or manufacturer's instructions and 29 CFR 1910.333 shall be followed and other maintenance personnel informed of the actions. If work is done on energized circuits of 50 volts or more, arc flash protection must be worn. Refer to paragraph [14.4.8.3](#) for additional guidance. If de-energized, approved procedures shall be strictly followed. For on-equipment aircraft maintenance, the AF Form 1492, *Warning Tag*, shall be used to

flag a condition that could cause damage or injury if ignored. Warning tags shall be used during maintenance actions as required by applicable technical data and/or local procedures. Refer to AFI 21-101, *Aerospace Equipment Maintenance Management*, for additional guidance. Do not use the **AF Form 979, Danger Tag**, for on-equipment aircraft maintenance. The **AF Form 979** shall only be used when an immediate hazard exists and specific precautions are required to protect personnel or property or as required by TOs, instructions or other directed requirements. Tags shall be placed on damaged equipment to be taken out of service and sent to the repair shop. To reduce the probability of internal electrical shorts, aircraft wiring, including wire bundles, shall be secured to prevent scraping and chafing. Electrical components shall be bench-tested in a properly designed shop. Testing of electrical systems or equipment while installed on the aircraft shall be held to a minimum.

24.15.2.2. If a circuit breaker (CB) opens (pops) during maintenance on the aircraft, the popped CB shall not be reset without following specific guidance in the applicable aircraft system TO and the cause is determined. An unexpected popped CB may result from an overload or ground fault. A popped fuel system CB shall not be reset without following specific guidance in aircraft system TOs.

24.15.2.3. Electrical components and systems shall be de-energized and isolated from other energized circuits or power sources during cleaning operations.

24.15.3. Aircraft Painting and Paint Removal Operations. There are many safety and health hazards associated with painting and paint removal operations. Spray painting an entire aircraft is permitted only in hangars designed for the purpose. Refer to **Chapter 28, Interior Spray Finishing**, NFPA 410, *Standard on Aircraft Maintenance*, and NFPA 33, *Spray Application Using Flammable or Combustible Materials*, for additional information.

24.15.3.1. General Safety.

24.15.3.1.1. Fire. Painting and paint mixing operations, and paint and thinner storage, shall be conducted in areas or facilities free from ignition sources. Quantities of combustible materials stored in hangars and shops shall be minimized. Only approved cabinets (paragraph **22.5.3**) with self-closing doors shall be used when incidental storage of small amounts of paints and thinners is required in a facility. Dispose of masking materials, paper and soiled rags in self-closing containers which shall be emptied or removed to an approved location outside the shop for pickup and disposal at the end of each day or shift. Contact the installation Environmental Management office for waste disposal guidance. Spills shall be cleaned as they occur.

24.15.3.1.2. Toxicity. Whenever possible, painting shall be done in well-ventilated rooms or booths that have been evaluated and approved for use by BE. Workers painting outside their areas shall obtain clearance from BE and the Ground Safety office. Personnel engaged in painting and paint removal will wear protective clothing, respiratory devices (if required), and appropriate face, eye and hand protection. Painting tasks using polyurethane or other chemical resistant coatings shall only be done after a thorough evaluation of the facility, equipment and procedures by BE, Ground Safety office and FES Flight. All painting operations shall be completed IAW 29 CFR 1910.107., *Spray Finishing Using Flammable and Combustible Materials*, and **Chapter 28**. Refer to **Chapter 14** for additional guidance on PPE requirements.

- 24.15.3.1.3. Mechanical. Spray-painting equipment shall be kept clean and well maintained. Pressure hoses shall be inspected for excessive wear and replaced as necessary. To prevent tripping hazards, hoses shall be properly stored when not in use. Workstands and/or scaffolds shall be sized to permit reasonable ease and comfort while painting. Spray painting air pressure hoses must have fittings that are incompatible with breathing air hoses as required by AFOSH Standard 48-137, *Respiratory Protection Program*. Refer to **Chapter 16**, *Mobile Elevating Work Platforms*, for additional information on scaffolding. **Warning:** Never point high-pressure paint nozzles at any body part or another person.
- 24.15.3.1.4. Sanding, Blasting and Paint Stripping Operations. These operations produce inhalation hazards and shall be evaluated by BE to ensure workers are protected and proper controls are identified and provided.
- 24.15.3.2. Operational Requirements. Use the minimum amount of flammable or toxic paints or solvents needed. All materials shall be properly identified and material safety data sheets (MSDS) shall be immediately accessible (via electronic or hard copy format) IAW AFI 90-821, *Hazard Communication*, paragraph 2.5.1.
- 24.15.3.2.1. Cleaning, preparing and painting major aircraft assemblies and subassemblies, which are not removable, may be performed in any hangar meeting requirements of NFPA 70, *National Electric Code*, NFPA 409, *Standard on Aircraft Hangars*, and NFPA 410, *Standard on Aircraft Maintenance*. These procedures shall be approved by the Maintenance Group Commander or equivalent in coordination with the installation Ground Safety office, FES Flight and BE. No concurrent hazardous operations shall be conducted within 50 feet of major cleaning, painting or paint removal operations. The work area shall be inspected prior to start of paint touchup operations to eliminate sources of ignition. Hazard-free work conditions shall be maintained during the entire work period. No food shall be brought into painting, cleaning or paint removal work areas. Workers performing painting tasks shall wash hands thoroughly before eating. Refer to **Chapter 28**, and NFPA 33 for additional information.
- 24.15.3.2.2. A hangar's general ventilation may be supplemented by opening hangar doors (not less than 10 feet) to provide additional air movement. This may help prevent flammable vapor concentrations exceeding 20 percent lower explosive limit (LEL), especially at floor level, in pits and drains. **Note:** If hangar doors are opened less than 10 feet due to severe weather conditions, such as extreme cold, the door's main electrical power switch shall be locked out (OFF) and remain locked out until the door is either opened more than 10 feet or closed. Forced air ventilation shall be used if these actions do not achieve the desired results. This would be considered a service/administrative lockout condition IAW **Chapter 21** information on locking out door controls and service/administrative lockout and tagout.
- 24.15.3.2.3. Fixed electrical equipment shall conform to the NEC, Article 513, *Aircraft Hangars*. General illumination lighting and other equipment shall not be in range of any flammable sprays or liquids or overspray areas. Unless approved for

Class I, Group D hazardous locations, electrical equipment shall be removed from the area.

24.15.3.2.4. Use of heat lamps to accelerate drying of painted surfaces shall be prohibited unless part of an approved drying booth or enclosure IAW NFPA 33. Nozzles used to spray cleaning or paint removal agents under pressure shall automatically self-close when released by the operator.

24.15.3.2.5. Aircraft electrical systems shall be de-energized during cleaning, painting and paint removal operations. **Exception:** When aircraft power is required for concurrent operations, all electrical equipment exposed to flammable or combustible liquids or vapors shall be de-energized to avoid ignition from arcs, faults or hot surfaces.

24.15.3.2.6. Ramp or flight line areas used for maintenance procedures shall be designated as servicing areas not open to public access. Sufficient clearance shall be maintained to avoid hazards to adjacent aircraft or structures and to ensure access by firefighting equipment. Aircraft being worked on shall be isolated from aircraft taxi and tow routes.

24.15.3.2.7. Painting, paint removal and associated clean-up operations may generate hazardous wastes. These operations shall be evaluated by BE and Environmental Management office IAW AFI 32-7042, *Waste Management*, to ensure wastes are characterized, controlled, handled and properly disposed of.

24.15.3.3. Control of Flammable and Combustible Materials. Storage of more than one day's use of paints, flammable thinners and solvents shall be located in a separate building or segregated from aircraft maintenance and servicing hangars by a fire partition with openings protected by approved fire doors. See NFPA 30, *Flammable and Combustible Liquids Code*, for additional guidance.

24.15.3.3.1. Only a one day supply of paints and flammable solvents shall be maintained in a hangar. These items shall be in approved, marked containers isolated from other operations. Dispensing drums, when essential, shall be equipped with positive acting pumps and pressure relief fittings, drip pans and static bonding clamps and cables. Drums shall not be pressurized to dispense these products. Flammable solvents shall not be dispensed from open containers. **Note:** A day's supply, generally 1 to 10 gallons depending on amount used during the shift or work day, is considered a small amount. If operations involve more than one shift, each shift can replenish its paints and solvents as needed, but the quantity on hand shall not exceed a day's supply.

24.15.3.3.2. Petroleum distillate used as a dry cleaning solvent and other solvent cleaners, such as mineral spirits, aliphatic naphtha, aromatic naphtha, trichloroethylene, xylene, methyl ethyl ketone and other ketone-based thinners, are not compatible with oxygen and shall not be used near aircraft oxygen systems. These restrictions also apply to storage areas.

24.15.3.4. Fire Extinguishers. Fire extinguishers shall be available IAW TO 00-25-172 and other applicable technical data. For operations not addressed, fire extinguishers shall comply with NFPA 10, *Standard for Portable Fire Extinguishers* (current edition).

Portable dry chemical or equivalent fire extinguishers shall be placed within 25 feet of the aircraft during cleaning, painting or paint removal operations. The FES Flight will assist the using organization in selection of size and type of extinguishers to be used.

24.15.4. Aerospace Ground Equipment (AGE). Operators shall be familiar with operating instructions for equipment they use, including emergency shutdown, other precautionary measures and use of fire extinguishers. Operators shall review maintenance records and inspect equipment for leaks, damage or malfunction before operation. Refer to paragraph [24.13](#) for guidance on vehicle operations on the flight line, in hangars and AGE support activities. AGE equipment shall not be left unattended while running, unless specifically designed for unattended operation. Contact the installation AGE Maintenance Shop for further guidance. **Warning:** Danger Area. Personnel shall not climb inside combustion powered AGE (i.e., light carts) as the enclosure may contain fatal levels of carbon monoxide.

24.15.4.1. Towing AGE. Refer to paragraph [24.13.4](#) for additional guidance. Do not tow compressors, ground power units, oxygen carts and similar equipment using general purpose vehicles unless equipped with a pintle hook attachment with proper rated load capacity (which shall be marked on the pintle hook and stated in the AF Form 1800) to tow AGE. Pintle hooks shall be closed and a cotter-pin or other locking device used during towing operations. Safety chains are not required to tow AGE. A maximum of eight (8) small AGE units may be towed, provided:

24.15.4.1.1. Combined load does not exceed rated load capacity of tow vehicle.

24.15.4.1.2. Tandem loads do not exceed load capacities of the equipment.

24.15.4.1.3. Loads, regardless of the number of units being towed, shall be kept symmetrical. If towing one unit, it shall be towed on the center pintle hook. When towing two units, the preferred method is to use both outside pintle hooks. When towing more than two units simultaneously, they shall be distributed as evenly as possible on each of the two outer pintle hooks. Refer to the appropriate vehicle technical data to determine load ratings.

24.15.4.2. Ground Power Units. When refueling/defueling aircraft, ground power generator sets and converter and rectifier units shall be positioned IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. These units shall not be placed less than 10 feet from any aircraft fuel vent or under wing surfaces. Do not stretch cables, which strains the cables and connectors, when positioning power units. Refer to NFPA 407, *Aircraft Fuel Servicing*, for additional information. All cables shall be de-energized (turned off), disconnected from aircraft and ensure water does not enter the connection end of the cable. **Warning:** Enclosures of combustion powered AGE may contain carbon monoxide or an oxygen deficient atmosphere and are not suitable for human occupancy.

24.15.4.2.1. Engine-driven generators shall not be refueled inside maintenance shops.

24.15.4.2.2. Output contacts shall be energized (turned on) only after the connector is installed in the aircraft receptacle and de-energized (turned off) before disconnecting the connector from the aircraft.

24.15.4.3. Compressed Gases. Nitrogen and freon displace oxygen in air and shall be handled carefully in poorly ventilated or confined spaces to minimize the potential for asphyxiation. Freon is a fluorocarbon and requires stringent environmental controls IAW local procedures. Refer to paragraph [24.15.1.4](#) and TO 42B-5-1-2, *Gas Cylinders (Storage Type) – Use, Handling and Maintenance*, for general safety guidance and requirements for compressed gases.

24.15.4.4. Test Equipment. Multimeters are used in most AGE shops. Users shall ensure the meter is set on the proper scale before connecting equipment to a power source. The calibration date shall be checked before each use and recalibrated if out of date. Personnel shall be trained prior to using this equipment and shall not hold meters in their hand when testing energized circuits. Use non-conductive, insulated gloves or other effective PPE when necessary to handhold meters or test cables. Users shall also comply with UFC 3-560-01, *Electrical Safety O & M*.

24.15.4.4.1. Generator load banks are used to test generator sets. Use caution when testing due to the high amperage associated with the procedure. Load banks shall be maintained in strict compliance with applicable TOs and manufacturer's manuals.

24.15.4.4.2. Hearing protection may be required due to high noise levels when the generator is operating at heavy loads. Contact BE for hearing protection guidance.

24.15.4.5. Jacking Operations. Prior to jacking equipment, the parking brake shall be set or chocks used or both. Jack stands of the proper capacity shall be used. Equipment shall be jacked to the minimum height required for the task and jacks shall be removed when the task is completed. Workers shall remain under a jacked unit only as needed to accomplish the task. Jacks and jack stands shall be marked with load capacity, and inspected and maintained IAW the manufacturer's instructions, [Chapter 32](#), *Motor Vehicle – Operations and Maintenance*, 29 CFR 1910.244, *Other Portable Tools and Equipment*, or applicable TO.

24.15.4.6. Tire Maintenance. Tires shall not be removed from AGE unless the unit is on jack stands or similarly blocked to prevent falling after tire removal. Tires shall be deflated prior to wheel disassembly. Tires shall be inflated IAW applicable TO guidance. High pressure air shall not be used to inflate tires. Multi-piece rim wheels require special attention during mounting, demounting and inflation. Refer to paragraph [24.12.6](#) for more information on multi-piece rim wheels. Tires on multi-piece wheels shall be inflated in a cage or other approved restraining device. Refer to paragraph [32.14](#) for additional tire servicing information.

24.15.4.7. Oxygen Carts. Oxygen carts shall be kept clean and free of moisture, oil and grease. Oxygen carts shall not be parked in grassy, sodded or asphalt-covered areas nor exposed to extreme weather conditions, parked in direct sunlight or allowed to accumulate ice or snow. LOX carts containing LOX shall not be parked in hangars, nose docks or shelters unless designed or modified for this purpose. LOX carts shall be transported with vent valve closed and parked with vent valve open. Refer to TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, TO 42B5-1-2, *Gas Cylinders (Storage Type) – Use, Handling and Maintenance*, [Chapter 43](#), *Liquid Nitrogen (LIN) and Oxygen (LOX)* and applicable aircraft TOs for more information on gaseous oxygen and LOX handling, servicing and storage.

24.15.4.7.1. Gaseous oxygen and LOX carts shall be parked and stored at least (IAW TO 00-25-172):

24.15.4.7.1.1. Twenty-five feet from structures with fire-resistant or non-combustible exterior walls or automatic fire extinguishing systems.

24.15.4.7.1.2. Fifty feet from combustible structures or sources of ignition, such as heavy vehicle traffic areas, areas where equipment is operating or designated smoking areas.

24.15.4.7.1.3. Seventy-five feet from aircraft parking, fueling or defueling areas.

24.15.5. Communication and Navigation Equipment Repair. Repair communication and electronic (C-E) equipment on an approved shop bench IAW TO or manufacturer's instructions. Do not operate, test or check radar or high frequency (HF) radio transmitting equipment with power-on during aircraft fueling/defueling, fuel cell/integral tank repair activities or when hazardous vapors may be present. No radar emissions are allowed in hangars due to personnel hazards or inadvertent activation of facility warning and fire protection systems. See AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, for additional information.

24.15.6. Flight Control Systems. Unexpected movement of flight controls may cause severe injuries. Maintenance personnel shall be trained and aware of dangers with flight control system operation. Flight control operation shall be directed orally by interphone or after visual assurance from a person outside the aircraft that flight control surfaces and movement areas are clear. All maintenance activities shall be coordinated and a warning tag applied to the flight controls to prevent movement when workers are exposed to potential injury. Local procedures shall be developed to address work shift changes when tags must remain in place or be reapplied.

24.15.7. Aircraft Hydraulic Systems. Workers shall ensure pressures are relieved prior to disassembling any hydraulic lines or system components. Control(s) that could injure personnel or damage equipment shall be tagged out IAW TO procedures and/or local procedures while maintenance activities are in progress. Proper PPE, such as goggles, shall be worn. Hydraulic spills shall be cleaned up immediately to prevent slips and falls.

24.15.8. Battery-Powered Screwdrivers and Drills. Cordless drills and screwdrivers are authorized for use outdoors and indoors during all periods of aircraft maintenance on JP-8 or other high flashpoint fueled aircraft, with the following restrictions: Note: Battery-powered screwdrivers and drills that are intrinsically safe or listed for use in Class 1, Division 1 or 2 areas (may be used in listed areas) need only comply with paragraph [24.15.8.6](#).

24.15.8.1. Tools shall not be used within fuel servicing safety zones described in TO 00-25-172.

24.15.8.2. Tools shall not be used within 5 feet of a fuel vent or open fuel tank.

24.15.8.3. Use on JP-4 fueled aircraft is not permitted. When JP-4 and JP-8 fueled aircraft occupy the same maintenance hangar, requirements for JP-4 fueled aircraft shall apply.



24.15.8.4. Tools are not used to install/remove fasteners from fuel tanks, fuel cell cavities or engine enclosures.

24.15.8.5. Tools shall not be used when there is a suspected or known fuel leak.

24.15.8.6. Tool battery exchanges and recharging shall not be conducted in Class I, Division 1 or 2 hazard areas.

24.15.9. Parachute Shops. Many fabrics, paints and cleaning components used in parachute shops are highly flammable or toxic. Good housekeeping in parachute shops is essential to a safe and efficient operation. Ventilation, temperature and humidity shall be carefully controlled to prevent deterioration of materials and minimize mishap potential. Covered metal safety waste containers shall be provided for the disposal of waste and rags saturated with flammable substances. These containers shall be emptied or removed at the end of each day or shift to an approved location outside the shop for pickup and disposal. Contact the installation Environmental Management office for waste disposal guidance. Cleaning fluids shall be used only in well-ventilated rooms equipped with exhaust systems as required by the BE OEH risk assessment. Cleaning booths approved by the installation FES Flight and BE shall be provided, when necessary, for spot cleaning parachutes or components. The handling of carbon dioxide (CO<sub>2</sub>) cylinders in parachute shops shall be under the direction of supervisors or trained technicians.

24.15.9.1. Parachutes and Harness Fabrics. These fabrics are subject to spontaneous combustion when treated with paints containing waterproof compounds. Fabrics treated with these paints shall be thoroughly dried in open air and not packed, stored, left in shops or shipped before dry.

24.15.9.2. Wire, Cords and Receptacles. Damaged or frayed electric wires, cords and plugs shall be immediately replaced or repaired by qualified electricians.

24.15.9.3. Smoking. Smoking shall be prohibited in all parachute facilities.

24.15.9.4. Kapok Storage. Kapok and other padding materials shall be stored in reasonable amounts in covered and vented metal safety containers.

24.15.9.5. Hoisting and Hold Down Devices. Supervisors shall ensure all devices used to hang parachutes in drying towers are periodically inspected by qualified personnel. Recessed hold downs shall be installed in drying room floors to eliminate tripping hazards. Hard hats shall be worn by workers in drying towers.

24.15.9.6. Explosives. Storing, handling and using explosives shall be IAW specific TOs and AFMAN 91-201, *Explosives Safety Standards*.

**24.16. Fall Protection Requirements.** Maintenance group commanders or designated representative must ensure safe Air Force maintenance operations. Flight line and hangar operations must include an appropriate level of fall protection commensurate with Air Force mission requirements. To ensure consistency across Air Force operations, AFMC and the lead MAJCOM for the Mission Design Series (MDS) will work together to ensure development of standardized fall protection requirements and procedures are published in the applicable weapon system TOs. Maintenance group commanders may declare a non-routine operation military-unique on a case-by-case basis, in coordination with the organizational/appropriate chief of safety. These terms are defined as follows:

24.16.1. Military-Unique. Per DoDI 6055.1, *DoD Safety and Occupational Health (SOH) Program*, USAF military and civilian operations, workplaces, equipment and systems that are unique to the national defense mission (not normally performed across the general aviation industry or private enterprise) are considered military-unique. This includes combat operations, testing, maintenance of military-unique equipment and systems such as military weapons, military-unique aircraft, missiles, early warning systems, military space systems, ordnance and tactical vehicles. It also includes operations such as peacekeeping missions, field maneuvers, combat training, military flight and missile operations, military-unique research, development, test and evaluation activities, and actions required under national defense contingency conditions. OSHA and other non-DoD regulatory fall protection safety and health standards shall be applied to military-unique equipment, systems, operations or workplaces, in whole or in part, insofar as practicable. When military design, specifications or deployment requirements render compliance with existing fall protection standards unfeasible or inappropriate, or when no standard exists for such military application, the USAF shall develop standards. For military-unique operations, AF guidance applies to military members, AF civilians and contractor personnel.

24.16.2. Nonmilitary-Unique. DoDI 6055.1 defines nonmilitary-unique operations as DoD military and civilian workplaces and operations whose operations are generally comparable to those of the private sector, i.e., Air Force flight line operations or processes common to general aviation industry normal, day-to-day operations. This includes facilities involved and work performed in the repair and overhaul of weapons, aircraft and vehicles (except for equipment trials). Nonmilitary-unique activities, both on the flight line and in hangars, require fall protection be used where there is a potential of falling: a) four (4) feet or more to the next lower level, or b) regardless of height, into unguarded machinery or dangerous equipment (includes hot/cold surfaces, electrified contacts, chemicals, sharp or impalement hazards, etc.).

**Note:** Maintenance activities performed in hardened aircraft shelters are nonmilitary-unique unless they meet paragraph **24.16.1.** definition of military-unique above.

24.16.3. Given the diversity and complexity of Air Force operations, it is impossible to address every situation in this guidance. However, the intent is reasonably clear and commanders have the authority to make final determinations regarding military uniqueness. Decisions that are based upon sound risk management principles, and the DoD guidance provided, are very likely to be defensible and correct. Supervisors working with the local safety staff are in the best position to recommend decisions that optimally balance safety and mission accomplishment.

24.16.4. While the Air Force must comply with OSHA requirements to the maximum extent practical, there may be operations where, due to facility or equipment design, or operational requirements, active or passive means of fall protection are not feasible. In such cases, the best level of fall protection available, within existing operational limitations, shall be provided. Where adequate lead time is available or for repetitive operations, a JSA shall be conducted and documented IAW AFI 91-202. Organizations should discuss JSAs with the applicable TO writer or Aircraft Item Manager for their airframe, then involve organizational/appropriate safety office. Also see paragraph **24.16.5.3.** **Note:** For ALC Depots, a standardized Process Order integrated into the task may be used in lieu of a JSA.

24.16.5. Types of Fall Protection. Fall hazards from aircraft walking and working surfaces are controlled through application of Risk Management, at command and local levels, to determine which fall protection method offers optimal worker safety for the tasks performed. The maximum use of maintenance stands and work platforms, whenever possible, will reduce the exposure and risk. Whenever it becomes necessary to perform required tasks where a worker can fall four (4) feet or more, fall protection will be used. Refer to paragraphs [24.16.1](#) and [24.16.2](#) for additional guidance.

24.16.5.1. Passive. Passive fall protection is the most preferred means of protecting workers from falls. Passive Systems need not be directly connected to the worker to prevent a worker from falling. These systems include guardrails, work stands and platforms (including aircraft maintenance stands, i.e., B-1, B-4, B-5, etc.), nets and other devices. If passive fall protection is not feasible, active fall protection will be the next option considered.

24.16.5.2. Active. Active fall protection, such as positioning devices, fall restraint systems, ladder climbing devices and Personal Fall Arrest Systems (PFASs), require the worker to wear a full body harness and components and attach himself/herself to an anchorage or lifeline. Positioning devices and fall restraint systems prevent a worker from falling off unprotected sides and edges by restricting the worker's range of movement while a Personal Fall Arrest System (PFAS) allows a worker to fall off unprotected sides and edges, but the PFAS and components absorb the energy forces during a fall, reducing the potential for injury.

24.16.5.2.1. PFASs require an anchorage connection point, connecting hardware components, body and fixed or shock absorbing lanyard, depending on system design. Anchorage connecting point(s) for each worker will have minimal support strength of 5,000 pounds (22.2 kilo-newton [kN]). Vertical and horizontal lifelines shall have a minimal breaking strength of 5,000 pounds (22.2 kN). Horizontal lifelines shall be designed, installed and used under the supervision of a qualified person, as part of a complete PFAS, which maintains a safety factor of at least two. Lanyards, D-rings, locking snap-hooks and all components of a fall arrest system will also be capable of sustaining a minimum tensile load of 5,000 pounds (22.2 kN). See paragraph [13.2](#), and 29 CFR 1926.502, *Fall Protection Systems Criteria and Practices*, 29 CFR 1910.66, Appendix C, *Personal Fall Arrest System*, and 29 CFR 1926.104., *Safety Belts, Lifelines, and Lanyards*, for additional PFAS guidance. To prevent worker injury or death, PFASs shall not be used without a rescue plan. IAW ANSI Z359.4, *Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components*, prompt rescue means getting to the subject within six (6) minutes after an accidental fall. **Caution:** Shock absorbing lanyards will not be used in conjunction with self-retracting lifelines, fall limiters, retractable web lanyards or decelerator packs (inertial reel type lifelines) devices. Multi-use or combinations of use can result in two falls and could hinder and/or prevent self-rescue or external rescue. **Warning:** Hanging in a harness for an extended period of time can be fatal. Supervisors shall ensure workers using a PFAS can be properly rescued or can rescue themselves should a fall occur. Availability of rescue personnel, ladders or other rescue equipment shall be determined prior to using a fall arrest system.

24.16.5.2.2. Positioning and restraint systems. Fall restraint systems restrict a worker's range of movement so the individual cannot get into a position that would allow a fall. Positioning systems allow a worker to be supported on an elevated vertical/inclined surface and body support is hands free. Anchorage connecting point(s), work positioning and restraint lanyards for each worker will have minimal support strength of 5,000 pounds (22.2 kN). Secure the worker to an anchor using a lanyard short enough to prevent the worker's center of mass from reaching the fall hazard. When exposed to a fall hazard, a PFAS must also be used. Refer to paragraph [24.16.5.2.1](#) for additional guidance.

24.16.5.3. Procedural Controls. Active and passive means of fall protection shall be used to the maximum extent practical. However, procedural controls, the least preferred method of fall protection, may be used for aircraft operations (such as those conducted outside a hangar, wash rack or at any location without an overhead structure) where the use of active or passive means of fall protection, i.e., railings, work stands, portable anchorages, mobile lifts, nets, PFAS, etc., is ineffective, would create a greater hazard or is not feasible. MDS procedural controls, such as restricting workers to TO designated aircraft surfaces, require aggressive risk management and shall be documented in a JSA developed by the lead MAJCOM for the MDS and incorporated in the applicable weapon system TOs to standardize the process. Local procedural controls, driven by conditions unique to a local facility or equipment design, or local operational requirements, will be developed and documented in a JSA IAW AFI 91-202 by the maintenance group (or equivalent), approved by the maintenance group commander and coordinated with the organizational/appropriate Ground Safety office before the procedural controls are used. In the absence of active or passive fall protection, the JSA identifies the best level of fall protection available within existing operational limitations. Procedures and equipment identified in the JSA are considered to be the minimum mandatory requirements for operations covered in the JSA. Considerations when developing procedural controls include:

24.16.5.3.1. Controlled Access Zones (CAZs). CAZs are a procedural control method consisting of designated working surfaces that are restricted to those individuals specifically trained for and required to enter the area during the maintenance operation.

24.16.5.3.2. TO Designated Walkways. TO designated walkways shall be considered when maintenance or inspections can be performed from within the TO designated walkways. **Note:** Some TO designated walkways may be suitable for use as procedural controls for fall protection. However, TO designated walkways are primarily designed to protect the aircraft and are not necessarily areas that, by virtue of location, provide workers a minimal risk of falling to the next lower level. During maintenance within the designated walkways, walkways that become minimized by the removal of leading or trailing edge surfaces, fall protection will be employed.

24.16.5.3.3. Extra caution and risk management (RM) shall be used when aircraft surfaces are wet or covered with snow, frost or ice; when winds are 20 knots or greater; or other adverse environmental conditions exist.

24.16.6. Mobile Work Platforms. Mobile work platforms (vehicle-mounted elevating and rotating work platforms, manually propelled maintenance stands and self-propelled mobile work platforms and scaffolds) shall have protective guardrails, midrails and toe boards (or equivalent) installed on all open sides, except the side facing the aircraft when it is within 14 inches of the working surface, unless workers are protected by a PFAS. See [Chapter 16](#) for additional information. **Note:** The side of the platform facing the stairway is not considered an open side when the stairway is equipped with the required handrails.

24.16.7. Manually Propelled Aircraft Maintenance Stands:

24.16.7.1. Maintenance stands will be designed and maintained IAW applicable ANSI standards, manufacturer's guidance and technical order (TO) requirements.

24.16.7.2. Requirements for towing small aircraft maintenance stands such as the B-1, B-4 or B-5 or larger stands such as the B-3 and J-7, are found in paragraph [24.7](#) or in [Chapter 16](#).

24.16.7.3. No stand will be used unless a minimum of two brakes are set and all wheel casters locked, with the wheels locked in an opposite facing direction. Wheel chocks may be used to supplement these requirements. Stands will be locked when not in use to avoid rolling down slanted surfaces or being moved by the wind when outdoors. Chocks will be constructed as per Commercial Item Specification A-A-52475 or locally manufactured IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, [Chapter 4](#).

24.16.7.4. Follow approved guidance to raise and lower maintenance stands. Unless required by TO or manufacturer's instructions, personnel will not stand on or ride maintenance stands being raised or lowered. Locking pins or other devices, as required, shall be in place before anyone is allowed to ascend the stairs or ladder.

24.16.7.5. Where location and aircraft configuration permit, required stand railings will be in place before stand is used.

24.16.7.6. Guardrails and midrails (when required) shall be installed and access gates or openings closed per TO or manufacturer's instructions (including bolts, pins or other locking devices on removable railings and attachments) where location and aircraft configuration permit when there is a possibility of falling four (4) feet or more to the next lower surface.

24.16.7.7. Platforms used at a height of 10 feet or more shall include toeboards or equivalents on all sides. The minimum toeboard height shall be 4 inches.

24.16.7.8. The side of the platform facing the stairway is not considered an open side when the stairway is equipped with the required handrails.

24.16.7.9. Maintenance stands will be visually inspected IAW TO 00-20-1 by the user daily, before use, for serviceability and leaks. Items to be inspected will include brakes, jacks, wheel locks, securing cables, locking pins, hydraulic systems, anchor connections, railings and removable attachments, including bolts, pins or other locking devices and overall equipment condition. Stands with defects shall be tagged as unserviceable. Inspection should be documented on AFTO Form 244, Industrial/Support Equipment Record. **Note:** A daily inspection is not required for days the stand is not used.

24.16.7.10. Personnel will not use railings, planks, toeboards, ladders or any other device in or on the work platform for achieving additional working height or reach.

24.16.7.11. Vehicle-Mounted Elevating and Rotating Work Platforms and Self-Propelled Mobile Work Platforms.

24.16.7.11.1. When using vehicle mounted and self-propelled mobile work platforms, which have manufacturer-installed structural anchor points, with the platform elevated four (4) feet or more above the surface, personal fall arrest systems shall be worn with lanyard attached to an approved structural anchor point. When these platforms have not been manufactured with an approved structural anchor point, protective guardrails, midrails (when required), and toeboards must be installed on all open sides, except the side facing the structure (i.e., aircraft, buildings) when it is within 14 inches of the working surface. Personnel will not use railings, planks, ladders or any other device in or on the work platform for achieving additional working height or reach.

24.16.7.11.2. A removable protective guardrail shall only be removed from the side of the platform that has been positioned as close as practical, but 14 inches or less and parallel to an aircraft, building or other working surface. Guardrails will be installed on all open sides if platform levels are four (4) feet or higher above the ground or floor. Bolts, pins or other locking devices will be provided and used on all removable railings and attachments. Only guardrails and toeboards meeting the criteria in paragraph **16.4.6.10.8** will be used.

#### **24.17. Safety in Flight Line Contractor Operations.**

24.17.1. Contractor operations may create hazardous working conditions for Air Force personnel. To ensure Air Force personnel or resources are not subjected to hazards, the installation Ground Safety office, FES Flight, Airfield Management and BE shall review contracts and activities of contractors performing a task or service for the Air Force. Appropriate safety, fire and health requirements shall be included in contract specifications. This is normally accomplished by including appropriate Defense Acquisition Regulations (DAR) and Federal Acquisition Regulation (FAR) provisions or clauses in the contract. Installation Ground Safety office, FES Flight, Airfield Management and BE shall help the contracting officer and using organization establish appropriate requirements. Also, appropriate US Air Force and installation traffic provisions shall be identified to help control contractor vehicles on base. If a contractor procedure or condition requires correction, action shall be initiated through the Contracting Officer. Refer to AFPAM 91-210, *Contract Safety*, for additional guidance. **Note:** Contractors shall adhere to Department of Defense (DoD) and US Air Force rules and policies. Unless otherwise stated in the contract, contractors shall comply with DoD and Air Force standards, instructions, pamphlets, manuals, technical data, regulations and other applicable official technical publications and guidance.

24.17.2. Construction Contracts. The contracting officer shall call a pre-construction conference before the contractor begins construction on an Air Force installation. Installation Ground Safety office, Flight Safety Office, FES Flight, Airfield Management, BE, the using organization, CE, contractor representatives and other affected agencies, as appropriate, shall be present. The Contracting Officer shall ensure the contractor knows all necessary Air Force

safety requirements associated with the contract. **Note:** This guidance does not apply to US Army Corps of Engineers contracts.

24.17.3. Non-Construction Contracts. Most non-construction contracts on Air Force installations involve persons or companies providing goods and services to installation personnel and activities. Contracting Officer coordination with the installation Ground Safety office, FES Flight, Airfield Management, BE, contract representatives, using organization and other affected organizations, as appropriate, is necessary to assure appropriate safety, fire prevention and health requirements are included in the contract. Prior to contract renewal, Ground Safety office, FES Flight, Airfield Management, BE, contract representatives and the using organization will review the contract to ensure its continued adequacy.

**24.18. Aircraft Flight line – Ground Operations and Activities Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

24.18.1. Are pressure regulators installed to prevent over-pressurization of components being serviced with compressed air? Reference [24.2.5.2.3](#)

24.18.2. Are wiping clothes, oily waste and other flammable materials placed in self-closing metal containers? Reference [24.3.3.4.2](#)

24.18.3. Is an **AF Form 592, USAF Hot Work Permit**, issued prior to welding on aircraft? Reference [24.3.3.5](#)

24.18.4. Are suitable fire extinguishers placed throughout maintenance areas? Reference [24.3.3.6](#)

24.18.5. Are personnel prohibited from wearing hats and caps on the flight line or in an engine intake danger zone? Reference [24.4.1](#)

24.18.6. Are all bicycles (Air Force and privately owned) operated on the flight line during hours of darkness equipped with an operational headlight and reflective markings front and rear? Reference [24.4.4.2](#)

24.18.7. Do parking lines have spots painted where the nose or forward wheel of the aircraft are positioned on aircraft parking spaces on the flight line and in maintenance hangars? Reference [24.5.5](#)

24.18.8. Have emergency procedures been developed to remove endangered aircraft in the event of a fire, adverse weather or other emergency situations? Reference [24.5.7](#)

24.18.9. Have local procedures been established to ensure key agencies are notified of adverse weather conditions? Reference [24.6.1](#)

24.18.10. Has the installation established a lightning safety program with a two-tier notification system? Reference [24.6.1](#)

24.18.11. Does the tow supervisor clearly define duties and responsibilities to the towing team at the pre-tow briefing? Reference [24.7.2](#)

- 24.18.12. Is the supervisor the only team member authorized to give the “all clear to move” order? Reference [24.7.2.1](#)
- 24.18.13. During towing operations, does the supervisor have a clear view of both wing walkers, the vehicle driver and direct contact with the person in the pilot’s seat? Reference [24.7.2.6](#)
- 24.18.14. Do tow team members use luminous wands when aircraft are towed at night? Reference [24.7.5](#)
- 24.18.15. Prior to and during taxi, is radio contact established and maintained between the aircraft and control tower? Reference [24.7.21.1.2](#)
- 24.18.16. Are aircraft jacks operated, maintained, inspected and tested IAW applicable TOs or handbooks? Reference [24.8.1.1](#)
- 24.18.17. Are all workstands and other equipment not required to be under the aircraft during jacking operations removed before aircraft are raised on jacks? Reference [24.8.1.2](#)
- 24.18.18. When an aircraft is on jacks, is the area around the aircraft properly secured and appropriate warning signs posted? Reference [24.8.1.4](#)
- 24.18.19. Do supervisors ensure engines or other major components, such as wing panels, stabilizers, etc., are not changed when the aircraft is on jacks and landing gear clear of the ramp or floor, unless authorized by applicable TOs? Reference [24.8.1.5](#)
- 24.18.20. Are aircraft properly chocked and parked IAW applicable TOs and job guides before starting engines? Reference [24.9.2](#)
- 24.18.21. Is a qualified and trained fire guard in position by the fire bottle(s) prior to starting aircraft engines, and does he/she remain in place until all engines are operating and the danger of fire no longer exists? Reference [24.9.4](#)
- 24.18.22. Do crew and maintenance personnel wear approved hearing protection in noise hazard areas? Reference [24.9.9](#)
- 24.18.23. On jet engine aircraft, are crewmembers, maintenance workers and personnel with flight line access briefed not to approach closer than 5 feet from the side or rear or 25 feet from the front of engine intake ducts when the engine is in operation? Reference [24.10.3](#)
- 24.18.24. Are ground safety pins installed by aircrew or maintenance workers immediately after the landing aircraft is parked and engines shutdown or by egress workers after maintenance work requiring removal of the pins is complete? Reference [24.10.5.1](#)
- 24.18.25. For work in a jet engine tailpipe, is a responsible individual positioned adjacent to the tail pipe or entrance of the aircraft to prevent anyone entering the cockpit and to maintain communication with the person in the tail pipe? Reference [24.10.8](#)
- 24.18.26. At the end of each day or shift, are flammable waste containers emptied or removed to an approved location outside the shop for pickup and disposal? Reference [24.11.2.2](#)
- 24.18.27. Are flammable storage areas kept cool (55° to 80° F) and free from spark or heat-producing equipment? Reference [24.11.2.3](#)



- 24.18.28. Are tire cages used when servicing aircraft tires in the tire shop? Reference [24.12.2](#)
- 24.18.29. Are procedures in place to ensure only oil-free nitrogen is used to inflate aircraft tires? Reference [24.12.4.1](#)
- 24.18.30. Are aircraft wheel and tire removal operations IAW TO 4T-1-3? Reference [24.12.5](#)
- 24.18.31. Are tire servicing restraint devices visually inspected prior to each day's use? Reference [24.12.8](#)
- 24.18.32. Has the Airfield Manager established a program for issuing AF Form 483, *Certificate of Competency*, endorsed for flight line driving? Reference [24.13.2.4](#)
- 24.18.33. Do all passengers use available seat belts while vehicle is in motion? Reference [24.13.8](#)
- 24.18.34. Are FOD Check signs posted at entrances to ramp area/flight line? Reference [24.13.13](#)
- 24.18.35. Are guides/spotters used to assist K-loader and roller equipped trailer operators when approaching an aircraft to load or off-load? Reference [24.13.19](#)
- 24.18.36. Are passengers prevented from riding on tow tractors unless adequate seats are provided for that purpose? Reference [24.13.20](#)
- 24.18.37. Are pintle assemblies and towing connections secured with a pintle hook safety locking device or cotter pin that will positively lock towing connections? Reference [24.13.20.2](#)
- 24.18.38. Are hazardous areas in aircraft hangars or nose docks, such as crush and pinch points that cannot be eliminated by engineering controls or mechanical safeguards, highlighted with colored paint and signs? Reference [24.14.4.1](#)
- 24.18.39. Have all personnel who routinely work in hangars or require access through the hangar doors received annual Hangar Door Awareness Training? Reference [24.14.5](#)
- 24.18.40. Are only qualified personnel, approved by the squadron commander or designated representative, authorized to operate hangar doors? Reference [24.14.8.3](#)
- 24.18.41. Are overhead hangar doors fully opened before moving aircraft through the door? Reference [24.14.8.4](#)
- 24.18.42. Do facility managers conduct monthly inspections of hangar door operational and safety features? Reference [24.14.8.7](#)
- 24.18.43. Are visual inspections of the door path and track-way accomplished before hangar door movement? Reference [24.14.9](#)
- 24.18.44. Is temporary or makeshift electrical wiring prohibited in hangars? Reference [24.14.13](#)
- 24.18.45. Are emergency procedures established to remove aircraft in case of fire, severe weather or other hazards? Reference [24.14.15](#)

- 24.18.46. Do supervisors prohibit wear of finger rings and loose clothing when they pose a hazard to workers? Reference [24.15.1.6](#)
- 24.18.47. Is incidental storage of small amounts of paints and thinners in approved cabinets with self-closing doors? Reference [24.15.3.1.1](#)
- 24.18.48. Are hazardous operations prohibited within 50 feet of major cleaning, painting or paint removal operations? Reference [24.15.3.2.1](#)
- 24.18.49. Is the work area inspected to eliminate ignition sources prior to paint touchup operations? Reference [24.15.3.2.1](#)
- 24.18.50. If hangar doors are opened to disperse flammable vapor concentrations, are the doors opened at least 10 feet? Reference [24.15.3.2.2](#)
- 24.18.51. If opened to less than 10 feet, are procedures in place to lock out the main door switch? Reference [24.15.3.2.2](#)
- 24.18.52. Is the multimeter calibration date checked prior to each use? Reference [24.15.4.4](#)
- 24.18.53. Are parking brakes set and/or chocks used prior to jacking equipment? Reference [24.15.4.5](#)
- 24.18.54. Are jacks and jack stands inspected and maintained IAW TO or manufacturer's instructions? Reference [24.15.4.5](#)
- 24.18.55. Are locking pins installed, hydraulic pressure released, platform eased down onto the locks and the hydraulic valve closed before anyone is allowed on the maintenance stand? Reference [24.15.4.8.1](#)
- 24.18.56. Are procedures in place to protect workers from unexpected movement of flight controls? Reference [24.15.6](#)
- 24.18.57. Is fall protection available and used by workers exposed to a fall of 4 feet/10 feet or more? Reference [24.16](#)

## Chapter 25

### CIVIL ENGINEERING

**25.1. Hazards.** Civil engineering (CE) units are typically involved in numerous planning, maintenance and fire prevention activities that have a high risk for mishaps. Safe management of the work force, inclusion of safety features (most economical during the identification, planning or design phases) and the correction of facility and grounds hazards are instrumental in preventing mishaps. Training, safe work practices, correct personal protective equipment (PPE), proper tools, human factors and operational risk management (ORM) should all be addressed/accomplished prior to starting tasks.

25.1.1. Confined Spaces. Personnel working with electricity, plumbing, water and wastewater treatment, heating maintenance, power production and other allied trades may need to enter tanks, vaults, manholes and other above or below-ground level environments. Personnel entering or working in confined spaces may encounter serious hazards. These may include atmospheric hazards such as lack of sufficient oxygen to support life, excessive oxygen levels that increase the danger of fire or explosion, presence of flammable or explosive atmospheres, and materials or the presence of toxic gases or materials. In addition, the confined workspace may include electrical or mechanical hazards that must be locked out, or engulfment or entrapment hazards. Many of these hazards are not readily apparent, detectable by odor or visible by normal means, which may result in workers entering confined spaces without consideration of potential dangers. Workers must consider all confined spaces unsafe and not enter or work in these spaces until tests, evaluations and requirements of **Chapter 23**, *Confined Spaces*, and locally developed procedures are performed to ensure safe conditions exist prior to entry and that safe conditions are maintained during the entire work period.

25.1.2. Cleaning. Soaps and solvents can cause surfaces to become slippery and increase the potential for slips and falls. Certain cleaning solvents may ignite if applied to hot surfaces or when heated, causing fires and injuries to workers.

25.1.2.1. Pressure cleaners and steam cleaners operate at pressures in excess of 100 psi and temperatures near 200° F which can scald or burn workers on contact.

25.1.2.2. Soaps and solvents can cause dermatitis, eye irritation and other medical problems if the solvents become inhaled.

25.1.3. Interruption of services, injury to workers and equipment damages can occur when electrical, gas and steam lines are broken during digging operations. Ensure digging permits are obtained prior to digging.

25.1.4. Flammables and Combustibles. Improper use of flammable and combustible liquids can result in explosions, burns from fire and chemicals, asphyxiation, inhalation of vapors, absorption through the skin, skin irritation and eye damage from direct contact or exposure. The volatility of flammable or combustible liquids is increased by heating and, when heated higher than their flash points, they present additional hazards.

25.1.5. Power Tools. Portable power tools receive power from electricity, air pressure, explosive charges or a rotating flexible cable. While the portable tool increases mobility and

convenience, it is frequently more hazardous to use than its stationary counterpart because portable tools are small, making safety guarding more difficult. Typical injuries from portable power tools include electrical shock, burns, cuts, eye injuries from flying particles and muscle strains. The most common injuries from portable circular saws result from contact with the blade, electric shock or burns, tripping over cords or saws, losing balance while using the saw, dropping the saw on one's self or another person and kickbacks from pinching blades in the cut. Severe eye injuries may result from flying particles or sawdust.

25.1.6. Shock or electrocution may occur from contact with energized systems. Electrical equipment can also be an ignition source for fire or explosion caused by short circuits, overheated equipment or failure of current limiters, thermal sensors and other devices. Explosions may occur when flammable liquids, gases or dusts are exposed to ignition sources generated by electrical equipment.

25.1.7. Electrical Cords and Power Cables. Abuse or improper care of electrical cords and power cables may cause insulation to become frayed or damaged, which may lead to electrical shock of workers using the damaged cords or cables.

25.1.7.1. Excessive scraping, kinking, stretching and exposure to grease and oils will damage electrical cords and power cables and cause premature failure and possible shock or burns.

25.1.7.2. Electric cords of power hand tools may be damaged or cut if the operator allows the cord to fall in the path of material being worked or sawed.

25.1.8. Manual Handling Practices. Hernias, back strains, crushed hands and feet, broken bones and severe lacerations can result from poor manual handling practices. Injuries may occur from improper lifting procedures or failure to use mechanical lifting devices for handling heavy loads.

25.1.9. Many hazards are associated with physical limitations, e.g., fatigue and adverse working conditions. Refer to [Chapter 2, Human Factors](#), for additional information.

25.1.9.1. Fatigue may cause worker inattention and inability to concentrate on job tasks that could result in trips, falls, inability to carry heavy articles properly and exposure to vehicles and other moving objects the worker may fail to observe.

25.1.9.2. Extreme or adverse weather conditions, i.e., heat, cold, extreme humidity, affect each individual worker differently and may increase the probability of a mishap.

25.1.10. Use of the wrong tool and failure to inspect tools prior to use may cause cuts, eye injury and broken bones.

25.1.11. Unsafe work practices when performing hot-work operations, such as welding, brazing, soldering, heat treating, grinding, powder-actuated tools, hot riveting and all other similar applications producing a spark, flame or heat-producing operation, may result in serious burns.

25.1.12. Working with or around hazardous substances places workers in hazardous situations, such as working with or around battery acids, paints, chemicals, sewage or other cleaning operations. For example: substances such as mercury and phosphor contained in fluorescent lamps are dangerous in open cuts, mouth or eyes. Skin problems or dermatitis

may result from handling epoxy cements, caustics, oils and solvents without protection. Proper PPE shall be used.

25.1.13. Simple yet dangerous work, such as excavation, earth and rock removal, may result in cave-ins, causing serious injuries or death by suffocation or crushing. Additional hazards from buried pipes or lines may also be encountered when excavating around utilities.

25.1.14. Work in areas where flying or falling objects may be present could result in a “struck-by” incident. For example: tools left on a ledge could fall on workers below.

25.1.15. Exposure to hazardous noise either in the shops or in other work areas, such as equipment rooms, generator rooms, heavy equipment operations and the flight line, without proper hearing protection can result in temporary or permanent loss of hearing.

25.1.16. Attics, crawl spaces, tanks, vaults and similar areas frequently lack illumination resulting in falls, burns, cuts or electrical shock.

25.1.17. Injuries from working on or near moving machinery range from minor cuts and bruises to a severed limb. This hazard exists where machinery is operated, including job sites where vehicles, equipment or machinery are in use. Ensure all guarding is in place and workers briefed on hazards.

25.1.18. Mechanical lifting devices include cranes, hoists, slings, jacks and forklifts. Their use is subject to certain hazards that cannot be controlled by mechanical means, but only through proper supervision and training. Hazards include overloading, dropping or slipping of the load, obstructing the free passage of the load, moving a vehicle with an unsecured load, not using outriggers and other misuse of lifting devices.

25.1.19. Motor vehicle operation mishaps may occur from improper backing of vehicles. Injuries are also sustained when a person gets on or off the vehicle while it is moving or when left in neutral without the parking brake set, when operators fail to adjust for weather conditions, speed or are inattentive to the driving task. Training and licensing is required for each type of vehicle utilized.

25.1.20. The use of propane or gasoline-powered equipment, i.e., forklifts and materials handling carts, produces carbon monoxide. Worker exposure to carbon monoxide may be excessive if such operations are conducted in low ceiling, enclosed or non-ventilated areas. Ensure proper ventilation is available at all times.

**25.2. Supervisory Responsibilities.** Supervisors must recognize workplace hazards and apply ORM when existing guidance, i.e., manufacturer’s instructions, does not sufficiently address operational concerns or requirements. Supervisors shall not require personnel to work in environments or conditions that are hazardous to their safety or health without first providing adequate engineering and administrative controls or PPE. The supervisor shall frequently inspect job sites, work methods and materials, and equipment used. Any unsafe equipment or material shall be tagged and rendered inoperative or physically removed from the workplace. The supervisor shall permit only qualified personnel to operate equipment and machinery according to safe work practices. Refer to AFI 90-901, *Operational Risk Management*, for additional ORM information.

25.2.1. Supervisors will:

25.2.1.1. Ensure safe working conditions.

- 25.2.1.2. Ensure all electrical, power production and Heating, Air Conditioning and Ventilation (HVAC) personnel are trained in cardiopulmonary resuscitation (CPR) procedures.
- 25.2.1.3. Provide necessary protective equipment in consultation with BE and the Ground Safety office. **Figure 25.1** contains additional guidance concerning PPE.
- 25.2.1.4. Ensure required guards and protective equipment are provided, used and properly maintained.
- 25.2.1.5. Ensure tools and equipment are properly maintained and used.
- 25.2.1.6. Plan the workload and only assign workers to tasks they are qualified to perform. Personnel shall not work alone in remote or isolated work areas.
- 25.2.1.7. Ensure workers understand the work to be done, the hazards that may be present and procedures for performing the work safely.
- 25.2.1.8. Take immediate action to correct any violation of safety rules observed or reported to them.
- 25.2.1.9. Ensure workers exposed or potentially exposed to hazardous chemicals or materials are trained to identify, minimize or eliminate the hazards of those chemicals and materials per AFI 90-821, *Hazard Communication*. Follow information from the MSDS for specific chemicals or materials. This information shall be used by supervisors in conjunction with worker training.
- 25.2.1.10. Conduct a job safety analysis (JSA) of job tasks whenever required to determine the safest, most efficient means to accomplish a given task. **Note:** A JSA shall be accomplished when new equipment is installed, equipment is relocated or new procedures are implemented in critical or hazardous operations and existing guidance is not available. Refer to AFI 91-202, *The US Air Force Mishap Prevention Program*, for additional guidance.
- 25.2.1.11. Ensure all personnel are trained on required equipment and their work environments.
- 25.2.1.12. Ensure industrial shops and sites have a basic first aid kit, NSN 6545-00-922-1200, or suitable substitute, approved by the installation medical services, available to care for workers injuries until professional help arrives or they can obtain full medical care. Refer to **Chapter 8**, *Electrical Safety*, for additional guidance.
- 25.2.2. The following guides will aid supervisors in administering task briefings, i.e., tailgate meetings, to workers:
- 25.2.2.1. Remind workers to check work areas for hazards.
- 25.2.2.2. Review the work request or sketch with employees.
- 25.2.2.3. Explain why the job is being done.
- 25.2.2.4. Point out existing and potential hazards and steps required to control them.
- 25.2.2.5. Explain work methods to be used.

25.2.2.6. Ask for questions and suggestions. Let workers know they may come to you or the safety representative with safety, fire prevention, or occupational health problems.

25.2.2.7. Ensure all employees fully understand their work assignments and safety responsibilities.

25.2.2.8. Recurring safety/weekly tailgate meetings are an excellent way for the supervisor to stress the importance of worker safety, both on- and off-the-job. Additionally, supervisors have the flexibility to include pertinent safety information relevant to their local area and work environment. These meetings allow for worker feedback and discussion and shall include one or more of the following topics as applicable to the job:

25.2.2.8.1. Occupational Health and Safety Reports.

25.2.2.8.2. Lifting and handling techniques.

25.2.2.8.3. Hazards associated with various jobs in progress.

25.2.2.8.4. Unsafe practices.

25.2.2.8.5. Recent mishaps.

25.2.2.8.6. Protective equipment.

25.2.2.8.7. Portable electric tools.

25.2.2.8.8. Hand tools.

25.2.2.8.9. Chemicals and health hazards.

25.2.2.8.10. Location and use of MSDSs.

25.2.2.8.11. Safe housekeeping practices.

25.2.2.8.12. Working on or near machinery.

25.2.2.8.13. Use of ladders.

25.2.2.8.14. Working on elevated platforms or positions.

25.2.2.8.15. Falls from elevated positions.

25.2.2.8.16. Lifting and hoisting equipment.

25.2.2.8.17. Fire hazards and fire prevention.

25.2.2.8.18. First aid and CPR training.

25.2.2.8.19. Falls.

25.2.2.8.20. Pertinent safe practices. Any worker identification of safety, fire prevention or occupational health hazards that cannot be corrected by the supervisor shall be handled by existing documentation systems, such as hazard reports, self-inspection reports or internal worker complaint channels. The organization chain of command shall be used to identify and correct hazards; however, if action is not taken, the installation Ground Safety office should be contacted.

25.2.3. Safety, Fire Protection and Health On-The-Job Training (OJT). Workers shall be thoroughly trained in the use of protective equipment, guards and safeguards for chemicals and the safe operation of equipment, machines and tools they use or operate. Only workers who have been trained and those undergoing supervised OJT shall be allowed to operate shop equipment, machines and tools. Certification and licensing are required for some tools and equipment, e.g., powder-actuated tools and electrical generators. Supervisors will ensure these special qualifications are complete and documented in workers' training records (military or civilian, as appropriate) before allowing or requiring the worker to use the tools.

25.2.4. Supervisors shall watch for signs of fatigue and prevent workers from overexerting themselves. Physical limitations shall be considered when assigning job tasks. Other factors to consider when assigning job tasks include mental preoccupation resulting from personal problems that may have an impact upon workers' and co-workers' safety.

25.2.5. Shop supervisors shall be aware of each worker's limitations, as reasonably possible, under different weather conditions and on-site job conditions and select personnel for job assignments accordingly.

25.2.6. Supervisors and workers shall perform pre-job planning. Supervisors shall ensure operators are competent, careful, physically and mentally fit and thoroughly trained for assigned tasks.

**25.3. Occupational Health.** Health hazards that affect CE workers also affect building occupants where work is performed and personnel passing by work in progress. Adequate controls shall be used whenever an operation poses a potential health hazard to any personnel.

25.3.1. AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, addresses program responsibilities, designation of hazardous noise-producing equipment and hazardous noise areas, required PPE and required medical examinations for personnel exposed to hazardous noise. BE shall be contacted to evaluate and determine noise levels.

25.3.2. Breathing Hazards. If process has not already been evaluated, contact BE for an OEHR risk assessment. Refer to paragraph 2.3 for additional guidance.

25.3.3. Internal combustion engines shall not be operated inside buildings unless an exhaust system or other ventilation approved by BE is installed and used. When equipment is operated adjacent to buildings, the exhaust shall be directed away from the buildings. Substitution of internal combustion engine forklifts with electric forklifts, modification of existing equipment, or appropriate ventilation may be necessary to keep concentrations of carbon monoxide within permissible levels. Where high concentrations of carbon monoxide accumulate (e.g., in warehousing areas with a large number of forklifts in use), BE shall be contacted to survey and identify requirements to make the work area safe. Refer to AFMAN 24-306 (IP), *Manual for the Wheeled Operator*, for requirements and information on safe vehicle operation.

25.3.4. Skin Irritants. Dermatitis, one of the leading occupational diseases in today's workplace, is also easy to prevent. Gloves can easily provide adequate protection. Caution is advised in the selection process as not all gloves are adequate for all cleaning solvents and applications. If process has not already been evaluated, contact BE for Occupational and



Environmental Health (OEH) risk assessment. Refer to paragraph 14.4.7 for additional guidance on selecting gloves.

25.3.5. Hazards from Flying or Falling Objects. **Chapter 14**, *Personal Protective Equipment (PPE)*, and other specific job safety standards outline requirements for protective equipment, barriers and procedures to prevent injuries from flying or falling objects, e.g., face shield, hard hats or construction barriers. Proper eye protection equipment shall be provided when needed, and its use shall be strictly enforced. This requirement includes workers not actually involved but who are within the area and may be affected by flying or falling objects.

25.3.6. Asbestos fibers can cause lung diseases such as asbestosis and cancer of the lung. If asbestos is used or already in place, safe handling procedures shall be IAW 29 CFR 1910.1001, *Asbestos*. Workers shall not be exposed to unsafe levels of airborne asbestos. Consult BE prior to all planned asbestos projects. Immediately notify BE if asbestos is suspected or confirmed during a project. Workers shall not resume work until receiving proper guidance from BE. Refer to AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, and AFI 32-1052, *Facility Asbestos*, for additional guidance.

25.3.7. Confined Spaces. Confined spaces can pose serious health hazards to workers involved in entry. Supervisors and workers must be aware of potential hazards and precautions needed to avert a serious consequence. **Chapter 23**, *Confined Spaces*, addresses specific responsibilities, requirements and procedures for entry into confined spaces.

#### **25.4. Shop Layout, Equipment, General Walking and Working Surfaces.**

25.4.1. Layout. Proper layout, spacing and arrangement of equipment, machinery, passageways and aisles are essential to orderly operations. Good layout is best achieved in the design stage, with recommendations from the installation Ground Safety office, Fire Emergency Services (FES) Flight, BE and CE. Whether a facility is in the design stage, being remodeled or repositioning of equipment and machinery is required, basic layout considerations are important factors in planning a facility for safe operations. All interior walking and working surfaces that are part of the means of egress shall comply with UFC 3-600-01, *Fire Protection Engineering for Facilities*, and NFPA 101, *The Life Safety Code*. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, and **Chapter 18**, *Machinery*, for additional guidance on proper layout, spacing and arrangement.

25.4.1.1. Equipment and machinery shall be arranged to permit an even flow of materials. Sufficient space should be provided to handle the material with the least possible interference from or to workers or other work being performed. Place machines so the operator does not stand in a passageway, aisle or exit access. If this cannot be accomplished, the unit will submit an ORM review to the commander for approval prior to operation. Additionally, machine positioning should allow for easy maintenance, cleaning and removal of scrap. After the initial positioning of equipment and machines is decided, clear zones (work spaces) shall be established. These clear zones should be of sufficient dimensions to accommodate typical work. If material exceeds established clear zones, rope and stanchions may be used to temporarily extend the workspace. In cases where marking may be necessary, installation Ground Safety office and the shop supervisor will determine, based on hazard potential, which machine shops will require clear zones to be marked. When marking is used, yellow or yellow and black hash-

marked lines, 2 to 3 inches wide, shall be used. Machines designed for fixed locations and those with shock-mounting pads shall be securely anchored and installed IAW manufacturer's instructions.

25.4.1.2. Passageways and aisles shall be provided and marked to permit the free movement of employees bringing and removing material from the shop. These passageways are independent of clear zones and storage spaces. They shall be clearly recognizable. Floor markings should provide a contrast to the floor color, such as yellow lines 2 to 3 inches wide on a gray floor.

25.4.1.3. Where powered materials handling equipment is used, facility layout shall provide enough clearance in aisles, on loading docks, and through doorways to permit safe turns. Aisles shall be at least two (2) feet wider than the widest vehicle used or most common material being transported.

25.4.1.4. Aisles shall be at least 36 inches wide to permit free movement of workers, equipment and supplies, and at least 18 inches shall be provided for passageways formed by or between movable obstructions.

#### 25.4.2. Electrical Installations and Equipment.

25.4.2.1. Supervisors will ensure work areas are inspected for possible electrical hazards. Sufficient workspace shall be provided and maintained around electric equipment to permit safe operation and maintenance of such equipment. Only qualified operators designated in writing by the supervisor shall be allowed to operate the equipment. This listing of personnel qualified to operate equipment shall be maintained in the work area.

25.4.2.2. Frames of all electrical equipment, regardless of voltage, shall be grounded.

25.4.2.3. Exposed non-current-carrying metal parts of electrical equipment that may become energized under abnormal conditions shall be grounded IAW NFPA 70, *National Electrical Code*.

25.4.2.4. Exposed non-current-carrying metal parts of the following plug-connected equipment that may become energized shall be grounded or double insulated and distinctly marked: portable, hand-held, motor-operated tools, appliances or any equipment operated in excess of 150 volts to ground.

25.4.2.5. Wires shall be covered wherever they are joined (e.g., outlets, switches and junction boxes).

25.4.2.6. Parts of electrical equipment which in ordinary operation produce arcs, sparks, etc., shall not be operated or used in explosive atmospheres or in close proximity to combustible materials.

25.4.2.7. Spring-loaded switches for equipment shall not be secured, e.g., taped or wired, in the ON position at any time.

25.4.2.8. Flexible extension cords and power strips shall not be:

25.4.2.8.1. Used as a substitute for fixed wiring.

25.4.2.8.2. Run through holes in doors, windows, walls, ceilings or floors.

25.4.2.8.3. Attached to building surfaces, i.e., stapled/nailed to surfaces.

25.4.2.8.4. Spliced, stapled, tacked or placed where they create a hazard or are subject to damage.

25.4.2.9. Flexible extension cords may be used for temporary taskings if:

25.4.2.9.1. Cords are of continuous lengths without splices or taps.

25.4.2.9.2. Cords are fastened so there is no pressure on joints or screws of the plug or sockets.

25.4.2.9.3. Cords are replaced when insulation has frayed or deteriorated.

25.4.2.9.4. Cords of proper size and temperature rating to withstand the electrical load and approved by a recognized testing agency are used.

25.4.2.9.5. Cord is a three-prong, dead-front plug type.

25.4.2.10. Equipment connected by flexible extension cords shall be grounded either by a three-wire cord or by a separate ground wire (except double-insulated equipment). Refer to paragraphs [25.4.2.9](#) through [25.4.2.9.5](#).

25.4.2.11. Ground Fault Circuit Interrupters (GFCI) shall be used on all 120-volt, single-phase, 15- and 20-ampere receptacle outlets at job sites when the receptacles are not a part of the permanent wiring of the building or structure. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5 kilowatts (kW), where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with GFCIs.

25.4.3. Illumination. Adequate illumination shall be provided to ensure safe working conditions. Illumination for night work shall also be supplied for warning as well as work visibility. Essential regulatory information is listed below. Refer to 29 CFR 1926.26, *Illumination*, and 29 CFR 1926.56, *Illumination*.

25.4.3.1. Portable lamps will have Underwriters Laboratories (UL) listed plugs, handles, sockets, guards and cords for normal working conditions. Lamps used in wet or damp locations shall be equipped with a waterproof housing. In flammable atmospheres, approved explosion-proof lights shall be used.

25.4.3.2. For work in boilers, condensers, tanks, turbines or other grounded locations that are wet or may cause excessive perspiration, a low-voltage lighting system shall be used, either from a battery system or low-voltage lighting unit. Many organizations only permit a six or twelve volt system for tools and lights used inside boilers. These are usually connected to a transformer located outside of the boiler. Battery powered lights are an even safer alternative to installed systems. In situations where these lighting systems are not available, a vapor-proof 110-volt lighting system shall be used.

25.4.3.3. Flashlights for use near energized electrical equipment and circuitry will have insulated cases.

25.4.3.4. At least 50 foot-candles of illumination shall be provided at all work stations. However, fine work may require 100 foot-candles or more. This can be obtained with a combination of general lighting plus supplemental lighting. If fluorescent lighting is

installed, it shall be installed in a manner to eliminate any stroboscopic effect with moving machinery. Standard fluorescent fixtures not designed with self-locking tubes shall be fitted with tube-retainer devices, screens or guards to prevent tubes from falling out. Consult installation CE whenever specific guidance on lighting is required and submit an AF Form 332, *Base Civil Engineer Work Request*, when a lighting survey is required.

#### 25.4.4. Ventilation.

25.4.4.1. Minimum safety, fire prevention and occupational health requirements pertaining to ventilation are addressed in this chapter. Ventilation and exhaust systems details, including information on flow-rate requirements, and the design of ventilation and exhaust systems are in the most current edition of the American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. BE will determine what, if any, periodic testing of ventilation systems is required IAW the above reference.

25.4.4.2. Machines that generate dust, vapors, mists, etc., shall be connected to an effective industrial-exhaust ventilation system. In shops where small numbers of installed machines are not continuously in operation, portable collection systems may be used. Hoods and exhaust systems shall be constructed and installed IAW the manufacturer's instructions. Also, refer to [Chapter 18](#).

25.4.4.3. In areas where welding, soldering, brazing and burning hot-work operations are performed, fumes from operations contain the metals being welded together (e.g., cadmium, zinc, lead, iron or copper). The filler material, flux and the coating on the welding rods used may generate other gases (e.g., carbon monoxide, arsine, or ozone) at concentrations hazardous to workers. When extensive hot-work operations are conducted, particularly in enclosed areas, excessive exposure to these materials could occur. Ventilation or respiratory protection may be required for these operations based on measured or calculated concentrations. Supervisors shall contact BE whenever workplace operations change, when new chemicals are introduced, processes or procedures change, or engineering controls are modified or added. When welding, soldering, brazing and other hot-work operations are performed in a space screened in on all sides, i.e., welding booths, screens or non-rigid heat/spark barriers, the screens shall be arranged to ensure adequate ventilation.

25.4.4.4. Boiler and furnace rooms shall have ventilation to permit clean, safe combustion and to minimize soot formation. An unobstructed air opening shall be provided, sized on the basis of 1 square inch (645 square millimeter [sq mm]) free area per 2,000 British Thermal Units (BTU) maximum fuel input of the combined burners located in a boiler room. Air supply openings will be kept clear at all times and regularly inspected. ANSI Boiler Codes may be consulted for more detailed information on boiler ventilation and combustion air requirements.

25.4.5. Walking-Working Surfaces. CE workers are frequently victims of falls at work sites inside and outside the shop. Walking and working surfaces often include a floor opening or platform through which persons may fall, such as a hatchway, stair or ladder opening, pit or large manhole. Elevated working spaces above the surrounding floor or ground, such as a

balcony or platform for the operation of machinery and equipment, may also be encountered by civil engineering personnel. Supervisors will ensure fall protection procedures or systems are available and used by workers where the potential of a fall from a height of four (4) feet or more exists. Refer to **Chapter 7**, **Chapter 13** and 29 CFR 1910.23, *Guarding Floor and Wall Openings and Holes*, for additional guidance.

25.4.6. Construction. Personal fall arrest or fall protection systems are often necessary to safely accomplish tasks performed from elevated surfaces during construction activities. Workers exposed to a walking or working surface (horizontal and vertical surface) with an unprotected side or edge, which is six (6) feet or more above a lower level, shall be protected from falling by the use of guardrail systems, safety net systems or personal fall arrest systems (PFAS). Refer to **Chapter 13**, 29 CFR 1926.501, *Duty to Have Fall Protection*, and paragraph **25.13.5** for information on roofing operations.

25.4.7. Fixed ladders and requirements for guarding and training workers are addressed in **Chapter 7** and 29 CFR 1910.27, *Fixed Ladders*. Any fixed ladder of 20 feet or more continuous length requires fall protection.

25.4.8. When working over or near water:

25.4.8.1. Where the danger of drowning exists, workers shall be provided with US Coast Guard-approved life jackets or buoyant work vests. This includes, but is not limited to, water-treatment ponds, storage tanks and Air Force operated Morale, Welfare and Recreation (MWR) recreational lakes or large ponds. Life jackets or buoyant work vests shall be worn at all times when workers are working alone over or near water.

25.4.8.2. Prior to and after each use, buoyant work vests or life preservers shall be inspected for defects that would alter their strength or buoyancy. Defective units shall not be used.

25.4.8.3. Where feasible, ring buoys with at least 90 feet of line shall be provided and be readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

25.4.8.4. At least one lifesaving skiff shall be immediately available.

25.4.9. Exits and Exit Markings. Essential regulatory information is included below. For additional guidance, see 29 CFR 1910.37, *Means of Egress, General*.

25.4.9.1. Every exit will have "EXIT" in plain legible letters not less than six (6) inches high with the strokes of the letters not less than 3/4 inch wide.

25.4.9.2. Doors, passageways or stairways that are neither exits nor ways to an exit (but may be mistaken for an exit) shall be clearly marked "NOT AN EXIT" (or similar designation) or by a sign indicating their actual use; for example: "STORAGE ROOM" or "BASEMENT."

25.4.9.3. When the direction to the nearest exit may not be apparent to an occupant, an exit sign with an arrow indicating direction shall be used.

25.4.9.4. Exit access shall be arranged so it is unnecessary to travel toward any area of high hazard potential in order to reach the nearest exit (unless the path of travel is effectively shielded by suitable partitions or other physical barriers).

25.4.9.5. Exit signs shall be clearly visible from all directions of egress and shall not be obstructed at any time. If occupancy is permitted at night, or if normal lighting levels are reduced at times during working hours, exit signs shall be suitably illuminated by a reliable light source. New exit signs shall be the internally illuminated, light emitting diode (LED) type. Existing signs may be internally or externally illuminated. Use of radio luminescent signs is prohibited without the written approval of the USAF Radioisotope Committee. Replace and dispose of existing radio luminescent signs IAW AFI 40-201, *Managing Radioactive Materials in the US Air Force*. As the installation Radiation Safety Office, BE will direct the proper disposal methods and guidelines.

25.4.9.6. A door from a room to an exit or to a way-of-exit access shall be the side-hinged swinging type. It will swing out in the direction of travel if 50 or more persons occupy the room or the exit is from an area of high hazard potential.

25.4.9.7. Areas around exit doors and passageways shall be free of obstructions. The exit route shall lead to a public way. The exit access must not go through a room that can be locked, nor may it lead into a dead-end corridor.

25.4.9.8. Where occupants may be endangered by the blocking of any single exit due to fire or smoke, there shall be at least two means of exit remote from each other.

25.4.9.9. Exits, exterior steps and ramps shall be adequately lighted to prevent mishaps. Separate lighting shall not be required if street or other permanent lighting gives at least one foot-candle of illumination on the exit, steps and ramp.

25.4.9.10. Monthly testing of exit lights shall be accomplished IAW NFPA 101, *The Life Safety Code*.

25.4.10. Housekeeping. See paragraph 5.9 for housekeeping in industrial areas.

25.4.11. Machinery, Shop Equipment, Machine Guarding and Power Transmission Apparatus. Refer to **Chapter 18**.

**25.5. Fire Prevention.** All CE personnel shall receive fire prevention training as part of their general non-supervisory (AFOSH) training. Training shall be documented IAW AFI 91-202. Regulatory OSHA fire extinguisher requirements are IAW AFI 32-2001, *Fire Emergency Services Programs*. Also see **Chapter 6**, *Fire Protection and Prevention*, and NFPA 10, *Standard for Portable Fire Extinguishers*, for additional information.

25.5.1. Supervisors in charge of operations where fuels, solvents or other flammable liquids are used shall be constantly alert for hazards and unsafe acts.

25.5.1.1. Fuels such as gasoline shall never be used to clean floors or clothing.

25.5.1.2. Solvents shall not be used as cigarette lighter fluid.

25.5.1.3. Open solvent or gasoline containers shall not be kept near electrical equipment.

25.5.1.4. The use of low flash point petroleum solvents shall be avoided whenever possible.

25.5.1.5. Open flames, open element heaters, equipment not properly grounded and non-explosion-proof electrical equipment used in the presence of flammable or combustible liquids shall be avoided.

25.5.2. Fire extinguishers with a rating of at least 2A80BC shall be installed in shop areas. The number of extinguishers depends upon the size and layout of the facility. The installation FES Flight shall be consulted for more detailed information on the type, selection, installation, inspection, maintenance and hydrostatic testing of portable fire extinguishers. Fire extinguishers will:

25.5.2.1. Be kept fully charged and in their designated area.

25.5.2.2. Be located along normal paths of travel.

25.5.2.3. Not be obstructed or obscured from view.

25.5.2.4. Be visually inspected by management or a designated worker at least monthly to ensure they:

25.5.2.4.1. Are serviceable.

25.5.2.4.2. Are in their designated places.

25.5.2.4.3. Have not been tampered with or actuated.

25.5.2.4.4. Do not have corrosion or other impairments.

25.5.2.4.5. Are accessible and not obstructed.

25.5.2.5. Be examined, and, if necessary, after inspection, recharged or repaired to ensure operability and safety. Attach a tag or keep a central record to indicate the maintenance or recharge date and signature or initials of the person performing the service/inspection.

25.5.2.6. Be hydrostatically tested. Fire extinguishers shall be hydrostatically tested every five years IAW NFPA 10.

25.5.2.7. Be placed so the maximum travel distance does not exceed 75 feet for Class A or 50 feet for Class B locations, unless there are extremely hazardous conditions.

25.5.3. Smoking at job sites shall only be permitted in approved designated smoking areas and NEVER while performing work.

25.5.4. Supervisors will ensure workers remove construction debris and rubbish from the job site upon completion of the job, or daily if extended beyond one day. Hazardous materials shall not be left at job sites unless properly stored. Work being performed on job sites shall not endanger building occupants (e.g., exits blocked, fire alarm devices disconnected, etc.).

## **25.6. Compressed Air.**

25.6.1. All workers shall be aware of the inherent dangers of using compressed air. Alternate methods of cleaning surfaces should be sought. Compressed air may be used if no alternative method of cleaning surfaces is acceptable. Compressed air shall never be used to blow debris from a person. The downstream pressure of compressed air will remain below 30 psi whenever the nozzle is dead-ended and then only when effective chip guarding and PPE are used. Face shield and safety goggles are required when cleaning with compressed air.

25.6.2. All personnel assigned to shops with air compressors shall be familiar with compressor operating and maintenance instructions.

25.6.3. The following are requirements for air compressors:

25.6.3.1. The drain valve on the air tank shall be opened daily to prevent excessive accumulation of liquid.

25.6.3.2. Air tanks shall be protected by adequate safety relief valves. These valves shall be tested at regular intervals (as required by manufacturers' specifications) to ensure they are in good operating condition. There shall be no valves between the air tank and the safety valve.

25.6.3.3. The pressure controller and gauge shall be maintained in good operating condition.

25.6.3.4. Air compressors shall be maintained strictly IAW manufacturer's instructions or an applicable TO.

25.6.3.5. The maximum working pressure of compressed air lines shall be identified in psi. Pipeline outlets shall be tagged or marked showing maximum working pressure immediately adjacent to the outlet.

25.6.4. Air supply lines shall be protected from damage by vehicles, tools and equipment. They shall be inspected regularly and maintained in good condition. Air supply lines shall be marked or tagged to identify the maximum psi on the lines. Tools shall never be raised or lowered by the air hose.

25.6.5. Compressed Air Systems. Plumbing workers shall be trained and authorized to inspect, maintain or install compressed air systems. Before opening a compressed air line, workers shall ensure the line has been completely drained of existing air to prevent a sudden release of air that could cause the line to whip. The reverse is also true; when personnel have installed a new compressed air system, all parts of the system shall be secured together before air is put into the system.

**25.7. Jacks and Portable Hoists.** Equipment maintenance personnel shall not use hydraulic floor jacks, post jacks, portable hoists or mechanical jacks to support equipment while repair is being accomplished. The equipment shall be blocked or placed on approved axle or frame stands before repair operations are begun. Jacks used primarily in one location shall be inspected every six (6) months, or before and after the jack is sent out of the shop for special work. Shop personnel shall not use a jack or hoist that is leaking or is faulty in its operation. Faulty jacks and hoists shall be taken out of service, tagged and not used until repaired. Load ratings shall be stenciled or otherwise plainly marked on all jacks and hoists. Inspection dates shall be properly documented by shop supervisors. Refer to paragraph [35.5.2.3](#) for guidance on inspecting hoists.

**25.8. Shoring and Trenching.** The walls and faces of excavations and trenches over five (5) feet in depth, where workers may be exposed to danger of a cave-in, shall be guarded by a shoring system, sloping and benching system or some other equivalent means consistent with 29 CFR 1926, Subpart P – Excavations. Trenches less than five (5) feet deep with hazardous soil conditions, shall also be effectively protected. Refer to 29 CFR 1926, *Subpart P - Excavations: 1926.650, Scope, Application and Definitions Applicable to Subpart P, 1926.651, Specific*



*Excavation Requirements, 1926.652, Requirements for Protective Systems*, for additional guidance. **Note:** A competent person will examine the excavation soil to determine the need for a shoring system, sloping and benching system or some other equivalent means. A registered professional engineer shall be consulted in areas required by 29 CFR 1926, Subpart P – Excavations.

25.8.1. Appropriate trench boxes or shields may be used instead of shoring or sloping.

25.8.2. Tools, equipment and excavated material shall be kept two (2) feet or more from the lip of the trench. Where workers are required to be in or work in trenches 4-feet deep or more, an adequate means of exit such as ladders or steps shall be provided (within 25 feet of travel) and used.

25.8.3. Trenches and excavations over five (5) feet deep or more shall be inspected daily by the supervisor in charge to ensure there are adequate slopes, shoring, benching and bracing, and no evidence of possible slides or cave-ins. A new inspection is required whenever supervision on the site changes and the new supervisor will document and sign the inspection document. More frequent inspections may be necessary as work progresses or after inclement weather conditions, such as rain, or where loose compacted or unstable materials are present. Inspection(s) shall be documented and signed by the supervisor and a copy of the inspection document(s) shall be maintained on the site at all times.

25.8.4. Workers will take extra care when hand excavating in close proximity to utilities to preclude interruption of services, equipment damage or injury to workers, which can result from breaking electrical, gas or steam lines. Simple pre-planning, shoring and bracing, and hand digging around known utilities pipes and lines, should prevent most mishaps associated with excavations. AF Form 103, *Base Civil Engineering Work Clearance Request*, shall be coordinated and approved before any digging commences.

25.8.5. If a hazardous atmosphere exists or there is a potential for one to exist in the excavation (i.e., welding in/or near the excavations, other hazardous work activities, excavations in landfill areas or excavations in areas where hazardous substances are stored nearby), the atmospheres in the excavation shall be tested before workers enter excavations greater than four (4) feet in depth. The competent person shall consult with BE for proper atmospheric evaluation of the excavation.

25.8.6. Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres or other hazardous conditions, exposed workers shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety. The proper precautions shall be taken by the competent person which may include the following:

25.8.6.1. Cave-in. Fix the sloping and benching system or provide a shoring system. If cave-in is the result of water accumulation, then remove water and possibly use a shoring system if the competent person believes it is necessary.

25.8.6.2. Failure of protective system. If there is evidence of failure to the protective system, stop the work and replace the protective system.

25.8.6.3. Hazardous atmosphere. If the competent person suspects a potential hazardous atmosphere or there is one in the trench, workers shall be removed from the trench and testing shall be accomplished. Refer to paragraph [25.8.5](#) for additional guidance.

25.8.6.4. Water accumulation. Workers shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect workers against the hazards posed by water accumulation. The precautions necessary vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control accumulating water or use of a safety harness and lifeline. **Note:** An attempt to remove the accumulating water shall be accomplished first.

**25.9. Barricades and Traffic Signs.** Whenever a common area is disturbed by CE maintenance, repair or construction operations and presents a hazard to personnel in the area (residents, other workers or passers-by), care shall be taken to warn these personnel and other engineering workers of the potential hazard.

25.9.1. Appropriate barriers shall be erected around excavations, open manholes, open electrical panels, etc., whenever they will be left unattended.

25.9.2. Appropriate warning signs and steady or flashing warning lights for periods of reduced visibility (i.e., nighttime operations, inclement weather, fog) shall be posted a sufficient distance from the hazard to give ample advance warning to approaching pedestrian or vehicular traffic. For vehicular traffic, comply with Department of Transportation's (DOT) *Manual on Uniform Traffic Control Devices (MUTCD)*.

25.9.3. Airfield hazard warnings will comply with AFI 32-1042, *Standards for Marking Airfields*.

25.9.4. Traffic control signs or devices will conform to the DOT's *MUTCD*.

25.9.5. Workers exposed to vehicle traffic shall be provided with and required to wear warning vests marked with or made of reflector-type or high visibility material. [Chapter 14](#) provides additional guidance for these requirements.

25.9.6. In some situations, the use of flagmen to control the flow of traffic may be necessary. Workers in equipment operations, pavement maintenance, plumbing, heating maintenance and exterior electrical career fields shall be trained in traffic control procedures.

## **25.10. Sanitation.**

25.10.1. Shop supervisors shall ensure shop personnel use the protective clothing and equipment that will protect them from hazards of the work they perform. It is the responsibility of workers to keep their PPE in a clean, sanitary state of repair and use the proper equipment when required.

25.10.2. Workers shall keep their hands and face clean, change clothes when they are contaminated with solvents, lubricants or fuels and keep their hands and soiled objects out of their mouth. No food or drink shall be brought into or consumed in areas exposed to toxic materials, chemicals or industrial shop contaminants. After exposure to any contaminant, shop personnel shall wash their hands before eating or smoking. Safe drinking water shall be provided in or reasonably near all shops. Waste food from the lunch area shall be kept in a

receptacle that is tightly covered and kept clean. Restrooms must be provided with hot and cold running water and shall be kept clean and in a sanitary condition.

25.10.3. Shop personnel required to wear protective clothing shall be provided with change rooms equipped with clothing lockers having separate storage facilities for clean and soiled clothing. Shower facilities shall be provided when necessary to remove contamination from skin.

25.10.4. Clothing used daily and issued by the shop shall be cleaned and stored in shop lockers or fenced areas within the building. Workers shall inspect clothing and protective equipment daily for servicability and satisfactory condition. In addition, supervisors or a designated worker will spot check equipment and clothing. Refer to 29 CFR 1910.141, *Sanitation*, for additional guidance.

**25.11. Restrictions.** Long full beards, unrestrained long hair, frayed trouser and shirt cuffs, loose clothing (such as loose shirt tails, improperly worn coveralls), loose shoe laces and torn clothing can become caught in tools or machinery and cause serious injury to workers. Personal grooming and appearance standards shall be enforced to prevent serious injuries should clothing, hair or jewelry be caught in operating tools and machinery. Clothing worn shall be suitable to weather conditions and work being done. Highly combustible garments or coveralls made of a synthetic material such as nylon shall not be worn in or around high-temperature equipment or operations such as boiler operations, hot-tar roofing, welding or any other work with open-flame devices. Refer to AFI 32-1064, *Electrical Safe Practices*, ETL 06-9, *Arc Flash Personal Protective Equipment (PPE) Requirements for High-Voltage Overhead Line Work at 69 kV (Nominal) or Less*, and **Chapter 9, Jewelry**, for additional guidance.

**25.12. Equipment Operations and Pavements.** CE construction equipment varies considerably in size, age, capabilities and operating characteristics. Training outlines for operator qualifications shall be tailored to the particular equipment and shall be updated as new equipment is received. Equipment manufacturers normally have copies of their training guides and operator manuals available for use in developing training outlines. ANSI standards on lifting devices have additional information about some types of equipment. Appropriate PPE, e.g., hard hats, as required, shall be used. 29 CFRs 1926.600, *Equipment*, 1926.601, *Motor Vehicles*, 1926.602, *Material Handling Equipment*, 1926.603, *Pile Driving Equipment*, 1926.604, *Site Clearing*, 1926.605, *Marine Operations and Equipment*, and 1926.606, *Definitions Applicable to Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations*, contain general requirements applicable to construction equipment. Additional information on PPE is listed in **Figure 25.1**

25.12.1. Backhoes. The front bucket, if so equipped, and outriggers shall be fully down before attempting to dig. To prevent being struck, workers shall not enter the area through which the digging arm can swing. To avoid being struck by spillage or falling materials, workers shall not be permitted under loads and they will stand away from any vehicle being loaded or unloaded. The operator will check overhead and lateral clearance for fixed obstructions such as trees, poles, wires, etc. Operation under energized electrical lines shall be permitted only where absolutely necessary. These operations shall be approved by the commander, and a spotter shall be used to constantly check clearance. Refer to AFI 32-1064, *Electrical Safe Practices*, and ETL 06-9, *Arc Flash Personal Protective Equipment (PPE) Requirements for High-Voltage Overhead Line Work at 69 kV (Nominal) or Less*, for

additional guidance. When traveling to and from job sites, the backhoe shall be completely folded, secured and centered and the front bucket raised only high enough to provide adequate ground clearance.

#### 25.12.2. Mobile Cranes.

25.12.2.1. Operators. Mobile cranes shall be operated only by designated, qualified operators who possess a valid Operator's Identification Card, or by persons in training under the direct supervision of a qualified operator. The only other personnel who will enter a crane cab are persons such as supervisors and inspectors when duties require them to do so. A list of qualified crane operators shall be kept by the using organization with appropriate entries made in the individual's training record or on the applicable form(s).

#### 25.12.2.2. Operator Qualifications.

25.12.2.2.1. Operator Exam. Potential crane operators shall pass a written examination containing the safety requirements of this chapter and **Chapter 35, *Materials Handling Equipment***. They shall also be given a practical operating examination to demonstrate task-qualification to operate the crane safely. These examinations shall be developed by the using activity IAW AFI 24-301, *Vehicle Operations*. All vehicle lesson plans shall be coordinated through the Vehicle Operations Superintendent and Vehicle Fleet Manager and approved by the unit commander. Operator Records and Licensing shall maintain a copy of the approved lesson plan on file. The examination shall be administered by examiners appointed by the using activity.

25.12.2.2.2. Medical Exam. Prior to assignment, operators shall be evaluated to determine their physical and mental capability to operate cranes. This examination shall include visual acuity, depth perception, hearing, peripheral vision, color vision, reaction time and knowledge of crane operations. The unit's vehicle control officer (VCO) will ensure this testing is conducted. Medical examinations shall be requested any time supervisors believe that inadequate operator performance may be due to physical or mental problems.

#### 25.12.2.3. Operating Practices.

25.12.2.3.1. Operators shall not divert their attention elsewhere while operating the crane. They will first stop the crane, then proceed with the new task.

25.12.2.3.2. Operators shall respond to signals only from the appointed signal person. A stop signal shall be obeyed at any time no matter who gives it.

25.12.2.3.3. Operators shall be responsible for those operations under their direct control. Whenever there is any doubt as to safety, the operator shall have the authority and responsibility to stop and refuse to handle loads until safety has been ensured.

25.12.2.3.4. If an audible warning signal is furnished, the operator will sound it each time before traveling and when approaching workers or other congested areas.

25.12.2.3.5. Before leaving the crane unattended, the operator will:

25.12.2.3.5.1. Land (set down) any suspended load, bucket, lifting magnet or

- other device.
- 25.12.2.3.5.2. Disengage clutch.
  - 25.12.2.3.5.3. Set travel, swing, boom brakes and other locking devices.
  - 25.12.2.3.5.4. Put controls in the “OFF” or neutral position.
  - 25.12.2.3.5.5. Stop the engine.
  - 25.12.2.3.5.6. Secure crane against accidental travel.
- 25.12.2.3.6. During periods of non-use or weather alerts, the operator shall lower the boom to ground level, to a resting platform or otherwise ensure the boom is secure against displacement from wind, loads or other outside forces.
- 25.12.2.3.7. If there is a warning tag on the switch or engine starting controls, the operator shall not close the switch or start the engine until the warning tag has been removed by an authorized person.
- 25.12.2.3.8. Before closing the switch or starting the engine, the operator will ensure all controls are in the “OFF” position and all personnel are in the clear.
- 25.12.2.3.9. If power fails during operation, the operator will:
- 25.12.2.3.9.1. If practical, land the suspended load under brake control.
  - 25.12.2.3.9.2. Set all brakes and locking devices.
  - 25.12.2.3.9.3. Move all clutch or other power controls to the “OFF” position.
- 25.12.2.3.10. Operators shall familiarize themselves with the equipment and its proper care. The operator shall conduct a daily or prior-to-use inspection before using the crane. If adjustments or repairs are necessary, or any damage is known, the operator will report them promptly to the supervisor. Use AF Form 1800, *Operator’s Inspection Guide and Trouble Report*, to record daily or prior-to-use inspections and to report damage or need for repairs.
- 25.12.2.3.11. All controls shall be tested by the operator at the start of a new shift. If any controls do not operate properly, *they shall be adjusted or repaired before the operation is continued.*
- 25.12.2.3.12. Booms being assembled or disassembled on the ground, with or without support of the boom harness, shall be securely blocked to prevent dropping the boom and boom sections.
- 25.12.2.3.13. Booms being manually telescoped shall be carefully repositioned prior to pinning to prevent injury to personnel.
- 25.12.2.3.14. When rotating the crane, sudden starts and stops shall be avoided. Rotational speed shall be such that the load can be controlled. A tag or restraint line shall be used when rotation of the load is hazardous.
- 25.12.2.3.15. When a crane is to be operated at a fixed radius, the boom hoist pawl or other positive locking device shall be engaged on rope-supported booms.

- 25.12.2.3.16. Ropes shall not be handled on a winch head without the knowledge of the operator. While a winch head is being used, the operator shall be within convenient reach of the power unit control level.
- 25.12.2.3.17. On cranes having a powered telescoping boom, the hook is drawn closer to the boom head when hoisting, extending the boom or lowering a boom on machines where the winch is mounted stationary to the rear of the boom hinge. If the machine is not equipped with a “two-blocking damage prevention feature,” the rope must be “let-out” from the load hoist mechanism so the hook will not be jammed (two-blocked) against the boom head. The jammed condition may cause overload and result in rope or other component failure.
- 25.12.2.3.18. Telescoping boom sections shall be telescoped in the manner and sequence specified by the manufacturer.
- 25.12.2.4. Handling the Load. Refer to **Chapter 35**, *Material Handling Equipment*.
- 25.12.2.4.1. No crane shall be loaded beyond its rated load. The weight of all loads shall be determined before lifting. Outriggers shall be set before lifting, telescoping the boom or turning a load within the ratings.
- 25.12.2.4.2. A load shall not be transported on a crane unless the crane is designed for that purpose. Normally, the load will be placed on a vehicle designed and rated to handle the particular load and transported to the new location, where it can be off-loaded and placed by the crane without movement of the vehicles.
- 25.12.2.4.3. When attaching the load, the hoist rope shall not be wrapped around the load. The load shall be attached to the hook by means of slings or other approved devices of proper capacity.
- 25.12.2.4.4. When moving the load, the supervisor directing the lift will ensure:
- 25.12.2.4.4.1. The crane is level and, where necessary, blocked properly.
  - 25.12.2.4.4.2. The load is well secured and properly balanced in the sling or lifting device before it is hoisted more than a few inches.
- 25.12.2.4.5. Before starting to hoist, the operator will ensure:
- 25.12.2.4.5.1. The hoist rope is not kinked.
  - 25.12.2.4.5.2. Multiple part lines are not twisted around each other.
  - 25.12.2.4.5.3. The hook is brought over the load in a way that prevents swinging.
  - 25.12.2.4.5.4. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves.
- 25.12.2.4.6. During hoisting the operator will take care that:
- 25.12.2.4.6.1. There is no sudden acceleration or deceleration of the moving load.
  - 25.12.2.4.6.2. Load and boom do not contact any obstructions.
- 25.12.2.4.7. Side loading of booms shall be limited to freely suspended loads. Cranes shall not be used for dragging loads sideways.

25.12.2.4.8. The crane shall not be operated while anyone is on the load or hook. **Warning:** Riding on the hook or load is absolutely forbidden.

25.12.2.4.9. The operator will not carry loads over personnel.

25.12.2.4.10. On truck-mounted cranes, loads shall not be lifted over the front area unless specifically allowed in the manufacturer's operating instructions.

25.12.2.4.11. The operator will test the brakes each time a load is handled by raising it a few inches and applying the brakes.

25.12.2.4.12. Outriggers shall be used when the load to be handled at that particular radius exceeds the rated load without outriggers, as given by the manufacturer for that crane or if the ground where the lift is to be made is soft or otherwise unstable. Where floats are used, they shall be securely attached to the outriggers. Blocking used to support outriggers shall be strong enough to prevent crushing, be free from defects and be of sufficient width and length to prevent shifting or toppling of the crane under load.

25.12.2.4.13. Neither the load nor the boom shall be lowered beyond the point where less than two full wraps of rope remain on their respective drums.

25.12.2.4.14. When two (2) or more cranes are used to lift one load, one designated person shall be responsible for the operation. They will analyze the operation and instruct all personnel involved about proper positioning, rigging of the load and the movements to be made.

25.12.2.4.15. While holding the load:

25.12.2.4.15.1. The operator will not leave the position at the controls when the load is suspended.

25.12.2.4.15.2. No person shall be permitted to stand or pass under a load on the hook.

25.12.2.4.15.3. If the load hoist mechanism is not equipped with an automatic brake and the load must remain suspended for a considerable length of time, the operator will hold the drum from rotating in the lowering direction.

25.12.2.5. Cranes in Transit. Before any crane (except for small truck cranes) is moved to a new job site, the route of travel shall be checked to determine that adequate clearances exist along the entire route and Base Operations shall be consulted to ensure appropriate NOTAMs are issued, if required; coordination shall be documented on AF Form 103, *Base Civil Engineering Work Clearance Request*. This survey shall be conducted by the vehicle heavy-equipment supervisor and crane operator. Normal routes for assigned cranes shall be designated on an installation map and shall be approved for clearances by the installation Ground Safety office. The empty hook shall be secured to prohibit swinging and the boom shall be lowered to the boom rest or travel position. A red cloth or warning flag (at least 12 inches square) or a warning light shall be carried at the end of any boom that extends more than 4 feet beyond the truck platform. At night, a warning light (color according to local and state traffic codes) shall be used. The superstructure shall be secured to prohibit rotation except when there is an operator in the cab to ensure proper boom clearances around tight spots and corners. Additional vehicles

shall be used to aid in warning other motorists if the crane boom or wide load poses a hazard to the front or rear.

25.12.2.5.1. A designated supervisor shall be responsible for safe movement before a crane travels with a load. Decisions such as position of load, boom location, ground support, designated travel route and speed of movement shall be made by the supervisor. Specified manufacturer's tire pressures shall be maintained. The boom shall be carried in line with the direction of motion, sudden starts and stops shall be avoided and tag or restraint lines shall be used to minimize the swinging of the load.

25.12.2.5.2. A crane shall never be moved with the boom so high that it may bounce back over the cab.

#### 25.12.2.6. Signals.

25.12.2.6.1. Unless voice communication equipment is used, standard hand signals to the operator shall be used, and can be found in **Figure 35.21**. The operator shall not respond to any signal, except an emergency stop unless it is clearly understood.

25.12.2.6.2. When moving the crane, the following audible signals shall be used:

25.12.2.6.2.1. STOP. One audible signal.

25.12.2.6.2.2. GO AHEAD. Two audible signals.

25.12.2.6.2.3. BACK-UP. Three audible signals.

25.12.2.6.3. If it is necessary to give instructions to the operator other than those provided herein, the crane motions shall be stopped.

#### 25.12.2.7. Operating Near Electric Power Lines.

25.12.2.7.1. Overhead power exterior lines shall always be considered energized unless checked and certified de-energized by the electrical supervisor. Clearances and certifications for this type of work shall be annotated on AF Form 103. Refer to AFI 32-1064, *Electrical Safe Practices*, and ETL 06-9, *Arc Flash Personal Protective Equipment (PPE) Requirements for High-Voltage Overhead Line Work at 69 kV (Nominal) or Less*, for additional guidance.

25.12.2.7.2. No part of a crane or its load shall be permitted to come within 10 feet of any energized electrical power line. When this is impractical, the electrical power line shall be de-energized and visibly grounded.

25.12.2.7.3. For lines rated over 50 kilovolts (kV), minimum clearance shall be 10 feet plus 0.4 inch for each kV over 50 kV. AF Form 103 shall be used and any additional clearance requirements, as identified and listed on the AF Form 103 by the exterior electric supervisor, but never less than 10 feet, shall be followed.

25.12.2.7.4. A permanent sign shall be posted in the cab of the equipment in full view of the operator. This sign will read: "*DANGER—HIGH VOLTAGE—Do Not Operate Within 10 Feet of Electric Power Lines.*"

25.12.2.7.5. A dielectric boom shield and insulated link installed in the lifting line at the hook will provide some protection against electric shock if the crane accidentally



comes in contact with energized electric lines. Proximity warning devices are not fail-safe and shall be used in addition to and not as a replacement for other controls. Even though shields, insulated hooks and proximity warning devices are used, the clearance criteria specified in paragraphs [25.12.2.7.2](#) and [25.12.2.7.3](#) shall be followed.

25.12.2.7.6. If the boom of a rubber-tired crane contacts an electric power line, the entire piece of equipment will be energized since the rubber tires insulate the crane from the ground. Operators shall not attempt to leave the crane until they are certain that either the line is clear of the crane or that the line is deenergized, because to do so could result in electrocution. If the fuel tank or vehicle ignites, and operators cannot remain on the crane, they should jump, ensuring all parts of their body clear the crane before their feet touch the ground.

25.12.2.8. Night Operations. Cranes operated during darkness shall have clearance lights installed. Working areas shall be illuminated so the signal person, loads, rigging, obstructions, etc., are readily visible.

25.12.2.9. Clearance and General Requirements of Lifting Devices. Except as otherwise stated herein, mobile cranes will maintain at least two (2) feet of clearance from all walls, overhead trestles, columns and other structures. In operations where motorized or pedestrian traffic is anticipated or encountered, the working area will be blocked off or controlled to keep people and vehicles away. Refer to [Chapter 35](#) for additional guidance for these requirements.

25.12.2.10. A carbon dioxide, dry chemical or equivalent fire extinguisher shall be kept in the cab.

25.12.3. Dump Trucks. Dump truck operators shall be trained IAW Air Force Qualification Training Package (AFQTP) 3E2X1-15 prior to operating any dump truck in the performance of his or her duties. Dump trucks shall not be operated with loads exceeding the manufacturer's rated capacity. Different materials have different specific weights (e.g., wet sand versus bark mulch) and, although the truck may have the volumetric capacity for the load, it may not have the weight capacity. Loads that pose a flying debris hazard shall be covered with a tarp or similar covering. Before dumping the vehicle's load, operators will always check overhead clearance both directly over the vehicle and ahead of it in the direction to be traveled while the body is still raised. Distances traveled with the bed raised shall be kept to a minimum. Workers shall not be permitted in the bed while it is being raised. The cab floor shall be kept clear of debris that could interfere with controls. The number of people carried in the cab will never exceed the number of seat belts installed.

25.12.4. Motor Graders. Operators shall follow manufacturer's instructions of the particular equipment in use. Although similar in design, the variations in capabilities and operating characteristics are numerous. Clearances around machines can vary as much as several feet depending on the position of the mold board and circle, tilt of wheels, etc., and the operator must know these limits. Graders are noisy and often operated in dusty conditions. Proper hearing, respiratory and eye protection shall be provided and used, when required. Consult with installation Ground Safety office and BE on questions pertaining to PPE. Refer to [Chapter 14](#) for additional guidance on PPE requirements.

25.12.5. Wheeled Loaders. As with motor graders, the variety of wheeled loaders available to Air Force personnel is extremely varied. Operators shall be familiar with the operating characteristics of each vehicle and its limits. Such things as control positioning, turning radius and capacity vary widely. Solid frame equipment and articulated units are extremely different in handling characteristics, especially when being transported over the road. When traveling empty at excessive speed, a loader will bounce, weave or road walk. Loaders are noisy, and are frequently operated in dusty conditions. Proper hearing, respiratory and eye protection shall be provided and used, when required. Consult with installation Ground Safety office and BE on questions pertaining to PPE. Refer to [Chapter 14](#) for additional guidance on PPE requirements.

25.12.6. Bulldozers and Tracked Loaders. This equipment is available in a range of sizes from very small to large with a wide variety of attachments, e.g., swing blades, ripper teeth, and combination buckets. Bulldozers and tracked loaders are relatively slow moving; few are suitable for driving on streets and all are noisy. Each operator shall be thoroughly familiar with the equipment before being allowed to operate it without supervision. Proper hearing, respiratory and eye protection shall be provided and used, when required. Consult with installation Ground Safety office and BE on questions pertaining to PPE. Refer to [Chapter 14](#) for additional guidance on PPE requirements.

25.12.7. Sweepers. As with other construction equipment there is a great variety of street, airfield and combination sweepers in the Air Force inventory. All, however, share some common traits in that they are noisy, can create great quantities of dust and have extremely poor rearward visibility. In vehicles equipped with air conditioning, dust is less of a factor. In vehicles without air conditioning, respiratory protection may be required. If not already evaluated, contact BE for an OEH risk assessment. Sweepers operating on the airfield shall be radio-equipped and will have the headset-type radio due to the high volume of noise from the rear engine and blower. When operating on active airfields, these vehicles shall be in direct contact with the control tower or escorted by a vehicle that is in contact with the control tower. Extreme caution shall be exercised when backing this equipment; the use of a spotter is mandatory. Hearing protection shall be worn when required. Refer to paragraph [2.3](#) for additional guidance.

25.12.8. Rollers. Self-propelled rollers are heavy equipment and are difficult to stop once put into motion. The operator shall be intimately familiar with the equipment, especially the turning arc and stopping distances. When it is necessary to transport a roller over the road under its own power, its slow speed can present a hazard to other vehicle operators. Supervisors will attempt to make all such movements during non-peak traffic periods. Since few rollers are equipped with lights, movement during periods of reduced visibility shall be avoided unless escort vehicles are provided front and rear.

25.12.9. Concrete Saw. Personnel will stay clear of the front and blade operating side of the saw during operation. Cutter blades will be in good condition and not excessively worn, warped or broken. A good water supply shall be maintained to cool the cutting blade. Safety-toe shoes, goggles and hearing protection shall be worn during operation. Refer to paragraph [2.3](#) and contact BE for an OEH risk assessment.

25.12.10. Pavement Breaker (Jackhammer). The tool shall always be worked away from the body. Proper lifting techniques shall be used and personnel cautioned not to twist the upper body while moving the tool. Sound footing shall be used and a firm grasp shall be kept on the tool at all times. The operator and personnel in the hazard zone of the operating site will wear appropriate safety-toe shoes, goggles and hearing protection; the operator will wear gloves. A respirator may be required when operations create dust. If process has not already been evaluated, contact BE for an OEH risk assessment.

25.12.11. Router. Workers will keep their hands and feet clear of the cutting tool and maintain a firm grasp on the handle during operation. Safety shoes, goggles, hearing protection and gloves shall be worn during operation. All personnel exposed to hazards of the equipment will wear appropriate PPE. Consult with installation Ground Safety office and BE on questions pertaining to PPE. Refer to **Chapter 14** for additional guidance on PPE requirements.

25.12.12. Concrete Mixer. Workers will keep their hands and arms clear of moving parts of the mixer. The mixer shall be supported in a stable position before operation. The hopper shall not be overloaded since this could cause equipment damage as well as injury to employees. Safety-toe shoes, goggles and hearing protection shall be worn when operating or working near the equipment, when required, and a respirator used if heavy concentrations of airborne cement dust are created during operation. Consult with the installation Ground Safety office and BE on questions pertaining to PPE. Refer to **Chapter 14** for additional guidance on PPE requirements.

25.12.13. Concrete Spall Repairs Using Polymer. Polymers are used extensively on airfields because of their quick setting properties. Most are composed of two (2) separate components and are hazardous to mix and place. Manufacturer's recommendations shall be followed for safe handling.

25.12.14. Joint Seal Kettle-Melter.

25.12.14.1. Kettles shall not be operated without installation FES Flight approval. A permit shall be obtained at least two (2) working days prior to the placement of the tar kettle.

25.12.14.2. Serious burns can result from improper operation. Clothing that is loose fitting shall be worn. Pants will completely cover the legs to below the tops of shoes. Shirts shall be long sleeved. Loose-fitting gloves shall be worn.

25.12.14.3. Safety-toe shoes and a face shield shall be worn. The operator and personnel handling the heated kettle product will wear face shields and gloves. All tripping hazards shall be removed from the vicinity of the worksite.

25.12.14.4. Containers shall not be overfilled and shall be allowed sufficient room for the bitumen (tar) to slosh without spilling when the container is moved.

25.12.14.5. Appropriate number and type of fire extinguishers shall be kept near the kettle.

25.12.14.6. When adding bituminous or joint sealant materials to the kettle, the product shall be eased into the kettle to prevent splashing of heated materials on the operator. The

kettle shall be watched closely and the products not heated above the safe heating temperature specified by the product manufacturer.

25.12.14.7. Workers will never use direct heating of the materials. No open flame or source of ignition shall be permitted near an asphalt material that is heated to a temperature near its flash point. Wherever heating kettles are in use, the temperature of the product shall be controlled by thermostatic devices or checked at frequent intervals with an accurate thermometer to prevent overheating. **Warning:** Gasoline or other highly volatile solvents shall never be used for cleaning.

25.12.15. Pavement Grinders (Line Eradicator or Paint Scraper). Workers will keep their hands and feet clear of the cutting wheels. The operator and personnel within the immediate work area will wear safety-toe shoes, goggles and hearing protection.

25.12.16. Tampers. Workers will keep their hands and feet clear of the tamping tool. A firm footing shall be maintained while using this equipment. Safety-toe shoes and hearing protection are required when operating tampers.

25.12.17. Pneumatic Drill. Safety-toe shoes, goggles and hearing protection shall be worn during operation. A firm grasp will be maintained on the tool. It shall be kept aligned with the hole to prevent binding. The tool shall not be forced.

### 25.13. Carpentry and Structural Maintenance.

25.13.1. Potential physical and health hazards can be effectively controlled by following proper work procedures and controls, and by using required PPE. **Figure 25.1** contains additional PPE guidance and information.) Prior to commencement of work, ensure personnel are not exposed to asbestos or lead-based paint. Contact installation Environmental Management office and BE for asbestos and lead verification. If lead or asbestos is found, contact BE for an OEH risk assessment.

#### 25.13.2. General Carpentry.

25.13.2.1. Workers shall not leave a woodworking machine running unattended nor attempt to clear, clean, or repair the machine while it is operating. When maintenance is necessary, the machine shall be completely shut down and its control switches locked and tagged in the "OFF" position according to instructions in **Chapter 21, Hazardous Energy Control (Lockout and Tagout)**. Supervisors shall ensure periodic inspections are accomplished on all shop equipment. Chips or dust shall never be removed from machinery by hand. Machine guards shall not be removed nor made inoperative except for authorized maintenance. When guards are removed during machine repair, power control switches shall be locked in the "OFF" position and properly tagged. The machine will remain locked until the guards are replaced.

25.13.2.2. PPE worn while operating machinery, equipment and saws normally consists of eye protection, safety-toe boots and hearing protection. Other safety-related PPE include respirators and kneepads to protect the knees where workers must kneel while working. Refer to paragraph **2.3** and **Chapter 14, Personal Protective Equipment (PPE)** for additional guidance. Hard hats are required in lumber storage areas and on job sites

where the potential exists for being struck by falling objects, e.g., roofing and construction materials.

25.13.2.3. See general guidance that applies to both carpentry and structural maintenance work methods or tools. The following specific guidance applies to table saws:

25.13.2.3.1. Keep hands out of the line of cut when feeding table saws. Use a push stick when close to the blade.

25.13.2.3.2. Adjust saw to expose the least amount of saw blade above table and material being cut.

25.13.2.3.3. Always stand out of line of stock being ripped.

25.13.2.3.4. Hold stock being cut against a gauge when cutting with a circular table saw.

25.13.2.3.5. Always use the appropriate saw for the cut. For instance, it would be unsafe to rip with a crosscut saw or to crosscut with a rip saw.

25.13.2.3.6. Avoid crosscutting long boards on a table saw. Normally, long stock may be crosscut on a radial arm saw.

25.13.2.3.7. Never adjust the saw or fence gauge while the saw is operating. Designate the line of cut on the table top with a permanent mark when setting the gauge of a table saw without removing the guards.

25.13.2.3.8. Always use a brush or stick to clean or scrape sawdust from a saw.

### 25.13.3. Ventilation Systems.

25.13.3.1. Ventilation. Only essential safety, fire prevention and occupational health requirements are addressed in this standard. Contact BE for specific guidance, including information on flow rate requirements. Ventilation and exhaust systems shall be installed and maintained IAW the manufacturer's instructions.

25.13.3.2. Application. Machines that develop fine dust or other airborne contaminants shall be equipped with effective industrial exhaust ventilation. In shops where small numbers of installed machines are not continuously in operation, portable collection systems may be used. Hoods and exhaust systems shall be constructed and installed to meet requirements in ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. Refer to **Chapter 18, Machinery**, for additional guidance.

25.13.3.3. Exhaust Ducts and Pipes. These shall be constructed and sized to minimize clogging and shall discharge into an enclosed container.

25.13.3.4. Refuse. Refuse shall be removed daily in all operations not required to have an exhaust system or where the refuse cannot be handled by an exhaust system.

### 25.13.4. Storage and Handling of Lumber.

25.13.4.1. Storage areas for lumber and other building materials can be hazardous. For example, when lumber is stored upright, precautions shall be taken to prevent it from falling into aisles or passageways. Lumber stored in tiers shall be stacked, blocked and

interlocked. The stacks shall be limited in height so they are stable and secure against sliding or collapse. Storage areas shall be kept free of accumulations of materials that constitute tripping, fire or explosion hazards. Smoking shall not be permitted in outside or inside storage areas, and signs to this effect shall be posted. Refer to AFJMAN 23-210, *Joint Service Manual (JSM) for Storage and Material Handling*, for specific storage requirements.

25.13.4.2. When heavy stock cannot be safely handled by workers, suitable mechanical lifting devices shall be used.

25.13.4.3. Gloves shall be worn to reduce injury potential to the hands from splinters or from being pinched between stacks. Accidental movement of stacked material can cause serious injuries. Caution shall be taken not to disturb other tiers when removing partial stacks.

25.13.4.4. Manual handling is relatively safe if proper lifting and carrying positions are used. Balanced handling is the key to safe handling. However, disregard of accepted safe practices can result in injuries such as hernias, back strains, crushed hands and feet, broken bones and severe lacerations.

#### 25.13.5. Roofing Operations.

25.13.5.1. Roof work, because of its nature and the environment, has a high mishap potential. Pre-planning, refresher worker training, pre-job briefings and following required safeguards can prevent mishaps. Prior to commencement of work, ensure personnel are not exposed to asbestos. Contact the installation Environmental Management office and BE for asbestos verification. If asbestos is found, contact BE for an OEH risk assessment.

25.13.5.2. Roofing materials shall be segregated by type and size in stable stacks that are safe from falling.

25.13.5.3. Ladder requirements are included in **Chapter 7**. Chicken ladders or crawling boards shall have cleats spaced at equal intervals not to exceed 24 inches.

25.13.5.4. Workers engaged in roofing activities on low-slope roofs (a roof having a slope less than or equal to 4 in 12 [vertical to horizontal]), with unprotected sides and edges 4 feet or more above lower levels shall be protected from falling by guardrail systems, safety net systems, PFAS or a combination of warning line system and guardrail system, warning line system and safety net system, warning line system and PFAS, or warning line system and safety monitoring system. Scaffolding and fall protection systems shall be inspected daily and/or prior to use by the supervisor. Inspections shall be documented, signed by the supervisor and maintained on the job site at all times. On roofs 50 feet or less in width, the use of a safety monitoring system alone (i.e. without the warning line system) is permitted. Workers on a steep roof with unprotected sides and edges four feet or more above lower levels shall be protected from falling by guardrail systems with toe boards, safety net systems or PFAS. Proper PPE is identified in **Chapter 14** and **Figure 25.1** Additional guidance on fall protection may be found in **Chapter 13** and 29 CFR 1926.501.

25.13.5.5. Additional guidance on scaffolding is included in **Chapter 17, Scaffolding**. Refer to ANSI A10.8, *Safety Requirements for Scaffolding*, 29 CFR 1926.451, *Scaffolds, General Requirements*, and 29 CFR 1926.500, *Fall Protection Scope, Application and Definition Applicable*, for additional guidance.

25.13.5.6. To avoid splashing, asphalt and drip-dried material pieces shall be slipped rather than pitched into kettles containing melted bitumen.

25.13.5.7. Workers shall not stand or work below any hoisted materials or hot substances.

25.13.5.8. All housekeeping standards shall be followed to prevent injuries to workers and others who may pass near the roofing work site. Unsupervised open-flame devices, improper storage, and improper disposal of waste materials may cause a fire. Contact the installation Environmental Management office for proper disposal guidelines.

25.13.5.9. PPE will consist of eye and face protection, foot and leg protection, proper clothing and gloves, and hard hats for working with hot or cold application roofing maintenance or where overhead work is being performed. If process not already evaluated, contact BE for an OEH risk assessment. Refer to **Chapter 14** and **Figure 25.1** for additional PPE information and paragraph **2.3** for additional information on respiratory protection.

25.13.5.10. Tar kettles and pots, when used, shall be located so they shall not be a fire threat to surrounding buildings or other structures. When in operation, tar kettles and pots shall not be left unattended for extended periods of time, due to the possibility of fire. After use of the kettle, heavy tar buildup shall be cleaned from plumbing pipes. Refer to paragraph **25.12.14.1** for permit requirements. Additional information can be found in NFPA 241, *Standard for Safeguarding Construction, Alteration and Demolition Operations*.

#### 25.13.6. Masonry.

25.13.6.1. Mixing Concrete and Mortar. Mixing concrete and mortar, whether performed manually or by motorized mixers, is a very strenuous and often hazardous operation. During the operation, masonry shop workers will come in contact with Portland Cement. Workers will use every means possible to prevent inhalation, ingestion, or body contact with cement dust. Portland Cement will cause chemical burns and rashes when it comes in contact with parts of the body. Portland Cement can seep inside worker's shoes. Generally, once detected, feet and toes have already suffered permanent damage, and the worker may require hospitalization. Protective clothing and boots shall be worn when mixing concrete and mortar. If process not already evaluated, contact BE for an OEH risk assessment. Shop supervisors shall train new employees in the proper techniques for mixing and handling concrete and mortar. Refer to paragraph **2.3** for additional guidance on respiratory protection.

25.13.6.2. Brick and Concrete Block Work. Brick and concrete block operations include carrying brick, concrete or cinder block and mortar on the job site as well as putting them in place. Shop supervisors will ensure proper lifting and carrying techniques are used. They will also ensure workers raise or lower needed tools and materials by handlines after reaching the work position. No tools or materials will be carried at no time while

ascending or descending ladders. Tools and materials may be transported by scaffold as long as load capacity is not violated. Refer to **Chapter 4**, *Manual Material Handling and Lifting Techniques*, for additional guidance.

25.13.6.3. Cleaning and Etching Old and New Brick and Concrete Work. As a part of brick and concrete work, masonry workers may be required to clean or etch old and new work. Some agents used in this operation contain tri-sodium phosphate (TSP), muriatic acid and potassium or sodium hydroxide. TSP shall not come into contact with aluminum as hydrogen gas may form and cause an explosive hazard. Shop personnel shall be aware of the hazards associated with this work. Workers, when diluting muriatic acid, will never add water to the acid; they will always add the acid to water. Proper PPE shall be worn. Refer to **Figure 25.1** for additional guidance.

25.13.6.4. Fiberglass Work. When repairing fiberglass components such as tanks, bathtubs, shower stalls and lavatories, workers may be exposed to fiberglass filler, epoxies, resins, accelerating agents and ketones or acetone. Workers shall be aware of fire hazards associated with mixing epoxies and resins with accelerating agents and ketones. Workers shall be aware that ketone mixers are highly toxic and narcotic and could result in dizziness and nausea if inhaled. The supervisor will consult with BE to ensure worker exposure is monitored and appropriate respiratory protection requirements are established. Refer to **Chapter 33**, *Composite Materials*, for additional guidance.

25.13.6.5. Storage and Handling of Sand, Grout, and Cement. Sand and aggregate materials are often delivered in bulk form for shop use. Sand shall be covered to prevent it becoming wet during inclement weather. Also, grout and cement shall be kept in a dry place to prevent hardening. Workers shall wear the proper respiratory protection (as required), eye protection, clothing, and shoes when handling cement and grout compounds.

25.13.6.6. Care and Use of Power Mixers and Trowels. Cement mixers are operated with electric or gasoline motors or engines and are chain or belt driven. Gears, pulleys, chains or belts on power mixers shall be guarded to prevent workers being caught in them. The power source for electrically operated mixers shall be grounded. Power cords shall not be allowed to fray or break, exposing bare wires. The area surrounding electrically operated mixers shall be kept as dry as possible to prevent electrocution of the operator if an electrical malfunction occurs. Workers will not smoke during refueling operations on those mixers operated by gasoline engines. Hot engines shall not be refueled until they cool. All mixers shall be thoroughly cleaned after each use. Powered trowels or screens used to compact and smooth concrete shall be cleaned after each use and inspected for damage and serviceability prior to each use.

25.13.6.7. Preparation of Footings. Precautions that shall be taken by workers prior to pouring footings include:

25.13.6.7.1. Identifying the location of underground utilities such as gas, electric or water.

25.13.6.7.2. Study pre-excavation conditions such as soil conditions and hydrostatic pressure to evaluate changes that might occur or situations that might develop.



Generally, masonry shop workers will not arrive at the job-site to pour footings until all preparations have been made. They shall be made aware of existing hazards prior to pouring footings.

#### **25.14. Protective Coating Maintenance.**

25.14.1. General Requirements. Interior spray, airless and electrostatic painting facilities and requirements are addressed in **Chapter 28**, *Interior Spray Finishing*. General safety requirements of paragraph **25.1** address ladders, scaffolds, lifelines, housekeeping and fire prevention that apply to painting operations. Refer to **Figure 25.1** and **Chapter 14** for additional PPE information. Ventilated lockers for clothing and shower facilities located separately from the shop shall be provided.

#### 25.14.2. Occupational Health and Toxic Materials.

25.14.2.1. Pigments, Extenders and Fillers. The dry constituents of paints such as pigments, extenders, and fillers shall be handled carefully in receiving and storage areas as well as in product formulations to prevent overexposure of workers to airborne dusts. Spills shall be promptly cleaned up before the material is spread throughout the area. If during the addition of the pigments or extenders workers could be overexposed to toxic dusts, controls shall be instituted. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph **2.3** for additional guidance on respiratory protection. All inorganic pigment should be considered as potentially toxic. These hazards may exist in application of new paint, and in removal of old paint.

25.14.2.1.1. Special care shall be given to avoid overexposure of workers when pigments containing lead and metallic chromates (corrosion inhibitors), cadmium, copper or cobalt are used. Contact installation Environmental Management office for environmental concerns. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph **2.3** for additional guidance on respiratory protection.

25.14.2.1.2. Arsenic and mercury compounds used in anti-fouling marine paints shall be handled carefully. Employees may inhale these materials, and if good personal hygiene is not observed, employees may ingest significant amounts through contact of dirty hands with food or cigarettes.

25.14.2.1.3. Extenders or fillers such as silica, asbestos, talc or mica, when breathed in excessive amounts, will cause fibrosis in the lungs. Symptoms from overexposure to silica may not appear for 10 or more years depending on exposure levels and duration.

25.14.2.1.4. Asbestos extenders or fillers shall not be used.

25.14.2.1.5. Fillers containing talc or mica, although not as hazardous as free silica or asbestos, can also lead to lung damage. Employee exposure shall be controlled.

25.14.2.1.6. A pigment such as titanium dioxide or a filler such as gypsum is considered a “nuisance” dust. Dust levels must be controlled to ensure good visibility, prevent eye irritation and prevent lung deposits.

25.14.2.2. Organic Solvents. Organic solvents are widely used in painting. Solvents are used to suspend pigments, dissolve film-forming oil materials and as thinners to dilute paints and reduce paint viscosity. All organic solvents have some effect on the central

nervous system and the skin. The principal modes of exposure are inhalation of vapors and skin contact. Some solvents can be absorbed through the intact skin and migrate to the bloodstream. Excessive solvent vapor inhalation may cause impairments that have no discernible permanent effects on health, such as lack of coordination and drowsiness, but which may increase the risk of accidents. In other cases, exposure may result in serious damage to the blood, lungs, liver, kidneys and gastrointestinal tract. Supervisors will acquaint themselves and their employees with the properties and hazards of the solvents they use. Skin contact with solvents may cause dermatitis, ranging in severity from a simple irritation to actual damage to the skin. Even the most inert solvents can dissolve the skin's natural protective barriers of fats and oils, leaving the skin unprotected. When these natural lubricants are removed, the skin becomes subject to disabling and possibly disfiguring dermatitis and infection.

25.14.2.3. Measures to control exposures to solvents include substitution of a less toxic solvent, mechanical exhaust ventilation and use of protective clothing. Substitution of a less toxic or less volatile solvent is effective in controlling solvent exposure and reducing the hazard potential. However, this control method is more easily instituted when the actual function of the solvent is less specific than it is in paint formulating, such as in metal cleaning or degreasing operations. Substitution of a material or product should be accomplished when the replacement material or product would significantly reduce or eliminate risk to worker health and safety. The use of closed systems and local exhaust ventilation is an effective way of preventing solvent vapors from entering the workers' breathing zone. Containers of flammable solvents shall be covered when not in use. Local exhaust ventilation can remove vapors at their point of origin and thus prevent toxic concentrations in the workplace. If good personal hygiene is not observed, workers may ingest significant amounts of toxins through contact of dirty hands with food or cigarettes. The skin should always be protected from contact with solvents. Gloves, face shields, goggles and other protective clothing may be used. Do not wash skin with any raw organic solvent. Although some solvents are less toxic than others, good safety practices dictate that care be exercised when using any organic solvents.

## **25.15. Plumbing Maintenance.**

25.15.1. Plumbing maintenance normally includes the installation, preventive maintenance and repair of water supply systems, sewage and water disposal systems, natural, liquefied petroleum gas (LPG) or other gas supply systems (to include gas appliances) and oxygen supply systems. Hazards encountered during plumbing maintenance include, but are not limited to, entry into an oxygen-deficient atmosphere (enclosed area or confined space), fire or explosion by introducing an ignition or flame source into a hazardous environment, falls, cave-in of excavated area, burns from heat-producing equipment, strains and sprains of the back or other muscle group, cuts and bruises. Working in confined spaces, handling heavy and awkward materials, being subjected to numerous obstructions in limited working space and health related hazards are conducive to mishaps. Plumbing maintenance workers shall be knowledgeable of these hazards and conditions and take reasonable actions to prevent mishaps before they occur. Refer to [Chapter 23, \*Confined Spaces\*](#), for confined space entry procedures and requirements.

25.15.2. Personal Protective Equipment (PPE). Ventilated clothing lockers, shower facilities separate from the shop and clean towels shall be provided. Refer to **Figure 25.1** and **Chapter 14** for additional PPE guidance.

25.15.3. General Safety, Fire Prevention and Occupational Health Requirements. Requirements that apply to plumbing maintenance are in paragraph **25.1**. Other sources of guidance may be found in AFI 32-1066, *Backflow Prevention Program*, and ANSI B208.1, *Portable Pipe Threading Machines and Portable Power Drives*.

25.15.4. Hot Operations.

25.15.4.1. Torches and Furnaces. Work and storage areas for this equipment shall be well ventilated. Refer to **Chapter 27**, *Welding, Cutting, and Brazing*, **Chapter 36**, *Hydrocarbon Fuels*, NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, and **Chapter 22**, *Flammables and Combustibles*, for additional information.

25.15.4.1.1. No one shall be permitted to use a torch or furnace until trained on its use and familiar with the operating instructions.

25.15.4.1.2. Where flammable or explosive vapors or dust may be present, torches and furnaces shall not be used until the atmosphere has been tested and the sources of such vapors or dust removed.

25.15.4.1.3. Gasoline blowtorches and furnaces shall not be used in small, unventilated spaces since they could cause explosions or create an oxygen deficient atmosphere. Acetylene gas shall never be brought in contact with metal powders such as copper or silver as the combination may react with explosive atmospheres.

25.15.4.1.4. Heating pots shall be placed on non-combustible surfaces and heated slowly to prevent overflow or ignition of material in them. Material shall be broken into small pieces before being placed into heat pots.

25.15.4.1.5. Combustible materials in locations where torches or furnaces are used shall be protected or kept far enough away to prevent being subjected to sparks or dangerous temperatures. Appropriate type fire extinguishers shall be available. Refer to **Chapter 27**, *Welding, Cutting and Brazing*, for additional requirements and necessary permit(s).

25.15.4.2. Soldering and Brazing. Soldering and brazing is the joining of metal parts by melting a fusible alloy. When solders used have a melting point above 800° F, the procedure is called brazing.

25.15.4.2.1. Improper equipment or unsafe practices may cause lead poisoning, irritation from fluxes, burns, electric shock or fires.

25.15.4.2.2. The concentration of toxic fumes and irritants at the breathing level of the operation shall be checked. Where required because of toxic fumes, a respirator or adequate ventilation shall be provided. Lead-tin, zinc, silver, cadmium and antimony-tin solders can pose moderate to serious health hazards. If welding, soldering and brazing operations have not been evaluated, contact BE for an OEH risk assessment. Refer to paragraph **2.3** for additional guidance.

- 25.15.4.2.3. Electric soldering irons shall be grounded unless of double-insulation construction. All soldering irons shall be placed in suitable non-combustible receptacles when not in use.
- 25.15.4.2.4. When required, an **AF Form 592**, *USAF Hot Work Permit*, shall be obtained for these operations. Refer to **Chapter 27**, *Welding, Cutting and Brazing*, **Figure 27.1** and **Table 27.2** for additional information.
- 25.15.4.2.5. Appropriate safety eyewear shall be worn during all soldering and brazing operations.
- 25.15.5. Industrial Waste Drains. Entry into industrial waste manholes require the same precautions as other manholes. Applicable PPE and special consideration shall be given to the specific material carried by the system. The installation Ground Safety office shall be contacted for guidance concerning PPE and specific hazards. Refer to paragraph **2.3** for an OEH risk assessment and **Chapter 23** for confined space entry procedures and requirements.
- 25.15.6. Storm Drains. Hazards associated with storm drains include:
- 25.15.6.1. Manhole Covers. Manhole covers are heavy and closely fitted to the manhole opening. Never attempt to lift a cover without using proper pry bar tools, special lifting tools and additional help where needed. Ensure fingers and toes do not remain under manhole covers when putting them down.
- 25.15.6.2. Hazards. Insects, animals and snakes may nest or den in storm drains. Hazards encountered include:
- 25.15.6.2.1. Stings from wasps, spiders, scorpions and ants that could cause pain, swelling and lead to toxic shock.
- 25.15.6.2.2. Bites from animals that could lead to rabies.
- 25.15.6.2.3. Bites from poisonous snakes that could be fatal or cause gangrene.
- 25.15.6.3. Requirements. Prior to working in storm drains, inspect and clear the drains of dangerous insects, animals or snakes and glass, wire and other hazardous trash. Wear proper protective clothing, hard hats, boots and gloves while working in storm drains.
- 25.15.7. Gas Systems. Maintenance of gas systems includes natural gas, LPG, oxygen, nitrogen or nitrous oxide. Shop personnel shall be familiar with the properties of gases in the systems they maintain. Until proven otherwise, all escaping gases shall be considered flammable. Prior to entering an area where a gas leak is suspected, the area shall be properly vented and purged of existing gas. Personnel entering the area shall be suited with proper protective equipment and respiratory protective devices. Consult with installation Ground Safety office and BE with questions pertaining to PPE. Refer to **Chapter 14** for additional guidance. For oxygen-deficient atmospheres, supplied air systems with a special emergency escape air supply are required and shall be used. Tools used to repair leaks in or perform maintenance on gas lines shall be spark-free and protective clothing shall be static-free. When working on oxygen dispensing lines, workers will not use tools and equipment coated with flammable or combustible lubricating substances or grease.
- 25.15.8. Tunnels, Pits and Sumps.

25.15.8.1. Where shop personnel are required to work in utility tunnels, pits and sumps, the atmospheric conditions shall be checked for explosive atmosphere or oxygen deficiency before allowing workers to enter. Personnel shall be suited with proper protective equipment and respiratory protective devices, when required, while performing maintenance to underground utilities. Consult with the installation Ground Safety office and BE on questions pertaining to PPE. Refer to paragraph 2.3 for an OEH risk assessment and Chapter 14 for additional guidance on PPE. All tunnels, pits or sumps known to be contaminated shall be tagged or otherwise identified for work crews. Workers shall be assigned in pairs for work on underground utilities. All known contaminated tunnels, pits and sumps shall be ventilated while work is in progress. Smoking or open flames shall never be permitted in or around known or suspected contaminated tunnels, pits or sumps. Spaces determined to be permit required confined spaces shall be entered under all provisions addressed IAW Chapter 23.

25.15.8.2. When manhole covers are removed, barriers shall be installed to prevent injury to personnel not associated with the work in progress.

25.15.8.3. When a non-permit required confined space manhole or vault is open, at least one member of the crew shall be stationed at the surface as the observer. This person will remain at the post and not leave for any reason, except self-preservation, unless replaced by an equally qualified individual. The observer will order the entrants to exit the space if the observer must leave and there is no replacement. The observer will not enter the confined space to attempt rescue without proper training and access to necessary equipment and personnel. Additionally, where removal of a victim would be difficult, an approved lifeline equipped with a wrist harness shall be worn by the person entering the area to facilitate rapid removal if necessary. **Note:** Under no circumstances will a person enter a subsurface structure for any reason without a second person to act as an observer and to obtain assistance in the event of an emergency. Refer to Chapter 23 for additional guidance on work in confined spaces

## **25.16. Refrigeration and Air Conditioning Maintenance.**

25.16.1. Refrigeration and air conditioning maintenance personnel must be aware of the hazards of tasks they perform and the tasks performed around them. Potential hazards include hazardous noise, electrical hazards, exposure to refrigerants (possible asphyxiation if in enclosed areas or confined spaces), frostbite, lifting hazards, and compressed gases and cylinders. Potential physical and health hazards can be effectively controlled by following the proper work procedures and controls and using required PPE. Figure 25.1 contains additional guidance regarding PPE.

### **25.16.2. General Requirements.**

25.16.2.1. Equipment rooms (e.g., where air conditioning equipment is installed) shall be kept free and clear of all trash and clutter that could present tripping or fire hazards. Provide guards or shields for refrigerant hot or cold gas piping or moving parts to prevent injury to workers who may accidentally come in contact with it. Equipment rooms shall not be used for storage of materials.

25.16.2.2. All belts, pulleys and rotating shafts shall be guarded to prevent accidental contact. Large valve handle stems which can present a bump or trip hazard shall be marked (color coded) for easy recognition.

25.16.2.3. Electrical parts of the equipment and controls will have all covers and plates in place. Wiring shall be properly secured to the equipment or structure. Exposed metal surfaces shall be grounded IAW NFPA 70, Article 250.

25.16.3. Storage and Handling. Improper storage and handling of compressed gas cylinders can injure workers.

25.16.3.1. Cylinders shall be legibly marked with the type of gas contained and stored with minimum intermingling of types of refrigerant and shall be stored separately from flammable gases and oxygen.

25.16.3.2. Where caps are provided for valve protection, they shall be kept in place at all times until the cylinder is actually in use. Valves shall be kept closed at all times except when the cylinder is in use.

25.16.3.3. Cylinders shall not be used as rollers or supports. Their only use is to contain the gas.

25.16.3.4. Non-refillable containers, such as Department of Transportation (DOT) 2P, DOT 2Q, and DOT-39 containers, shall not be refilled with any material after use of the original contents. Containers shall be disposed of according to the manufacturer's or filler's instructions, or by the directions provided from the installation Environmental Management office.

25.16.3.5. Cylinders shall not be dragged, slid, dropped, or allowed to strike each other or solid objects violently. Whenever possible, a suitable hand truck or roll platform shall be used.

25.16.3.6. Cylinders shall never be lifted by the valve. Cylinders shall not be suspended by chains, ropes or slings unless the manufacturer has provided appropriate attachment points.

25.16.3.7. Storage areas shall be legibly marked with the names of gases being stored. Full cylinders and empty cylinders shall be segregated and full ones arranged so the oldest stock can be removed first with a minimum of handling. The storage area shall be kept as dry as possible and away from exposure to salt or other corrosive chemicals or materials. Cylinders shall be secured by a metal securing device or rack specifically designed to prevent damage.

25.16.3.8. The rules above apply to all refrigeration and air conditioning maintenance work centers that use and store compressed gases.

25.16.4. Fluorocarbons. Fluorocarbons are relatively inert, in general nonflammable (in all concentrations in air under ordinary conditions) and low in toxicity. Shipped as liquefied compressed gases under their own vapor pressures, they are colorless as liquids and freeze to white solids. Fluorocarbons are odorless in concentrations of less than 20 percent by volume in air but some have a faint and ethereal odor in higher concentrations. Fluorocarbons are unusually stable for organic compounds. Resistance to thermal decomposition, in general, is

high but varies with each product. When decomposition occurs, toxic products are very irritating and usually give adequate warning of their presence in very low concentrations in air. Hot work shall never be performed on charged systems.

25.16.4.1. Large Liquid Leaks. Large liquid leaks in fluorocarbon systems may be detected visually. As the material escapes, moisture in the air surrounding the leak condenses and freezes around the leak. The frost thus formed is readily apparent. Smaller leaks may be located with the use of:

25.16.4.1.1. A solution of liquid detergent in water applied directly to the area being tested. The formation of bubbles indicates a leak.

25.16.4.1.2. Electronic leak detectors are capable of sensitivities far greater than the other methods often in terms of fractions of an ounce of fluorocarbon per year. When the probe of the instrument is placed near a leak, positive identification of the leak is indicated by a flashing light, meter deflection or by audible means. Fluorocarbon vapors are all much heavier than air and tend to collect in low areas, thus possibly displacing available air. The vapors undergo decomposition when drawn through a flame or on contact with very hot surfaces. Decomposition products include hydrogen fluoride and hydrogen chloride and, perhaps, small quantities of carbonyl compounds such as phosgene. The halogen acids are both toxic and intensely irritating to the nose and throat with the irritating action readily noticeable before hazardous levels are reached. If such a situation develops, the affected areas should be vacated, the heat source and leak eliminated, and the area well ventilated before resuming work.

25.16.4.2. First Aid.

25.16.4.2.1. Due to their low boiling points, fluorocarbons evaporate very quickly at ambient temperature, minimizing dermal, eye and ingestion toxicity. However, liquid fluorocarbons in contact with the skin can cause severe freezing or frostbite because of their low temperatures. First aid procedures for freezing or frostbite injuries involve removing the victim from exposure immediately and implementing appropriate emergency procedures listed on the MSDS. Transport victim to the nearest emergency room, taking care to treat the frozen body part very gently:

25.16.4.2.1.1. Do not rub the frozen part.

25.16.4.2.1.2. Do not allow the patient to have alcohol or tobacco.

25.16.4.2.1.3. Do not apply ice or snow.

25.16.4.2.1.4. Do not attempt to thaw the frostbitten part in cold water.

25.16.4.2.1.5. Do not attempt to thaw the frostbitten part with high temperatures such as those generated by stoves, exhaust, etc.

25.16.4.2.1.6. Avoid additional exposure to cold and do not break blisters which may form.

25.16.4.2.2. The critical mode of entry of fluorocarbons into the body is by inhalation. These products generally show inhalation effects similar to anesthetics, causing central nervous system (CNS) depression and a decrease in activity, with an initial feeling of intoxication and euphoria (psychological effects). Under conditions

of progressively greater exposure, loss of coordination, loss of consciousness and eventually death occur. Accidental exposures to concentrations higher than the PEL shall be treated by prompt removal to fresh air.

### **25.17. Heating Systems and Central Heating Plant Maintenance.**

25.17.1. Written operating procedures and detailed checklists for operator guidance shall be posted in all equipment rooms with boilers. All functions shall be included, whether manual or automatic. The basic objectives of safe boiler operations are:

25.17.1.1. Require the minimum number of manual operations.

25.17.1.2. Standardize routine operating procedures for normal start-up and on-line operation. Ensure use of interlocks to minimize improper operating sequences and to stop sequences when conditions are not correct. Establish and enforce purge procedures with necessary interlocks.

25.17.1.3. Open register light-off and purge rate procedures are the only approved start-up methods. These procedures improve the margin of operational safety, particularly during start-up, by decreasing the number of required equipment manipulations, thereby minimizing the probability of operational errors or equipment malfunction. It provides a means for establishing the desired fuel-rich condition at individual burners during light-off.

25.17.1.3.1. All or most of the burner air registers are placed in a predetermined open position.

25.17.1.3.2. The furnace and boiler settings are purged with the burner air registers in the open position. The total air flow for purge shall not be less than 25 percent of full load volumetric air flow.

### **25.17.2. Boiler Safety.**

25.17.2.1. Water Level. Water in boilers shall be checked and kept at proper levels. Water columns shall be monitored to ensure connections are clear and water returns to the proper level in the gauge glass when drain valves are closed. When water is not visible in the gauge glass, all stresses on the boiler shall be gradually reduced and the following actions taken:

25.17.2.1.1. For heating boilers, follow procedures in American Society of Mechanical Engineers (ASME), BPVC-V1 - 2007 BPVC, Section VI, *Recommended Rules for the Care and Operation of Heating Boilers*, to safely shut down the unit. Inspect the boiler thoroughly, including a hydrostatic test before returning the boiler to service.

25.17.2.1.2. For power boilers, follow procedures in ASME, BPVC-VII – 2007 BPVC, Section VII, *Recommended Guidelines for the Care of Power Boilers*, to safely shut down the unit. Inspect the boiler thoroughly, including a hydrostatic test before returning the boiler to service.

25.17.2.2. Lighting Gas and Oil Fired Furnaces. Before lighting gas and oil fired furnaces, boilers and breaching shall be ventilated to remove explosive vapors. Burners



shall not be lit if there is oil on the floors or combustion chamber, around the burners, or in front of the boilers. If the flame of a gas or oil fired burner goes out, the fuel shall be immediately cut off and the furnace passages ventilated before the furnace is re-lit.

#### 25.17.3. Cleaning and Maintenance Procedures.

25.17.3.1. Whenever a boiler is taken out of service for a prolonged period, it shall be cleaned promptly and inspected for defects by the plant engineer. Authorized boiler inspectors can also examine the boiler at this time.

25.17.3.2. Regular prompt cleaning is important. Soot gathers moisture rapidly and thus contributes to deterioration of metal surfaces. Soot and fly ash shall be removed as soon as the boiler has cooled. Ashes may remain hot for days, presenting a hazard to anyone entering the combustion chamber. They shall be wet down with a hose before entry. The operator will wet down from the outside toward the center and stay clear of any steam and dust that arises. A jet of water shall not be directed into the center of a hot ash pile as it can literally explode. When removing ashes, the area around the ash gates shall be kept clear to prevent injury to personnel from steam or hot water when ash gates are opened. The disposal of soot and fly ash shall be IAW the direction of the installation Environmental Management office.

25.17.3.3. For boilers in continuous service, planned and scheduled boiler shutdown for preventive maintenance is far safer than risking an extensive shutdown caused by boiler failure. At least once a year, the boiler, the flame safeguard supervisory system, and other safety controls will be inspected during a scheduled shutdown by an authorized inspector who is accompanied by the plant supervisor. Defective parts shall be repaired or replaced. For inspection, boilers shall be cool, handholes and manholes open, and the boiler shall have been ventilated. Adequate lighting and protective equipment for work in the boiler shall be provided. Specific boiler inspection requirements may be found in AFI 32-1068, *Heating Systems and Unfired Pressure Vessels*.

25.17.3.4. Proper and convenient drain connections shall be provided for draining boilers. Unobstructed floor drains, properly located in the boiler room, facilitate proper cleaning. Infrequently used drains shall have water poured into the traps, as required based on local conditions, to prevent the entrance of sewer gases and odors into the boiler room. If there is a possibility of freezing, an antifreeze mixture should be used in the drain traps.

25.17.3.5. When cleaning a boiler, workers shall wear protective clothing, hats, goggles, heavy leather-palm gloves and safety-toe boots/shoes. Contact BE for an occupational and environmental health risk assessment and determination of proper respiratory protection, if warranted.

#### 25.17.4. Steam Piping and Valve Maintenance.

25.17.4.1. All four (4) inch and larger steam valves or main steam valves to any building shall be operated only by qualified heat systems personnel.

25.17.4.2. High-pressure steam valves located in enclosed areas or confined spaces shall not be turned closed until the area is completely protected against the release of steam into the area or space by such means as a double block and bleed system. Double block

and bleed requires the closure of a line, duct or pipe by closing two inline valves and by opening a drain or vent valve in the line between the two closed valves.

25.17.4.3. When a valve in a confined space or enclosed area is to be opened, the operator will close the main valve at the steam plant before opening the steam valve in the enclosed area or confined space. The operator will ensure all pressure has been bled off prior to opening the steam valve. The operator shall ensure the potential for hazardous release of steam is rendered safe before opening the steam valve.

25.17.4.4. Routine operations, maintenance and repair in steam pits and other enclosed areas or confined spaces may be accomplished on electric circuits, controls, motors, pumps, receivers, condensate lines and vent fans while steam pressure is in the steam line, providing conditions and temperatures are acceptable. However, no operational changes, repair or maintenance shall be accomplished on steam lines while there is steam pressure on the lines.

25.17.4.5. Operating personnel will open drain valves and remove water from the steam line prior to opening a high-pressure steam valve. They will familiarize themselves with the location of these drain valves to ensure water accumulations are drained from the distribution lines.

25.17.4.6. When bypass lines and valves are installed around a high-pressure steam valve, the bypass valve shall be opened first. When the steam line becomes heated or the steam pressure equalized on both sides of main steam valve, the main steam valve may then be opened.

25.17.4.7. All high-pressure steam valves shall be opened very slowly, and everyone will remain at a safe distance while valve positions are being changed.

25.17.4.8. When dismantling a valve (removing bonnet, etc.) for maintenance, the worker will ensure pressure has been relieved through all possible means. The valve body shall be checked for a removable plug to relieve pressure. Bolts shall be carefully removed. Personnel will never position their body over the valve or in line with the direction of travel, in case the bonnet blows. Many locations (boilers, steam pipes, etc.) associated with heating systems and central heating plants may have material containing asbestos present. BE shall be consulted on all planned asbestos projects and shall be immediately notified upon discovery of suspected or confirmed asbestos during a project or suspension of work due to asbestos. For further guidance, consult paragraph [25.1](#), AFI 32-1068, *Heating Systems and Unfired Pressure Vessels*, and AFI 32-1067, *Water Systems*.

#### 25.17.5. Vaults, Manholes and Tanks.

25.17.5.1. All confined spaces and enclosed areas shall be considered hazardous and shall not be entered until tested for oxygen amount, and flammable or toxic atmosphere by BE or other qualified individual. Refer to [Chapter 23](#) for confined space entry requirements.

25.17.5.2. Atmospheres containing 19.5 percent or less oxygen by volume shall not be entered without the use of an air-supplied respirator approved by BE.

25.17.5.3. Only manhole cover hooks or other methods approved for this purpose shall be used when removing or replacing manhole covers. When replaced, the covers shall be properly seated. The bearing surfaces shall be free from dirt or ice that might prevent proper seating of the cover.

25.17.5.4. Personnel will enter and leave manholes or vaults only by means of a ladder or built-in rungs; they shall not step on cables, cable hangers or pipes.

25.17.5.5. Personnel shall not throw tools or materials into or out of manholes or vaults. They will use canvas buckets, handlines or other approved methods for lowering and removing tools and equipment.

25.17.5.6. Working on energized equipment is especially hazardous in subsurface structures and shall be performed by a qualified electrician or qualified craftsman trained on energized equipment.

25.17.5.7. When a manhole or vault is open, at least one member of the crew shall be stationed at the surface to act as a safety observer and take appropriate actions in case of emergency. When manhole covers are removed, install barriers to prevent injury to personnel not associated with the hazard.

25.17.5.8. Cool vests or other heat-reducing equipment shall be made available to workers who enter vaults or manholes under high heat conditions, e.g., steam leak repair.

#### 25.17.6. Central Heating Plants.

##### 25.17.6.1. Boiler Safety.

25.17.6.1.1. As a minimum, each boiler shall be equipped with steam and water gauges, gauge cocks, safety and blowoff valves and low-water cutoff devices. Safety valves shall be tested for proper operation by the inspector by means of the try lever during boiler inspections. Safety valve inspections shall be as outlined in the National Board Inspection Code published by the National Board of Boiler and Pressure Vessel Inspectors. Boiler feedlines shall be equipped with check and cutoff valves placed as close as possible to each boiler. Water gauge glasses, less than 15 feet from the floor or water tender's platform, shall be carefully guarded to prevent accidents resulting from breakage or blowouts. High-pressure gauge glasses shall be drawn down on each shift. Low-pressure gauge glasses shall be checked at least weekly. Pressure gauges shall be inspected and tested every 12 months by heating plant personnel. Required testing equipment shall be included in the Table of Allowance (TA) for these facilities. Additional information can be found in AFI 32-1068, *Heating Systems and Unfired Pressure Vessels*.

25.17.6.1.2. No boiler shall be operated unless equipped with a safety valve, calibrated to the boiler manufacturer's recommendations, unless normal boiler operating pressures are changed. In the latter case, the maximum operating pressure then becomes the controlling factor on safety valve selection. No other valves shall be placed between the safety valve and the boiler or between the safety valve and the end of its discharge pipe. Safety valves shall be manually tested on steam or hot water systems at least monthly for proper operation. AFI 32-1068 and manufacturer's boiler operations manuals shall be consulted for detailed information on safety valve

capacities, settings, disks and springs. If it is not practical to test safety valves every month for High Temperature Hot Water (HTHW) boilers, the valves shall be removed from the boiler, tested and reset (if required) at a properly equipped safety relief valve testing facility by the valve manufacturer or by a certified ASME shop. Valves shall be tested and reset at least once a year for HTHW boilers.

25.17.6.1.3. When applicable, spark arresters shall be installed on boiler stacks to prevent flying sparks.

25.17.6.1.4. All safety and blowoff valve discharge pipes shall be located where the discharge shall not create a hazard. Discharge lines from water heater relief valves shall be arranged with the outlet within six (6) inches of the floor. Such an outlet shall not be threaded, capped or plugged. It shall be cut off diagonally and not extend outdoors where it may freeze. Discharge lines and outlets shall be capable of free flow at all times.

25.17.6.1.5. No boiler shall be operated at pressures higher than determined safe by the most recent boiler inspection. Boilers shall not be operated at greater pressures than those specified on the manufacturer's stamped instructions. The lowest of these two pressures will govern boiler operation. The instructions stamped by manufacturers on boilers shall not be covered, removed or rendered unreadable.

25.17.6.1.6. If safety valves do not pop when pressures rise above valve settings, or the valves cannot be opened by hand when tested, the boiler shall be taken out of service until the valves have been repaired or replaced.

25.17.6.1.7. When fires are banked, boiler tenders shall make certain that draft is sufficient to prevent accumulations of flammable gases.

25.17.6.1.8. When a boiler is returned to full operation, all external drains between the boiler and main header shall be left open until the boiler is on the line. The stop valve shall be kept closed until boiler pressure is equal to that in the steam main. The stop valve shall then be gradually opened; if no jars or disturbances occur in the line, the valve may be opened completely. If jarring or rumbling occurs during cutting-in, the stop valve shall be closed immediately.

25.17.6.1.9. Steam shall be introduced into cold pipes very slowly until they have warmed enough to preclude damage.

25.17.6.1.10. Boiler tenders will stand to one side when opening fire doors to protect themselves against flarebacks.

25.17.6.1.11. Because of the danger of flarebacks, boiler tenders will not throw coal dust sweepings on boiler floors.

25.17.6.1.12. When not in use, all boiler room tools shall be stored in suitable racks. Tool racks shall be constructed and located so personnel cannot accidentally touch hot surfaces or knock tools from racks while passing by.

25.17.6.1.13. Adjustments shall not be made to valves or valves removed to increase discharge pressure.

25.17.6.1.14. Hoistways, driving machinery, conveyors, worm gears, ash sluices and reciprocating pumps shall be properly guarded. OSHA 3067, *Concepts and Techniques of Machine Safeguarding*, further explains this information.

25.17.6.1.15. Ashes shall not be stored against boilers or combustible materials. Ashes contain sulfur compounds which, on contact with water, form highly corrosive acids.

25.17.6.2. Attendance. Only fully automatic plants of less than 30,000,000 BTU per hour may be left unattended. All other boiler furnaces, regardless of the types of fuels or firing methods, operating at 30,000,000 BTU per hour or more shall be operated per instructions in AFI 32-1068, *Heating Systems and Unfired Pressure Vessels*.

25.17.6.3. Boiler Water Treatment Tank. Some chemicals used to treat boiler water are hazardous and shall be handled properly. The following safety precautions shall be observed:

25.17.6.3.1. Acids. Tests for chemical residuals involve small quantities of acid. The risk is small if spillage is avoided and bottles containing acid are not broken. Greater risks are involved in handling sulfuric acid in hydrogen-zeolite, demineralizing and direct-acid treatment processes. Observe the following precautions when handling sulfuric acid:

25.17.6.3.1.1. Do not permit sulfuric acid to come in contact with eyes, skin or clothing.

25.17.6.3.1.2. Always wear full face shields, chemical safety goggles, neoprene gloves and a neoprene apron.

25.17.6.3.1.3. Never add water or caustic solutions to concentrated acid since a violent reaction will result; if dilution is necessary, add the acid to the water or caustic solution.

25.17.6.3.1.4. Ensure work leader supervises all cleaning and repairing of tanks. Observe instructions about entering and cleaning tanks, including the exact steps to be taken. Ensure emergency equipment is immediately available before workers enter tanks.

25.17.6.3.1.5. Wash down spills with plenty of water. Never use combustibles such as cloths, sawdust or other organic materials to mop up spilled sulfuric acid. Neutralize spills with soda ash before washing down.

25.17.6.3.1.6. In the event of accidental contact, remove all contaminated clothing immediately and wash affected areas with water for at least 15 minutes. Have medical personnel examine affected areas to determine if further treatment is necessary.

25.17.6.3.2. Caustic Soda. When mixing water and caustic soda, always add the caustic soda to the water to prevent generating enough heat to boil the solution and cause it to splatter. Splatter may injure personnel because liquid and solid caustic soda can corrode the skin and damage upper respiratory tract and lung tissue if dust or concentrated mist is inhaled.

25.17.6.3.2.1. Never store food or eat near caustic soda or in work areas where it is handled.

25.17.6.3.2.2. Do not depend upon creams or ointments for protection from caustic soda.

25.17.6.3.2.3. Ensure all workers exposed to caustic soda wear full face shield, close-fitting chemical safety glasses, neoprene gloves, apron and coveralls that fit snugly at neck and wrist.

#### 25.17.6.3.3. Application of Chemicals.

25.17.6.3.3.1. Always drain the feeder before introducing chemicals into it. Before opening the drain valve, close all pressure connections to the feeder to prevent operator injury from hot water or chemicals.

25.17.6.3.3.2. Never place dry chemicals in a chemical feeder or pump. This practice plugs the chemical feed lines in a short time.

25.17.6.3.3.3. Wherever possible, mix chemicals at floor level to minimize the possibility of injury to eyes and face.

25.17.6.3.3.4. Check specifications, temperature, pressure and construction materials of piping, valves and pumps, to determine whether they can be used safely with the chemicals.

#### 25.17.6.3.4. Emergency Shower and Eyewash Units.

25.17.6.3.4.1. An eyewash unit either permanent or portable (portable must be capable of providing a steady stream of water for at least 15 minutes) shall be available when workers are exposed to injurious corrosive materials. If even a minute quantity of sulfuric acid or caustic soda enters the eyes, irrigate immediately and copiously with water for at least 15 minutes. Refer to [Chapter 19](#), *Emergency Shower and Eyewash Units*, for additional guidance.

25.17.6.3.4.2. Have a well-marked safety shower available in the area where sulfuric acid, caustic soda or other chemicals are being handled and may come in contact with the body.

25.17.6.3.4.3. Supervisors will inspect all eyewash units and emergency showers IAW [Chapter 19](#). Documentation of inspection shall be kept in a log, computerized or affixed to the unit by tag or label. Personnel shall be trained in the use of eyewash units and emergency showers.

25.17.6.3.4.4. Eyewash units and emergency showers shall not be used in lieu of appropriate PPE. PPE requirements may be found in [Figure 25.1](#) and [Chapter 14](#).

#### 25.17.6.3.5. Chemical Storage and Handling.

25.17.6.3.5.1. Store all large quantities of chemicals used for boiler or condensate water treatment in locations where accidental spills will be contained and where drainage will not be hazardous to personnel or the environment.

25.17.6.3.5.2. Conspicuously post warning and handling instructions where use of toxic chemicals is necessary.

25.17.6.3.5.3. Because chemical storage equipment is subject to corrosion, deterioration or mechanical hazards, periodically inspect this equipment. Frequency shall be determined by supervision, based on local conditions.

25.17.6.3.5.4. Train personnel who handle chemicals in safe chemical handling practices.

25.17.6.3.5.5. Practice neutralization and containment techniques and disposal instructions. Contact the installation Environmental Management office for proper disposal guidelines.

25.17.6.3.6. Chemical Laboratories.

25.17.6.3.6.1. Ensure chemical testing laboratories associated with water treatment have operable mechanical ventilation, when required by the BE OEH risk assessment. Refer to AFOSH Standard 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories*, and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance.

25.17.6.3.6.2. Maintain chemical test kits and test instructions in a current and usable state.

25.17.6.3.6.3. Conspicuously post appropriate warning instructions for chemicals and their hazards.

25.17.6.3.6.4. Train personnel who conduct chemical tests in use of chemicals and hazards involved.

25.17.6.4. Railroad Coal Car Operations.

25.17.6.4.1. No person will climb on, in or under a railroad coal car while the railroad crane or switch engine is in operation or coupled to the railroad car.

25.17.6.4.2. The railroad crane shall be moved a minimum of one boom's length away from the railroad coal car while coal-handling personnel are working in, around or under the coal car.

25.17.6.4.3. Signs that read "Do Not Climb on Coal Car When Crane or Switch Engine is in Operation," or the nearest commercially available equivalent, shall be posted on each coal car by coal-handling personnel.

25.17.6.4.4. Blue flags or blue signals shall be posted on railroad rails when coal-handling personnel are working in, around or under coal cars. Flags or signals are to be a minimum of 50 feet from the coal car.

25.17.6.4.5. There shall be a qualified brakeman working with the crane or switch engine. No coal-handling personnel will function as a brakeman.

25.17.6.5. Coal Storage and Handling.

- 25.17.6.5.1. To minimize the probability of fire, free movement of air through all parts of the coal pile is needed to rapidly remove heat generated by oxidation. Air flow depends on preventing segregation (the separation of larger from smaller size lumps), on limiting the coal stored to a relative narrow range of sizes, not storing small sizes and not compacting the pile.
- 25.17.6.5.2. All closed coal storage structures should have, if practical, an access opening at the top with hinged cover and safety rail. Stringent safety precautions shall be followed whenever a storage facility containing coal is entered. No individual shall enter such a facility without a safety harness. In addition, a second individual shall stand at the opening and maintain visual contact. An intercom telephone system shall be used when visual contact cannot be maintained. Personnel will never step into coal; they will remain on ladders and catwalks.
- 25.17.6.5.3. There shall be no surface within the storage structure with a horizontal angle less than 60°, except that catenary bunkers may be used for free-flowing coal (e.g., high-rank, dry, double-screened).
- 25.17.6.5.4. A means of loosening coal jams from the outside of the storage structure shall be provided on all structures, except ones used exclusively for free-flowing coal (e.g., high-rank, dry, double-screened).
- 25.17.6.5.5. Considerable dust is generated during the filling and emptying of coal storage structures. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph 2.3 for additional guidance. If not confined within the storage structure, such dust settles on machinery and instruments causing rapid wear or improper operation. It also collects on ledges and in crevices, creating a fire hazard and an almost impossible housekeeping situation. Additionally, suspended coal dust in a storage structure presents an explosion hazard. Although relatively rare, such explosions can cause extensive damage. Such features as damage-limiting construction or explosion-venting panels shall be incorporated in the design of coal storage structures. Those structures used exclusively for anthracite coal storage are excluded because the dust from such coal is nonexplosive. Oil treatment of coal should be used if coal dust becomes a problem.
- 25.17.6.6. Oil Storage and Handling.
- 25.17.6.6.1. Operation of the burner shall not be attempted until a satisfactory fuel supply is ensured.
- 25.17.6.6.2. Fuel shall be continuously delivered to the combustion chamber in a finely atomized form that can be readily ignited and consumed.
- 25.17.6.6.3. All equipment associated with pumping, heating, and straining the fuel from storage to the service connection shall be designed, sized and interconnected to the unit to always provide a suitable fuel supply over a full range of conditions. Relief valves shall be installed after the pump to prevent system overpressure.



25.17.6.6.4. Fuel shall be delivered to the burner at the manufacturer's recommended temperature and pressure. Cold fuel may prevent satisfactory atomization, while excessively heated oil may create vaporlock that can interrupt continuous oil flow.

25.17.6.6.5. When oil must be heated, instruments shall be calibrated to ensure accurate measurements, particularly in dead-end lines where heavy oil tends to solidify.

25.17.6.6.6. Sufficient filters shall be installed to ensure oil is free from sludge, water or other contaminants that may cause fuel interruptions or interfere with proper operation of control and measuring equipment. Disposal of fuel filters and other fuel contaminated waste shall be consistent with approved waste disposal procedures and applicable environmental regulations. The installation Environmental Management office can provide additional guidance regarding waste disposal methods.

## **25.18. Water and Wastewater Treatment.**

25.18.1. Workers involved in operation and maintenance of water and wastewater treatment systems are exposed to many potential, but controllable hazards. Most mishaps can be prevented through a complete and ongoing training program, specific operating procedures, emergency operating procedures and being knowledgeable of unsafe chemical reactions. Mishaps can result from falls, improper lifting, electrical shock, not using protective equipment while handling chemicals, hazardous chemical reactions and asphyxiation from oxygen-deficient atmospheres (19.5 percent or less oxygen by volume). Other mishaps can be caused by ignition of flammable or explosive gases; hazards around open excavations; falls into water pits or lagoons; getting caught in moving mechanical parts; striking obstructions; improper use of hand or portable tools, equipment or vehicles; and exposure to toxic or harmful organisms. Refer to [Chapter 23](#) for confined space entry requirements.

25.18.1.1. Explosive Gases. The most common sewer gases are methane, carbon monoxide, and hydrogen sulfide. These gases, when mixed with air and a spark, can explode with great force. Such explosions are most common and dangerous in confined spaces such as tanks, underground lift stations or manholes. Hydrogen sulfide ( $H^2S$ ) is generally encountered more frequently in wastewater systems than any other hazardous gas. In light concentrations, it has a foul odor similar to rotten eggs. After continued exposure,  $H^2S$  will overstimulate the olfactory sensors and will no longer register as an odor. It is heavier than air and usually collects in low areas. Methane is lighter than air and will escape with proper ventilation. Closed tanks and tight rooms are the greatest danger areas. They shall be tested for oxygen and methane or  $H^2S$  with approved meters.

25.18.1.2. Oxygen Deficiency. Oxygen deficiency (19.5 percent or less oxygen by volume) is a major hazard in wastewater collection systems and treatment plants. Some gases, both explosive and non-explosive, are heavier than air and settle into low spots and physically displace oxygen. Ambient air shall be tested for oxygen deficiency with approved equipment. Required procedures and methods shall be used when entering system components suspected to be oxygen deficient.

25.18.1.3. Toxic and Hazardous Chemicals. Many different chemicals are used in water and wastewater treatment. Due to the large number of chemicals and the diverse processes in which they are used, it is not possible to list all chemical hazards in this

standard. Additionally, with the nature and number of chemicals, and their by-products that may be encountered, supervisors should conduct a JSA or other hazard or risk assessment, and, when necessary, develop operating instructions or written guidance for operations involving their use. Exposure to such substances can result in burns, rashes, nausea, loss of eyesight, damage to vital organs, fatal poisoning and various other conditions. Extreme care shall always be taken when working with chemicals to prevent accidental injury to workers.

25.18.1.4. Chemical Treatment Processes. Chemical treatment processes can pose hazardous situations for workers exposed to the various chemicals during handling, operations and maintenance. Due to the potential adverse health effects caused by inhalation of toxic hazardous materials, use of approved respiratory protection is often required in addition to atmospheric monitoring to ensure safe work conditions are maintained.

25.18.1.5. Federal and some state agencies set exposure limits to protect workers against exposure to hazardous substances. The Air Force incorporates the most appropriate limits as the Occupational and Environmental Exposure Limit (OEEL). OEELs are the Air Force limits on the amount or concentration of a substance in air. OEELs may also contain a skin designation. Contact BE for questions related to OELs.

25.18.1.6. OEELs are usually based on an 8-hour time weighted average (TWA) exposure. BE determines compliance with OEELs through quantitative measurements and/or professional judgment. Supervisors that need assistance complying with OEELs should contact BE.

25.18.1.7. Areas where chemicals are present may become immediately dangerous to life and health (IDLH) because of deficient facility design, location, or equipment malfunction. Each IDLH area will have a means of emergency contact available to personnel working in the area. Either a telephone shall be located immediately outside the IDLH area or radio contact capabilities shall be available while personnel are working in the IDLH area. IDLH levels vary depending on the chemicals involved. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph 2.3 for additional guidance.. Some locations may require, as a minimum, the installation of a mechanical exhaust system that is turned on prior to entering the room (e.g., automated door interlocks). In addition, local regulations may require modern gas detection alarms in locations where some gases are used, i.e., where chlorine gas is used an alarm that activates when the gas reaches the OEEL may be required. Electronic gas detectors may also be used to sense hazards or exposures associated with ammonia, hydrogen sulfide, carbon monoxide, etc. Additional points to consider include:

25.18.1.7.1. Type of ventilation system, exhaust duct location (should be near floor), size of fan, air changes per hour, automatic fan operation and availability of make-up air.

25.18.1.7.2. Level of chemical use, quantity stored, location of gas cylinders or chemical containers, condition of equipment and accessibility of equipment.

25.18.1.7.3. Room location (e.g., above ground or below ground), room size, room layout and cross-ventilation.

25.18.1.7.4. Mishap history, safety factors, equipment handling problems and unique conditions.

25.18.1.8. Each chemical treatment room shall be evaluated by BE. Contact BE for an OEH risk assessment. Follow the subsequent guidance related to IDLH:

25.18.1.8.1. If IDLH conditions exist:

25.18.1.8.1.1. Before entry into a potentially IDLH gaseous chemical treatment room, the person entering will ensure they have all required protective equipment, to include self-contained breathing apparatus (SCBA). IAW **Chapter 23**, an additional person shall be present with the proper rescue equipment, including SCBA, to assist the other person in case of emergency.

25.18.1.8.1.2. Any self-contained breathing apparatus shall be approved by BE as required by AFOSH Standard 48-137.

25.18.1.8.1.3. The chemical treatment supervisor will develop written OIs covering emergency procedures. Individuals shall be thoroughly trained in use of the equipment. Annual training shall be conducted and documented by the supervisor.

25.18.1.8.1.4. Self-contained breathing apparatus shall be inspected at least monthly or more frequently IAW manufacturer guidelines. A record shall be kept of inspection dates.

25.18.1.8.1.5. The functional manager should program and install engineering controls when feasible.

25.18.1.8.2. If IDLH conditions do not exist:

25.18.1.8.2.1. An additional person standing by with a self-contained breathing apparatus is not necessary when entering a chemical treatment room not determined IDLH by BE.

25.18.1.8.2.2. Workers should take precautions to ensure exhaust ventilation is operating when the chemical treatment room door is opened. If any hazardous condition is suspected or detected, the worker will not enter the room or area. The situation shall be evaluated and managed the same as an IDLH condition. Entry into the contaminated area shall only be conducted by properly trained and protected personnel.

25.18.1.8.2.3. For additional guidance refer to the following:

25.18.1.8.2.3.1. 29 CFR 1910.134, *Respiratory Protection*.

25.18.1.8.2.3.2. AFI 32-1067, *Water Systems*.

25.18.1.8.2.3.3. AFOSH Standard 48-137, *Respiratory Protection Program*.

25.18.1.8.2.3.4. AFOSH Standard 48-14, *Swimming Pools, Spas and Hot Tubs, and Bathing Areas*.

### 25.18.2. Personal Sanitation and Protective Equipment.

25.18.2.1. Wastewater and sewage systems often contain disease causing organisms. Every worker will practice good personal hygiene. Risk to occupational health and from physical mishaps are best reduced when a plant is kept clean. All personnel will comply with required periodic physicals and recommended vaccinations as determined by the local health authority.

25.18.2.2. Gloves, boots and coveralls keep wastewater from contacting the skin. Rubber gloves are essential when there are scratches or open wounds on the hands. If workers come in direct contact with wastewater, they will scrub thoroughly with strong soap and hot water as soon as possible. Running hot and cold water, strong soap, hand disinfectant and an adequate supply of disposable towels shall be maintained. All workers will scrub well and disinfect hands before eating or smoking. Emergency eyewashes or showers shall be provided IAW [Chapter 19](#).

25.18.2.3. PPE is required when loading, mixing or adding chemicals. Supervisors shall review the Material Safety Data Sheet (MSDS) for each chemical used and select PPE based on performance characteristics of the chemical protective equipment or clothing relative to the tasks performed, conditions present, duration of use and potential hazards identified. Verify proper selection of PPE with BE prior to original use. Refer to [Figure 25.1](#) for additional PPE guidance.

25.18.2.4. Food or drink preparation, eating, drinking or smoking shall be permitted only in authorized areas.

25.18.2.5. Because of the possibility of contamination, change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing shall be provided.

25.18.3. Treatment Plant. The following items shall be accomplished to prevent or lessen effects of mixing incompatible hazardous chemicals. Plans or OIs shall be developed for operations under emergency conditions to include, but not limited to, safe venting of toxic gases, neutralization, air sampling, evacuation of non-essential personnel and a respiratory protection program. There must be prompt mishap notification of appropriate officials such as the FES Flight, BE, commanders, Ground Safety office and others with technical knowledge or skill to help resolve emergencies. The nature of the emergency and chemicals involved shall be documented and distributed as written notifications. Supervisors shall ensure the following precautionary measures are adhered to for the plant components listed:

#### 25.18.3.1. Bar Screens and Racks.

25.18.3.1.1. All railings are firmly anchored.

25.18.3.1.2. All screening in tight, easily-removed cans.

25.18.3.1.3. Wash-down hoses are used to keep all screen deck areas clean.

#### 25.18.3.2. Shredding (Pulverizing) and Grinding.

25.18.3.2.1. All walkways are clean and free of grease.

25.18.3.2.2. All power is turned off and locked out before servicing.

- 25.18.3.2.3. All guards and screens are firmly in place.
- 25.18.3.3. Pumping and Lift Station Maintenance Repair.
  - 25.18.3.3.1. All power is switched off and locked out before servicing.
  - 25.18.3.3.2. Test for gas and oxygen if below ground level.
  - 25.18.3.3.3. Equipment removal hatches are not opened except during actual use, and then are fenced off.
  - 25.18.3.3.4. Positive displacement pumps are never started against a closed discharge valve.
- 25.18.3.4. Wet Pits and Sumps.
  - 25.18.3.4.1. All manhole safety steps are followed.
  - 25.18.3.4.2. Test for gases and oxygen before entering.
  - 25.18.3.4.3. All chlorination equipment is turned off upstream and enough time allowed for ventilation.
- 25.18.3.5. Grit Chamber.
  - 25.18.3.5.1. All walking and working surfaces are clean and free of grease or oil.
  - 25.18.3.5.2. Tools are not hand-carried up or down a ladder; always use a bucket and rope, tool belt or pouch.
- 25.18.3.6. Sedimentation Basin (Clarifier).
  - 25.18.3.6.1. Non-slip surfaces are maintained on all ladders, stairs and catwalks.
  - 25.18.3.6.2. Firm rails are provided on inside of all walks.
  - 25.18.3.6.3. Workers never walk on sludge, but hose a path ahead.
  - 25.18.3.6.4. Workers wear protective overalls and non-skid rubber boots.
  - 25.18.3.6.5. Approved life vests with attached lifelines are provided at appropriate points around the clarifier.
  - 25.18.3.6.6. Workers cleaning an effluent weir wear safety harness, gloves, goggles and have a helper standing by.
  - 25.18.3.6.7. Guards are in place around all moving parts.
- 25.18.3.7. Digester Equipment. Digester equipment locations are probably the most dangerous areas in any plant. Supervisors shall ensure:
  - 25.18.3.7.1. Testing for explosive gas and oxygen.
  - 25.18.3.7.2. Sufficient ventilation is maintained.
  - 25.18.3.7.3. A backup helper is standing by.
  - 25.18.3.7.4. All valves on both sides of sludge pumps are completely closed before servicing.

- 25.18.3.7.5. Below-ground pump room blowers are wired so ventilation is provided any time the pump is running.
- 25.18.3.7.6. Spillage is avoided and, if it occurs, is cleaned up at once.
- 25.18.3.7.7. Workers do not attempt to service radioactive element automatic sludge moisture meters. Meters containing radioactive material may require an Air Force radioactive material permit IAW AFI 40-201, *Managing Radioactive Materials in the US Air Force*. Contact the BE to determine if a permit is required.
- 25.18.3.8. Digester Tanks.
  - 25.18.3.8.1. On start up, completely fill the tank to overflow thereby preventing any air-gas mix in partly filled tank that would be explosive.
  - 25.18.3.8.2. Draw digested sludge at the same rate you add raw sludge to fixed roof digesters, thus preventing any vacuum or extinguishing of gas boilers.
  - 25.18.3.8.3. Maintain forced ventilation in all rooms and galleries.
  - 25.18.3.8.4. Test for gas and oxygen before entering any closed area.
  - 25.18.3.8.5. Always follow manufacturer's instructions in servicing boilers or heat exchangers.
  - 25.18.3.8.6. Ensure chamber is cleared before lighting the pilot.
  - 25.18.3.8.7. Ensure all electrical fixtures are explosion-proof.
  - 25.18.3.8.8. Always allow heat exchanger to cool before opening.
  - 25.18.3.8.9. Do not allow smoking anywhere around any digestion area equipment.
- 25.18.3.9. Empty or Partially-Filled Digester Tanks. Empty or partially-filled digester tanks are especially dangerous and shall be treated with extreme caution.
  - 25.18.3.9.1. Always test for explosive atmosphere and oxygen deficiency before entering.
  - 25.18.3.9.2. Open all manholes and force heavy ventilation during the time anyone is working inside.
  - 25.18.3.9.3. Always have at least two (2) backup helpers standing by.
- 25.18.3.10. Digested Sludge Storage Tanks.
  - 25.18.3.10.1. Ensure all electrical equipment is explosion-proof.
  - 25.18.3.10.2. Ensure forced air ventilation is provided before entry and during the period of occupancy by workers.
  - 25.18.3.10.3. Ensure air relief valves are working during draw-off.
  - 25.18.3.10.4. Regularly check for flammable gases.
  - 25.18.3.10.5. Carefully control draw-off rate. Prevent surges.
  - 25.18.3.10.6. Always clean lines with water, never air.

25.18.3.11. Sludge Gas Collection and Use Equipment.

25.18.3.11.1. Protect all gas lines from freezing weather.

25.18.3.11.2. Use antifreeze in all water traps during freezing weather.

25.18.3.11.3. Regularly check all points for gas leaks, using a meter or soapy water.

**Caution:** Never rely on odor to detect presence of sludge gas.

25.18.3.11.4. Maintain positive gas pressure in all lines.

25.18.3.11.5. Use enclosed dry type gas compressors, not water seals.

25.18.3.11.6. Check gas boiler safety devices often, especially pilot cut off and blow back protection devices (flame arresters).

25.18.3.11.7. When purging tanks of gas, open all manholes high and low and force ventilate from low ones.

25.18.3.12. Trickling Filter.

25.18.3.12.1. Anchor (tie down) the rotary distributor before inspection or servicing.

25.18.3.12.2. Walk carefully if necessary to get on filter media. Never allow equipment on the media.

25.18.3.12.3. Regularly inspect under drains for solids buildup and collapsed drains. These conditions hinder ventilation and induce septicity, causing gas formation.

25.18.3.12.4. Always provide a firm base off the media for the jack plate, if necessary, to lift distributors for servicing.

25.18.3.12.5. Prohibit mercury seals on distributors because of hazards to operators and contamination of receiving waters.

25.18.3.13. Aeration Tanks.

25.18.3.13.1. Provide guardrails for all work areas and walkways.

25.18.3.13.2. Place approved life vests with attached lifelines at appropriate locations around aerator rails.

25.18.3.13.3. Always center the test hoists used to service diffusers.

25.18.3.13.4. Use a dry fixed ladder to enter a dry empty tank and be careful of slick sides and floor. Use a water hose and stiff bristled brush to keep the work area clean and to provide safe footing.

25.18.3.14. Stabilization Ponds.

25.18.3.14.1. Maintain roads on top of levees with gravel or asphalt.

25.18.3.14.2. Never work alone while mowing or clearing vegetation on berms (dikes) because of drowning hazard.

25.18.3.14.3. Wear a life vest while working, inspecting or otherwise in a boat or raft on a pond.

25.18.3.14.4. Always work from a sitting position in a boat, unless it is designed to be stable while working in a standing position.

25.18.4. Manholes. The following safety precautions and procedures shall be observed:

25.18.4.1. Test for both oxygen deficiency and explosive gases with approved meters before entering.

25.18.4.2. Remove cover with a special hook, never by hand.

25.18.4.3. Place the cover flat and at least three (3) feet from the manhole lip.

25.18.4.4. When a manhole or vault is open, at least one member of the crew shall be stationed at the surface to act as a safety observer and take appropriate actions in case of emergency. When manhole covers are removed, install barriers to prevent injury to personnel not associated with the hazard.

25.18.4.5. Carefully test the permanent ladder for rust, weakness or slippery rungs before using.

25.18.4.6. Ensure the portable ladder is firmly seated and cannot slip. Always use a ladder to enter the manhole.

25.18.4.7. Ventilate the lowest working levels with portable blowers for at least 30 minutes before and during the time workers are in the hole.

25.18.4.8. Always wear a safety harness and lifeline and be constantly attended by a helper on the surface.

25.18.4.9. Wear a helmet, gloves and rubber boots while inside a manhole.

25.18.4.10. Ensure all lighting is explosion-proof.

25.18.4.11. Prohibit open flames, sources of ignition or smoking in or at the opening of an open manhole.

25.18.4.12. Lower tools in a bucket or pouch; never drop them into the manhole.

25.18.4.13. Continue testing for oxygen deficient, explosive and toxic atmospheres during the entire time a worker is inside a manhole, wet well, etc. Do not trust your nose. Some toxic and flammable gases have no odor or can quickly paralyze your sense of smell.

25.18.5. Laboratories. Laboratories use many dangerous chemicals. Many of the testing procedures can result in mishaps if the technician is not fully alert at all times. Basic rules for laboratory safety are:

25.18.5.1. Sampling Safety.

25.18.5.1.1. Never take field samples with bare hands; always wear gloves.

25.18.5.1.2. Do not climb over or go inside guardrails. Use poles, ropes, dippers or other long distance samplers.

25.18.5.1.3. When collecting gas samples, do not open the tank cover completely. Install a sampling port, if needed.



25.18.5.1.4. Use self-contained breathing apparatus, venting and a helper when taking gas samples in an IDLH environment.

25.18.5.2. Lab Housekeeping. General cleanliness and correct storage of chemicals and equipment are important for accuracy as well as safety in the laboratory. Basic rules include:

25.18.5.2.1. Follow a daily general cleanup schedule in the lab. Dirty glassware or clothing can encourage infection.

25.18.5.2.2. Have a special spot for storing each piece of equipment. After each use, clean, disinfect, and return equipment to its rack (an outline painting, as on a tool board, helps keep a place for everything and everything in its place).

25.18.5.2.3. Always clean up and discard any spills immediately following incident. All contaminated waste spills shall be disposed of in a manner consistent with approved waste disposal procedures and applicable environmental regulations. The installation Environmental Management office can provide additional guidance.

25.18.5.2.4. Keep the lab well lighted, at least 50-foot candles on every work surface.

25.18.5.2.5. Ensure all work benches or tables have slate or special plastic chemical-resistant tops or are painted with chemical-resistant paint frequently.

25.18.5.2.6. Ensure all work areas have non-drip edges or keep work that could be spilled in containers that would recover the spill.

25.18.5.2.7. If possible, provide deep sinks of stone or noncrack porcelain lined with disposable rubber or plastic mesh.

25.18.5.2.8. Do not crowd the lab; have plenty of room. Do not store any other equipment in the lab. Do not permit food or drink preparation, eating or smoking in the lab.

25.18.5.2.9. Color code all lab service lines (gas, water, electricity, etc.).

25.18.5.3. Chemical Safety. Refer to AFOSH Standard 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories*, for additional guidance and information.

25.18.5.3.1. Keep working amounts of chemicals stored in the lab to a minimum, never over one gallon (four [4] liters) of any one kind. Refer to [Chapter 22](#) for flammable chemical requirements.

25.18.5.3.2. Store all bulk chemicals in original containers in a separate fireproof storeroom. If possible, store larger bulk containers on the floor.

25.18.5.3.3. Have individual bulk siphons to transfer chemicals from bulk storage to working stock bottles. Never siphon by mouth.

25.18.5.3.4. If possible, place all chemical storage jars on wide shelves with retaining rails to prevent their being accidentally pulled or jarred off.

25.18.5.3.5. Stand jars containing highly corrosive acids or bases in lead, plastic, or ceramic individual trays that are deep enough to contain the solution in the event the jar breaks.

- 25.18.5.3.6. Store all chemicals as low as possible, never higher than shoulder height. Ensure chemicals stored together or close to each other are compatible with each other.
  - 25.18.5.3.7. Clearly label all chemicals with common and chemical names, formula, strength, and date prepared or received. Replace these labels as needed to keep them legible.
  - 25.18.5.3.8. Add red “Skull and Crossbones” labels to all containers of poisonous chemicals.
  - 25.18.5.3.9. Ensure used chemicals are carefully disposed of by workers who are familiar with their properties and disposal requirements. Do not flush them down the drain unless permitted by environmental disposal requirements. Contact the installation Environmental Management office for proper disposal guidelines.
  - 25.18.5.3.10. Keep highly reactive chemicals stored at safe distances.
- 25.18.5.4. Lab Equipment Safety.
- 25.18.5.4.1. Only trained, experienced technicians are permitted to operate lab equipment.
  - 25.18.5.4.2. Exact, clear operating procedures for autoclaves, water stills and any other special pressure equipment shall be permanently posted near the respective equipment.
  - 25.18.5.4.3. Valves and switches on such equipment shall be clearly numbered in their order of use.
  - 25.18.5.4.4. All electrical equipment shall be grounded.
  - 25.18.5.4.5. All electrical cords shall be inspected for wear or cracks in insulation and shall be replaced as necessary.
  - 25.18.5.4.6. Manufacturer’s operating and safety instructions shall be kept in a permanent file. Supervisors will ensure workers follow these rules.
  - 25.18.5.4.7. All equipment shall be set away from gas and electrical service switches or valves.
  - 25.18.5.4.8. All chemical reactions that produce vapors or gases shall be conducted in a ventilated hood with front closed and fan on.
  - 25.18.5.4.9. Chemicals with high temperature reactions shall be heated in a water, oil or salt bath, not over an open flame. A wired glass shield shall be placed between the fan and any high temperature or caustic reaction in case the vial or container breaks.
  - 25.18.5.4.10. Workers will ensure centrifuges are perfectly balanced before turning them on.
- 25.18.5.5. Glass Safety.
- 25.18.5.5.1. Always fire polish all ends of glass tubes that are used or stored.
  - 25.18.5.5.2. Wear gloves any time you are working with glass.

- 25.18.5.5.3. Hold rod or tube in contact with stopper and twist to insert.
  - 25.18.5.5.4. Keep cork borers sharp and use exact size needed.
  - 25.18.5.5.5. PYREX, KIMAX or equivalent tubing should be used whenever possible.
  - 25.18.5.5.6. Wear full or wrap-around goggles or a face shield when working with glass.
  - 25.18.5.5.7. Always support glass units with several padded clamps that are firmly anchored.
  - 25.18.5.5.8. Properly discard all glassware that is chipped or cracked in any way.
  - 25.18.5.5.9. Pad all glass storage drawers with clean paper towels. Change the towels frequently. Have individual cardboard tubes or dividers for pipette storage drawers.
- 25.18.5.6. Lab Safety Procedures. The safest lab can be dangerous unless precautions are observed.
- 25.18.5.6.1. Never pipette by mouth; always use a bulk siphon.
  - 25.18.5.6.2. Always wear rubber gloves to handle wastewater samples and perform analysis.
  - 25.18.5.6.3. Always scrub thoroughly and use a hand disinfectant after finishing any waste-water lab work.
  - 25.18.5.6.4. Know proper procedures and follow a checklist.
  - 25.18.5.6.5. Wear safety glasses or goggles in the lab, when required for safe operations.
  - 25.18.5.6.6. Always wear a rubber apron when working with acids or caustics.

25.18.6. Sanitary Sewer Systems. The buddy system shall be used when maintenance is performed on sewer systems in confined spaces. Before going into a sanitary sewer system, the atmosphere shall be tested to determine if dangerous gases are present. Sewer gases that may be encountered are methane, hydrogen sulfide and carbon monoxide. Presence of these gases could cause explosions, asphyxia or death. Refer to **Chapter 23** for additional requirements. Workers will use proper protective clothing, boots and respirator devices to perform emergency maintenance or rescue operations when these systems cannot be vented to a safe level. Immunizations required, such as tetanus, typhoid, cholera, etc., shall be determined by the installation medical authority IAW AFJI 48-110, *Immunizations and Chemoprophylaxis*.

## **25.19. Aircraft Arresting Systems (AAS).**

25.19.1. Personnel engaged in AAS operations and maintenance are exposed to several potential hazards, including exposure to flammable and combustible liquids and gases and absorption of toxic and hazardous chemicals through the skin and respiratory system. AAS personnel are subject to some physical injuries associated with AAS maintenance, and are also subject to noise, lifting hazards, and in underground facilities, confined space hazards (e.g., oxygen deficiency). Particular attention shall be given to prevent exposure to hazardous

noise levels since the effects of over-exposure are not always apparent immediately or in the near future. Potential physical and health hazards can be effectively controlled by following guidance in this chapter, by proper work procedures and controls, and by using protective equipment and clothing. Refer to **Chapter 14**, AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arrest Systems*, TO 35E8-2-4-1, *Operation and Maintenance Instruction Arresting Gear, ACFT Mod Bak-9/F48A*, TO 35E8-2-5-1, *Operation and Maintenance ACFT Arresting System Mod BAK-12/E32A*, and AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, for additional guidance.

#### 25.19.2. Requirements.

25.19.2.1. Housekeeping. Good housekeeping is essential to safe operations in AAS operations and maintenance areas:

25.19.2.1.1. Floors and grounds shall be kept free of grease and spilled liquids to minimize slips and falls.

25.19.2.1.2. In addition, dry floors are essential to electrical safety.

25.19.2.1.3. All work and storage areas shall be kept clean. Equipment and materials shall be stored in a proper and orderly manner.

25.19.2.1.4. Because toxic and hazardous chemicals cling to clothing and body parts, workers should be extremely careful about personal hygiene. They will wash hands thoroughly before eating or smoking and shower and change clothes after completion of work with chemicals.

25.19.2.2. Personal Protective Equipment (PPE). Engineering and administrative controls are the preferred means of protecting personnel. The use of PPE is supplemental to and not a replacement for such controls. PPE is identified in the text, **Figure 25.1**, and is also contained in **Chapter 14**.

25.19.2.3. Fire Prevention. **Chapter 22**, *Flammables and Combustibles*, provides guidance on the storage, use, and handling of flammable and combustible liquids. In addition, consult the installation FES Flight and **Chapter 6**, *Fire Protection and Prevention*, for guidance on selection and placement of fire extinguishers and required training.

25.19.2.4. Equipment and Component Cleaning.

25.19.2.4.1. If compressed air is used, limit the air pressure to the lowest possible level. Generally, 5 psi is adequate for equipment cleaning. Air pressure shall be kept less than 30 psi when used for cleaning and only when the nozzle is equipped with effective chip guarding and PPE is used. Eye protection with side shielding is required when using compressed air.

25.19.2.4.2. If solvents are used, use only approved and authorized types and ensure adequate ventilation is maintained throughout the operation. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph **2.3** for additional guidance. Refer to the most current edition of ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional information on ventilation requirements.

#### 25.19.2.5. Tools and Equipment.

25.19.2.5.1. Insulated metal tools shall be used while performing work on energized equipment. Dipped coated tools adds extra protection to tools, equipment and personnel, and are acceptable. Taping is not an acceptable means of insulation. Wooden handle tools shall not be issued or used.

25.19.2.5.2. All tools shall be maintained in a serviceable condition IAW TO 32-1-101, *Use and Care of Hand Tools*.

25.19.2.5.3. Tools, when not in use, shall be kept in suitable containers and not in pockets or left on the floor of the work area.

25.19.2.5.4. Whenever a tool develops a defect during use, the operation shall be stopped and the tool returned for repair or replacement.

25.19.2.5.5. When the work is complete, all tools and equipment shall be accounted for before departing the work site.

25.19.2.6. Illumination. At least 50 foot candles of illumination shall be maintained at the operator's position. Where necessary, additional artificial lighting shall be supplied.

#### 25.19.2.7. Occupational Health.

25.19.2.7.1. When noise level surveys identify a need for hearing protection, earplugs, earmuffs or both shall be provided to all personnel and their use strictly enforced. Emphasis shall also be placed on all personnel who are within the area and may be affected by a noise hazard when noise sources are operating. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraphs [2.3](#) and [3.1.2.11](#) for additional guidance.

25.19.2.7.2. Where the eyes or body of any person may be exposed to corrosive materials, suitable emergency showers shall be provided within the work area for immediate emergency use IAW [Chapter 19](#). If personnel are only exposed to materials considered to be an irritant to the eyes, a portable eyewash that provides 15 minutes of continuous flow may be used as an alternative for a plumbed eyewash. A water hose may NOT be used to meet the requirement in this paragraph. Medical attention shall be obtained as soon as adequate flushing and drenching of the eyes or body has been accomplished. When work is performed at locations where it is not feasible to provide emergency showers or eyewash units, portable eyewash bottles may be used to provide initial flushing of the injured area until the affected worker can reach an emergency shower or eyewash unit. Supervisors will contact the installation Ground Safety office for assistance in determining how to meet the requirements of this paragraph.

25.19.2.7.3. Where there is a possibility of injury from caustic cleaning materials, flying particles, splatters or chips, eye and face protection shall be worn, as appropriate.

25.19.2.7.4. Training. First aid training shall be provided at installation level for AAS individuals in need of such training. An initial group of first aid instructors shall be trained either by installation medical services or the American Red Cross. These instructors shall be responsible for providing first aid training for AAS personnel.

IAW AFH 36-2218, Volume 1, *Self Aid and Buddy Care*, individuals requiring this training shall be locally identified by the AAS supervisor, installation FES Flight and BE. The installation Ground Safety office will confirm first aid training was accomplished during the unit's annual safety inspection.

25.19.2.8. Whether by the installation Medical Group, American Red Cross or other appropriate organization, CPR training shall be provided for AAS individuals in need of such training. Each unit shall establish an initial group of CPR instructors. They may acquire this training from the installation medical services, the American Red Cross or the American Heart Association.

25.19.2.8.1. Personnel whose normal daily job exposes them to energized electric circuits shall be identified by the AAS supervisor to receive this training. Identified personnel will recertify annually and provide written documentation of recertification.

25.19.2.8.2. CPR training is emergency training and is not a substitute for safe electrical work practices.

25.19.2.8.3. Electrical circuits shall always be de-energized before attempting any work unless the nature of the work itself requires that the circuits remain energized. Prior to working on electrical circuits, an energized work permit is required and prepared by a qualified supervisor prior to working on or near any energized circuit regardless of the task. Approval and endorsement of the work permit is accomplished when maintenance or repair action to energized circuits/parts is required IAW AFI 32-1064. Installation CE endorsement/approval is not needed for tasks that place the circuit or part to be worked in an electrically safe condition (de-energized), inspection actions or voltage testing. However, an energized work permit is still required and shall be completed by a qualified supervisor in order to determine the proper PPE and work procedures to be followed.

25.19.2.9. Points to Remember.

25.19.2.9.1. Walking and Working Surfaces. Essential information is included in this standard. Refer to [Chapter 7](#) for more detailed information on walking surfaces, openings and holes.

25.19.2.9.1.1. The entrance to BAK-9 and BAK-12 pits is hazardous because of the ladder and hatchway counterweight proximity and the presence of the sump pump pit. Use extreme caution in both areas. Workers shall be trained in confined spaces and entry procedures IAW [Chapter 23](#). The CSPT will determine if the barrier pits are classified as confined spaces.

25.19.2.9.1.2. Use the two-person policy when working on the BAK-9 and BAK-12 due to pit cover weight and underground location, etc.

25.19.2.9.1.3. Be observant of liquid spills. Most fluids associated with the AAS are very slippery and can result in serious injury.

25.19.2.9.2. Active Runway Precautions. Communication is the key to controlling this hazard. Ensure continuous communication is maintained between the tower and operations during all phases of maintenance and operations. Contact installation

Airfield Manager or designated representative for training requirements and qualifications for operating vehicles on an airfield.

25.19.2.9.2.1. Maintain proper runway clearance as prescribed by local regulation. When approaching an active runway, do not proceed to a point beyond the runway hold position, or an equivalent distance from the runway edge without proper clearance from the Air Traffic Control tower.

25.19.2.9.2.2. Maintain adequate clearances to all types of engagements. **Note:** There is a hazard of the pendant or tape breaking, causing a whiplash of the extended tape or pendant.

25.19.2.9.2.3. Rotating Machinery Precautions. Rotating machinery is a hazard with all AAS. Use extreme caution during rewind operations and checkouts. Refer to 35E-8-series TOs and **Chapter 18**, *Machinery*, for detailed guidance.

25.19.2.9.2.4. High Voltage Precautions. High voltages are present in the BAK-9 system and airfield lighting system components; use caution and two-person policy.

### 25.19.3. Runway Barriers.

25.19.3.1. When engaging aircraft, the facilities (above or below ground) housing the arresting equipment shall be evacuated. Dangers arise from inhaling vapors or brake pad dust, which may contain asbestos particles. In addition, equipment failure can cause debris to fly about. Operators shall remain clear of the tape sweep area. Bailout alarms shall be included in barrier buildings to allow notification to evacuate the facilities by the tower.

25.19.3.2. When engaging an aircraft, personnel shall be behind the runway holding position, and at least 25 feet from the arresting system energy absorber. For MA-1A, E-5, and BAK-15 systems, personnel should retreat a distance equal to the span between the edge sheaves or 1.5 times the runway width, whichever is greater, but no closer than a distance equal to that of the runway holding position.

25.19.3.3. Each operator shall be trained in the use of hand signals IAW AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arresting Systems*, and any applicable TOs.. Refer to **Figure 35.21** for additional guidance.

25.19.3.4. When returning to a facility (above or below ground) after an engagement or to clean the equipment, protective clothing and respiratory protection may be necessary. Refer to BE's OEH risk assessment to determine if type of clothing and respiratory protection are recommended. This information shall be posted in each AAS facility.

25.19.3.5. All arresting systems (barriers) require a minimum of three (3) operators. Underground arresting systems require additional operators. Refer to applicable TO 35E8-series for additional requirements.

25.19.3.6. All operators shall be aware when cable is being rewound.

25.19.3.7. Sufficient ventilation shall be provided during maintenance or rewinding operations.

25.19.3.8. Operators shall be made aware of tripping hazards when using barriers. Hearing and respiratory protection shall also be used, as required.

**25.20. Personal Protective Equipment (PPE) for CE Operations.** Following is a quick reference guide to PPE that may be required for selected activities and equipment in CE operations. It is not all inclusive and the omission of an activity or item of equipment does not mean PPE is not required. The supervisor is ultimately responsible for providing and enforcing wear of PPE determined as recommended or required for the process by the installation Ground Safety or BE. Specific PPE for each work area and person is determined through coordination with the supervisor, unit commander, Ground Safety office and BE. BE is the OPR and installation authority for determination of respiratory protection IAW AFOSH Standard 48-137. All questions concerning respiratory protection shall be addressed to BE. The worker is responsible for the care and proper use of PPE provided. PPE shall be provided and used by workers wherever inhalation, absorption or physical contact injuries may occur. Refer to [Chapter 14, Personal Protective Equipment \(PPE\)](#), for additional information on PPE. **Note:** For respiratory protection, consult BE's OEH risk assessment.

**Figure 25.1. Personal Protective Equipment (PPE) For CE Operations.**

<b>Personal Protective Equipment (PPE) For CE Operations</b>	
<b>OPERATION</b>	<b>MINIMUM PPE REQUIRED</b>
<b>Operating Construction Equipment:</b>	
Dump Truck, Roller, Paver	Safety-toe boots Gloves Head protection
Loader, Grader, Sweeper, Backhoe, Bulldozer	Safety-toe boots Gloves Head protection Eye protection (if dusty) Hearing protection Respiratory protection (if dusty)
Crane	Safety-toe boots Gloves Hearing protection Head protection



<b>Pavement Maintenance Equipment:</b>	
Jackhammer, Pneumatic Drill/Tools	Respiratory protection Safety-toe boots Eye protection Face protection Hearing protection Gloves: Chemical resistant, vibration dampening (if required) Head protection
Concrete Saw, Router, Pavement Grinder	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Gloves: Chemical resistant, vibration dampening (if required) Head protection
Asphalt Kettle	Safety-toe boots Eye protection Gloves Apron Respiratory protection
Concrete Mixer	Safety-toe boots Eye protection Respiratory protection Hearing protection (if noisy) Head protection
<b>Landscape Maintenance Equipment:</b>	
Walk-Behind Mower, Powered Edger	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Head protection Safety-toe boots
Riding Mower	Eye protection Hearing protection Respiratory protection (if dusty)

Tractor-Towed Mower	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Gloves Head protection
Chain Saw	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Gloves Head protection Leggings
Powered Auger Rototiller	Safety-toe boots Eye protection Hearing protection Gloves Head protection
Stump Cutter, Chipper	Safety-toe boots Eye protection Hearing protection Gloves Head protection
Lawn Roller	Safety-toe boots Gloves
Fertilizer Handling and Application	Safety-toe boots Eye protection Respiratory protection Coveralls Gloves (chemical resistant)
Stationary Woodworking Machinery	Eye protection Hearing protection Respiratory protection (if dusty)
Portable Power Tools	Eye protection Hearing protection Respiratory protection (if dusty)

Powder-Actuated Tools	Eye protection Hearing protection
General Carpentry, Painting, Plumbing, Sheet Metal, Welding and Masonry	Safety-toe boots Gloves (chemical resistant) Eye protection Face protection Knee pad protection (if extended kneeling) Hardhat (overhead hazards) Respiratory protection (if Required by BE)
Roofing	Fall protection Eye and burn protection (if using asphalt, e.g., gloves, long sleeve shirts, aprons, etc.) Head protection
Soldering, Brazing, Welding	Safety-toe boots Eye protection Gloves Respiratory protection (if required)
Spray Painting	Eye protection Respiratory protection (if using dry tints) Gloves Coveralls
Paint Mixing	Eye/Face protection Respiratory protection (if using dry tints) Gloves
Working in Sewers	Respiratory protection Gloves Rubber boots Coveralls Head protection

Metal-Working Machinery	Safety-toe boots Eye protection Gloves Head protection (if overhead crane system is in use) Hearing protection
Mixing Concrete or Mortar	Safety-toe boots Gloves Eye protection Respiratory protection Hearing protection
Placing Brick or Block, etc.	Safety-toe boots Gloves Eye protection
Cleaning Masonry	Eye protection Acid resistant gloves
Working Below Other Workers	Eye protection Head protection
General Refrigeration or Heating Work	Safety-toe boots Gloves (chemical resistant)
Exterior Electric Work or Overhead Distribution (AFI 32-1064, <i>Electrical Safe Practices</i> , and ETL 06-9, <i>ARC Flash PPE</i> )	Head protection Fall protection (safety harness, lanyard) Electrician gloves Safety-toe boots ARC Flash PPE (if required)
General Interior Electric and Power Production Work or Barrier Maintenance	Safety-toe boots ARC Flash PPE (if required) Eye protection Gloves Respiratory Protection ARC Flash PPE (if required)

Battery Work (Liquid Electrolyte)	Safety-toe boots Acid resistant gloves and apron Eye and face protection
General Water or Waste Work	Safety-toe boots Gloves (chemical resistant) Splash protection for face Life vest
Water or Waste Laboratory	Eye protection Respiratory protection Chemical resistant gloves Chemical resistant apron
General Materials Handling	Safety-toe boots Gloves Hard hat (overhead hazard)

**25.21. Civil Engineering Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

25.21.1. Are lines completely drained of existing air prior to opening compressed air lines and are new lines completely secured prior to air entry into the system? Reference [25.6.5](#)

25.21.2. Are the front bucket (if so equipped) and outriggers of a backhoe in fully-down positions before digging is attempted? Reference [25.12.1](#)

25.21.3. Is the entire area where the backhoe digging arm may swing cleared of personnel? Reference [25.12.1](#)

25.21.4. Is backhoe operation under energized lines permitted only when absolutely necessary and are these operations approved by the commander? Reference [25.12.1](#)

25.21.5. During travel to and from worksites, is the backhoe completely folded, secured and centered? Reference [25.12.1](#))

25.21.6. During mobile crane operation, is a person appointed to provide signals to the operator? Reference [25.12.2.3.2](#)

25.21.7. Before leaving a crane unattended, are all shutdown procedures performed? Reference [25.12.2.3.5](#)

25.21.8. Are crane load weights determined before lifting? Reference [25.12.2.4.1](#)

25.21.9. Are crane outriggers, when required, set before lifting, telescoping the boom or turning a load within the ratings? Reference [25.12.2.4.1](#)

25.21.10. Are loads transported on cranes specifically designed for this purpose? Reference [25.12.2.4.2](#)

- 25.21.11. Are crane outriggers used, regardless of the load, when the ground is soft or otherwise unstable? Reference [25.12.2.4.12](#)
- 25.21.12. When two or more cranes are used to lift one load, is one person designated as the responsible individual? Reference [25.12.2.4.14](#)
- 25.21.13. Are normal routes for assigned cranes designated and approved by safety? Reference [25.12.2.5](#)
- 25.21.14. Are required safety measures such as securing the empty hook, attaching warning flags (as necessary), etc., taken before the crane is moved to a new job site? Reference [25.12.2.5](#)
- 25.21.15. Are all parts of the crane and load restricted within 10 feet of an energized power line? If this is not practical, is the line de-energized and visibly grounded? Reference [25.12.2.7.2](#)
- 25.21.16. Are additional clearances assured for work near lines greater than 50 kV and are they listed on AF Form 103, *Base Civil Engineering Work Clearance Request*? Reference [25.12.2.7.3](#)
- 25.21.17. Is a permanent sign posted within the crane cab warning of electrical power line dangers and restrictions? Reference [25.12.2.7.4](#)
- 25.21.18. Is an approved fire extinguisher kept in the crane cab? Reference [25.12.2.10](#)
- 25.21.19. Are dump trucks operated within the load capabilities established by the manufacturer and consideration given to the specified weights of the material being carried? Reference [25.12.3](#)
- 25.21.20. If dump truck loads pose a flying debris hazard is the load covered with a tarp or similar covering? Reference [25.12.3](#)
- 25.21.21. Before dumping the vehicle's load, do operators check overhead clearance both directly over the vehicle and ahead of it in the direction to be traveled while the body is still raised? Reference [25.12.3](#)
- 25.21.22. Are sweepers operated on airfields in direct contact with control tower or escorted by a vehicle that is? Reference [25.12.7](#)
- 25.21.23. Is a good water supply maintained during concrete saw operations? Reference [25.12.9](#)
- 25.21.24. Are proper lifting techniques used during pavement breaker (jackhammer) operation and transport? Reference [25.12.10](#)
- 25.21.25. Are concrete mixers supported in stable positions prior to operation? Reference [25.12.12](#)
- 25.21.26. Are kettles operated only if FES Flight approval has been obtained? Reference [25.12.14.1](#)
- 25.21.27. Is an appropriate fire extinguisher available near the kettle? Reference [25.12.14.5](#)

- 25.21.28. Are kettles watched closely to ensure the safe heating temperature specified by the product manufacturer is maintained during heating? Reference [25.12.14.6](#)
- 25.21.29. Is material eased into the kettle to prevent splashing? Reference [25.12.14.6](#)
- 25.21.30. Are open flames or other sources of ignition not permitted near material heated to its flash point? Reference [25.12.14.7](#)
- 25.21.31. Are air supply lines marked or tagged to identify the maximum psi on the lines? Reference [25.12.17.1](#)
- 25.21.32. Are woodworking machines shut down, locked out and tagged during maintenance? Reference [25.13.2.1](#)
- 25.21.33. When machine guards are removed for authorized maintenance, is the machine locked out and tagged? Reference [25.13.2.1](#)
- 25.21.34. Are industrial ventilation systems installed where machines that develop fine dust or other airborne contaminants are used? Reference [25.13.3.1](#)
- 25.21.35. Do industrial ventilation systems exhaust to an enclosed collection container? Reference [25.13.3.3](#)
- 25.21.36. When lumber is stored in tiers, is it stacked, blocked and interlocked? Reference [25.13.4.1](#)
- 25.21.37. When stock cannot be safely handled by hand, is suitable mechanical handling equipment available and used? Reference [25.13.4.2](#)
- 25.21.38. Are roofing materials segregated and stored in stable stacks that are safe from falling? Reference [25.13.5.2](#)
- 25.21.39. Do workers take appropriate fall prevention measures, as required? Reference [25.13.5.4](#)
- 25.21.40. Are tar kettles and pots located so they will not pose a fire hazard during roofing operations? Reference [25.13.5.10](#)
- 25.21.41. Are workers aware of potential hazards associated with use of Portland Cement? (Reference [25.13.6.1](#))
- 25.21.42. Are gears, pulleys, chains or belts on power mixers adequately guarded? Reference [25.13.6.6](#)
- 25.21.43. Is the power source for electrically operated mixers grounded? Reference [25.13.6.6](#)
- 25.21.44. Are locations of underground utilities identified prior to any excavations? Reference [25.13.6.7.1](#)
- 25.21.45. Are operators trained and familiar with operating instructions of torches and furnaces before being permitted to use them? Reference [25.15.4.1.1](#)
- 25.21.46. Are torches and furnaces restricted from use where flammable or explosive environments may be present? Reference [25.15.4.1.2](#)

- 25.21.47. Is the use of gasoline torches and furnaces prohibited in small, unventilated spaces? Reference [25.15.4.1.3](#)
- 25.21.48. Are appropriate fire extinguishers available as required during torch and furnace operations? Reference [25.15.4.1.5](#)
- 25.21.49. Are electric soldering irons grounded unless double insulated? Reference [25.15.4.2.3](#)
- 25.21.50. Are soldering irons placed in suitable non-combustible receptacles when not in use? Reference [25.15.4.2.3](#)
- 25.21.51. Are industrial waste manholes treated as confined spaces and appropriate safety measures taken prior to entry? Reference [25.15.5](#)
- 25.21.52. Are proper pry bar tools, special lifting tools, and additional help used when lifting manhole covers as necessary? Reference [25.15.6.1](#)
- 25.21.53. Are tools used to repair leaks or perform maintenance on gas lines spark-free and is clothing static-free? Reference [25.15.7](#)
- 25.21.54. Are atmospheric conditions tested prior to entry into tunnels, pits and sumps? Reference [25.15.8.1](#)
- 25.21.55. Are tunnels, pits, and sumps (which are known to be contaminated) tagged or identified for information of work crews? Reference [25.15.8.1](#)
- 25.21.56. Is a second person available to provide emergency assistance (without entry) for persons entering a confined space manhole or vault? Reference [25.15.8.3](#)
- 25.21.57. Is all gas piping guarded or shielded to protect workers from accidental contact? Reference [25.16.2.1](#)
- 25.21.58. Are all equipment room belts, pulleys and rotating shafts adequately guarded? Reference [25.16.2.2](#)
- 25.21.59. Are compressed gas cylinders adequately stored and handled? Reference [25.16.3](#)
- 25.21.60. Are written operating procedures and detailed checklists for operator guidance posted in all equipment rooms with boilers? Reference [25.17.1](#)
- 25.21.61. Are purge procedures with necessary interlocks developed for normal boiler start-up and on-line operations? Reference [25.17.1.2](#)
- 25.21.62. Is water in boilers maintained at proper levels and checked as required? Reference [25.17.2.1](#)
- 25.21.63. Are water columns monitored to ensure connections are clear and water returns to proper levels when drain valves are closed? Reference [25.17.2.1](#)
- 25.21.64. Are appropriate actions taken when water is not visible in the gauge glass? Reference [25.17.2.1](#)
- 25.21.65. Are furnace boilers and breaching ventilated prior to lighting? Reference [25.17.2.2](#)



- 25.21.66. Are boilers, flame safeguard supervisory systems and other safety controls inspected during scheduled shutdowns (at least annually) by authorized inspectors? Reference [25.17.3.3](#)
- 25.21.67. Are all 4-inch and larger steam valves or main steam valves operated only by authorized personnel? Reference [25.17.4.1](#)
- 25.21.68. Are high-pressure steam valves in enclosed areas or confined spaces prevented from releasing steam through the use of a double block and bleed or similar system? Reference [25.17.4.2](#))
- 25.21.69. Are drain valves opened and water removed from steam lines prior to opening high-pressure steam valves? Reference [25.17.4.5](#)
- 25.21.70. Is pressure relieved through all possible means prior to dismantling a valve? Reference [25.17.4.8](#)
- 25.21.71. Are all vaults, manholes, and tanks considered confined spaces and proper precautions taken, e.g., atmospheric testing, use of respirators, etc., prior to entry or otherwise proven not hazardous? Reference [25.17.5.1](#)
- 25.21.72. Are all boilers equipped with steam and water gauges, gauge cocks, safety and blowoff valves and low water cutoff devices? Reference [25.17.6.1.1](#)
- 25.21.73. Are boiler feedlines equipped with check and cutoff valves? Reference [25.17.6.1.1](#)
- 25.21.74. Are water gauge glasses located less than 15 feet from the floor or tender's platform carefully guarded? Reference [25.17.6.1.1](#)
- 25.21.75. Are pressure gauges inspected and tested every 12 months? Reference [25.17.6.1.1](#)
- 25.21.76. Are safety valves for boilers tested at the frequencies and by the methods prescribed in the National Board Inspection Code? Reference [25.17.6.1.1](#)
- 25.21.77. Are safety and blowoff valve discharge pipes located where discharge will not create a hazard? Reference [25.17.6.1.4](#)
- 25.21.78. Are discharge lines from hot water heater relief valves arranged with the outlet within six (6) inches of the floor, and not threaded, capped or plugged? Reference [25.17.6.1.4](#)
- 25.21.79. Are boilers operated at pressures within manufacturer's stamped instructions or at pressures determined by the most recent boiler inspection, whichever is lower? Reference [25.17.6.1.5](#)
- 25.21.80. Are hoistways, machinery, conveyors, gears, ash sluices, and reciprocating pumps properly guarded? Reference [25.17.6.1.14](#)
- 25.21.81. Are all boiler furnaces operating at 30,000,000 BTU per hour or more staffed at all times? Reference [25.17.6.2](#)
- 25.21.82. Are all eyewash units and emergency showers operable and inspected? Reference [25.17.6.3.4.3](#)
- 25.21.83. Are all chemicals stored properly? Reference [25.17.6.3.5.1](#) – [25.17.6.3.6.3](#)
- 25.21.84. Are railroad coal cars posted with signs as required? Reference [25.17.6.4.3](#)

- 25.21.85. Is there a qualified brakeman, other than coal-handling personnel, working with the crane or switch engine? Reference [25.17.6.4.5](#)
- 25.21.86. Are safety precautions established and followed whenever coal storage facilities are entered? Reference [25.17.6.5.2](#)
- 25.21.87. Are relief valves installed after pumps on fuel pumping lines? Reference [25.17.6.6.3](#)
- 25.21.88. Are required procedures and methods used in all areas addressed in this chapter when entering system components that can be classified as confined spaces? Reference [25.18.1](#)
- 25.21.89. Are chemical treatment rooms that are identified as potential IDLH areas equipped with a telephone located outside the IDLH area, or are other means of communication used? Reference [25.18.1.7](#)
- 25.21.90. Are mechanical exhaust systems in chemical treatment rooms turned on prior to entry? Reference [25.18.1.7](#)
- 25.21.91. At shredding and grinding stations, is power turned off and locked out before servicing? Reference [25.18.3.2.2](#)
- 25.21.92. Are guards and screens in place at shredding and grinding stations? Reference [25.18.3.2.3](#)
- 25.21.93. Are approved life vests and lifelines located around sedimentation basins? Reference [25.18.3.6.5](#)
- 25.21.94. Are guards provided around moving parts of clarifiers? Reference [25.18.3.6.7](#)
- 25.21.95. Are guardrails in place for work areas and walkways around aeration tanks? Reference [25.18.3.13.1](#)
- 25.21.96. Are approved life vests with lifelines located at appropriate points around aerator rails? Reference [25.18.3.13.2](#)
- 25.21.97. Are life vests available and worn when working in a boat or raft on stabilization ponds? Reference [25.18.3.14.3](#)
- 25.21.98. Are laboratories clean and chemicals stored properly? Reference [25.18.5.2](#)
- 25.21.99. Is all electrical equipment properly grounded in laboratories? Reference [25.18.5.4.4](#)
- 25.21.100. Is good housekeeping maintained in all AAS operations and maintenance areas? Reference [25.19.2.1](#)
- 25.21.101. Are flammable and combustible liquids stored, used and handled IAW [Chapter 22, Flammables and Combustibles](#)? Reference [25.19.2.3](#)
- 25.21.102. When using compressed air for cleaning is air pressure less than 30 psi and is required PPE used? Reference [25.19.2.4.1](#)
- 25.21.103. When working on active runways, is continuous communication maintained with the tower and operations? Reference [25.19.2.9.2](#)

25.21.104. Are facilities housing the AAS evacuated to proper distances prior to aircraft engagement? Reference [25.19.3.1](#)

25.21.105. Are the minimum number of operators available IAW applicable TOs? Reference [25.19.3.5](#)

## Chapter 26

### AGRICULTURAL TRACTORS AND IMPLEMENT ATTACHMENTS

**26.1. Hazards and Human Factors.** Injury to workers and damage to equipment are usually the result of careless or improper handling of tractors and the attached implements. The failure of workers to install and maintain guards at the point of operation, unauthorized removal of guards or controls, improper maintenance and unsafe operating practices are principal sources of mishaps. Tractor operators are exposed to many conditions which can affect their ability to safely operate equipment. Fatigue, equipment, vibration and environmental conditions such as noise, dust, engine exhaust, noxious fumes, temperature and climate may impair their physical condition and affect their awareness and judgment. Tractor operators must be acutely aware of pedestrian traffic in high noise areas such as aircraft parking ramps and taxiways, since the equipment shall normally not be heard and other personnel will not be aware of their presence. Operator training, environmental controls, maintenance programs and job planning shall eliminate the majority of hazards generated by or encountered in the operation of agricultural tractors and equipment.

#### **26.2. Requirements.**

26.2.1. Procurement. Agricultural tractors procured for the Air Force shall meet the requirements of 29 CFR 1928.51, *Rollover Protective Structures (ROPS) for Tractors Used in Agricultural Operations*, and military specifications. Where commercially available, agricultural tractors and implement attachments shall be purchased with noise levels at the operator position of less than 85 Decibels-A-Weighted (dBA).

#### 26.2.2. Supervisor's Responsibilities.

26.2.2.1. Ensure operators have completed a Commander approved training program IAW AFI 24-301, *Vehicle Operations*, for agricultural tractor operations. The program shall include, at a minimum, training on safe operating procedures and practices dictated by the work environment. Refer to paragraph 26.2.4 and AFI 24-301, paragraph 8.17. for additional information.

26.2.2.2. Be knowledgeable of terrain conditions in all areas of operation, especially where the degree of slope is at or exceeds a 4-inch (20-25°) drop or rise per foot of travel.

26.2.2.3. Identify hazardous areas to operators, particularly those where the use of agricultural tractors is prohibited.

26.2.2.4. Ensure availability and use of PPE that minimizes the possibility of injury to operators. These shall normally consist of:

26.2.2.4.1. Safety spectacles with side shields or goggles.

26.2.2.4.2. Hard hats when danger exists from falling objects and overhead obstructions.

26.2.2.4.3. Leather shoes or boots with a minimum of Class 75 safety-toe.

26.2.2.4.4. Leather or coated fabric gloves.

- 26.2.2.4.5. Noise and respiratory protection when determined necessary by BE.
  - 26.2.2.5. Ensure operators understand that no other riders are permitted on the tractor.
  - 26.2.2.6. Ensure operator's manual is accessible and warning decals are properly placed on tractor and implement attachments.
  - 26.2.2.7. Ensure operators are both physically and mentally fit before operating a tractor or implement attachment(s). Operators shall not be fatigued, stressed or on any medication, alcohol or drugs that may hinder safe operation of tractor or machinery.
  - 26.2.2.8. Ensure the tractor is only used for tasks it was designed for.
- 26.2.3. Operator's Responsibilities.
- 26.2.3.1. Operators shall wear and maintain the required PPE during all operations.
  - 26.2.3.2. All guards shall be kept in place when the tractor and implement attachments are in operation.
  - 26.2.3.3. Items not permanently installed, such as tools, radios, water coolers, shall be secured so they do not pose a hazard to operators and equipment should the tractor malfunction or overturn.
  - 26.2.3.4. Riders other than the operator shall not be permitted.
  - 26.2.3.5. Tractors equipped with cabs, operators shall clear the windshield and other transparent surfaces of ice, snow, dirt, grass and other obstructions to vision prior to use. Cracked or severely scratched windshield or transparent surfaces for vision shall be reported and repaired or replaced.
  - 26.2.3.6. Operators shall ensure all other personnel are safely clear of machinery prior to operation of the tractor or any attachment(s).
  - 26.2.3.7. Operators shall stop the engine, disconnect the power source, and wait for all machine movement to stop before servicing, adjusting or cleaning the equipment, except where the machine must be running to be properly serviced or maintained. In this case, the operator shall follow all steps as listed within the manufacturer's procedures or technical data to safely service or maintain the equipment.
  - 26.2.3.8. Operators shall be especially alert when operating over rough ground and limited access areas, and shall reduce vehicle speed when operating on sloping terrain. Mowing operations shall not be performed on slopes at or greater than a 4-inch (20-25°) drop or rise per foot of travel. When the operator is in doubt as to the degree of slope, the operation shall cease until the degree of slope is confirmed. When using a sickle bar to mow slopes, the sickle bar shall be placed on the up-slope side of the tractor.
  - 26.2.3.9. Operators shall park tractors on level surfaces. The implement attachment shall be lowered to rest on the surface. After the engine has stopped, the transmission shall be placed in low or reverse. Automatic transmissions shall be placed in "park" and the engine shall be shut off before the operator departs or dismounts the equipment. For flex-winged mowers, ensure that the appendages are folded in the "up" position and the locking pins are securely in place.

26.2.4. Training. Every employee who operates an agricultural tractor shall be trained in safe operating procedures and practices dictated by the work environment IAW the Commander's approved training program. A training plan shall be developed and, at a minimum, shall include all attachments used by the organization and a copy of the most recent noise hazard survey. Refer to paragraph 26.2.2.1 for additional guidance. Specific requirements for licensing and training of operators of agricultural tractors will be documented IAW AFI 24-301.

#### 26.2.5. Inspection and Maintenance.

26.2.5.1. The operator shall inspect the equipment prior to initial startup on each shift. Walk around the tractor and inspect for faults. Inspection shall also include: tire condition, ensure tires are properly inflated; fuel, oil and coolant levels; lubrication; exhaust system; lights and flashers; security of bolts and nuts; implement mountings; and minor adjustments, such as seat position, cutting height, tread width and tractor weights. The operator shall also inspect to ensure machine guards are properly installed and functioning, and verify safety signs are free from obstruction and ensure fire extinguishers are in place, as required. The AF Form 1800 shall be used as an inspection checklist and signed by the operator prior to use.

26.2.5.2. Immediately upon starting the vehicle, the operator shall check for oil pressure and braking devices shall be checked for serviceable condition. Steering shall be checked for excessive play, which may cause a steering problem.

26.2.5.3. Operators or qualified maintenance workers shall perform minor maintenance required to ensure safe operation of the vehicle.

26.2.6. Rollover Protection. Agricultural tractors with engines exceeding 20 horsepower shall be fitted with Rollover Protection Structures (ROPS). If a tractor is not equipped with ROPS, it shall not be operated on sloped areas. ROPS-equipped tractors shall be furnished with seat belts meeting the requirements set forth in Society of Automotive Engineers (SAE) Standard J4C, *Motor Vehicle Seat Belt Assemblies*. Where a suspended (i.e., air ride or shock absorber equipped) seat is used, the seatbelt shall be fastened to the movable portion of the seat to accommodate the ride motion of the operator. Safe driving and operating procedures shall reduce the risk of rollover. ROPS shall not prevent a tractor from overturning, but should a rollover occur, the protective structure shall minimize/prevent injury. Matching speed of the operating conditions, avoiding slopes that are too steep, watching for depressions on the downhill side and bumps on the uphill side, using engine braking when going downhill, and slowing down before turning are good operating procedures to mitigate or prevent rollovers. Additionally, the following practices shall reduce the risk of rear overturn: start forward motion slowly, change speed gradually, and, if possible, avoid backing downhill.

26.2.7. Seatbelts shall be worn at all times while operating tractors equipped with ROPS. Seatbelts shall not be worn while operating tractors not equipped with ROPS.

26.2.8. Hazardous Noise Warnings. If the noise level at the operator position is 85 dBA or greater, tractors shall be marked with a placard stating: "*Caution – Hazardous Noise – Operator Ear Protection Required.*" A noise hazard survey shall be conducted IAW DoDI

6055.12, *Hearing Conservation Program*, and a copy of the completed survey shall be attached to the unit training plan.

26.2.9. Vehicle Emblems. Each agricultural tractor shall have a “Slow Moving Vehicle” emblem affixed on the rear that is clearly visible to all traffic approaching the tractor from the rear. Care shall be exercised to prevent obstructing the rear view of the operator. Agricultural tractors that are operated in high traffic areas and at night shall also be equipped with a flashing amber caution light to ensure visibility of the tractor from all directions. Tractors operating at night shall have headlights installed and used during hours of darkness.

26.2.10. Guarding and Shielding.

26.2.10.1. All power take-off shafts, including rear-, mid-, or side-mounted shafts, shall be shielded to protect employee from contact with moving machinery parts.

26.2.10.2. Guards shall be capable of withstanding 250 pounds of force applied downward or inward.

26.2.10.3. Guards shall be free of burrs and sharp edges or corners, and shall be securely fastened to the equipment.

26.2.10.4. Guards may be removed for servicing or adjusting attachments only after the tractor has been stopped, the motor shut off, and all shafts, pulleys, and gears have ceased rotating, except where machinery must be running to be properly serviced or maintained. Guards shall be reinstalled prior to restart of the equipment for operation.

26.2.10.5. Agricultural tractors and implement attachments may be “field modified” for uses other than those intended by the manufacturer when the modification has been certified in writing by the manufacturer or equivalent entity. The manufacturer or equivalent entity must certify that the safety of the modified equipment has not been compromised during modification.

26.2.11. Protection from Spillage. Batteries, fuel tanks, oil reservoirs and coolant systems shall be constructed and located or sealed to assure that spillage, which may come in contact with the operator in the event of an upset, shall not occur.

26.2.12. Flight Line Operations. When an agricultural tractor is on or in the vicinity of the flight line, a “Slow Moving Vehicle” emblem shall be affixed on the rear that is clearly visible to all traffic approaching the tractor from the rear. Passengers shall not be allowed to ride on tractors. Tractors shall remain in contact with the tower at all times. Operators shall coordinate with airfield management to remediate any FOD created by the use of equipment on/near the flight line. Refer to **Chapter 24, *Aircraft Flight Line – Ground Operations and Activities***, for further guidance.

26.2.13. Operations during inclement weather will adhere to local policies concerning lightning warnings and watches. Additional weather information may be found in **Chapter 11, *Weather Safety***.

**26.3. Agricultural Tractors and Implement Attachments Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to

this checklist to include Command or individual location or shop-unique requirements and/or situations.

26.3.1. Do design and operating characteristics of agricultural tractors in use by AF units meet OSHA Standards? Reference [26.2.1](#)

26.3.2. Do supervisory personnel take needed actions to ensure proper training of assigned operators? Reference [26.2.2.1](#)

26.3.3. Do supervisory personnel ensure operators are aware of area operating hazards due to terrain features and conditions? Reference [26.2.2.2](#)

26.3.4. Do supervisory personnel ensure operators are aware of hazardous or prohibited areas? Reference [26.2.2.3](#)

26.3.5. Do supervisory personnel ensure operators have PPE such as head, eye and ear protectors, gloves, respirators, etc.? Reference [26.2.2.4](#)

26.3.6. Is the operator's manual accessible and are warning decals properly placed? Reference [26.2.2.6](#)

26.3.7. Is the operator both physically and mentally fit, not fatigued or stressed, or on any medication, alcohol or drugs that may hinder safe operation of the tractor and machinery? Reference [26.2.2.7](#)

26.3.8. Is the tractor only used for tasks it was designed for? Reference [26.2.2.8](#)

26.3.9. Does the operator walk around the tractor and inspect for faults:

1. Check radiator coolant level when cold?
2. Visually inspect all tires?
3. Ensure tires are properly inflated?
4. Ensure lights and flashers are operational?
5. Verify safety signs are free from obstruction?
6. Ensure first aid kit and fire extinguisher are in place, as required?
7. Check oil and fluid levels?
8. Braking devices and excessive play in steering wheel after start-up?

References [26.2.3.2.](#) and [26.2.5.](#)

26.3.10. Does the operator wear the required PPE during all operations? Reference [26.2.3.3](#)

26.3.11. Are all guards secured in place and kept in place during machine use? Reference [26.2.3.4](#)

26.3.12. Are items not permanently installed, such as tools, radios, water coolers, etc., secured so they do not pose a hazard to operators or equipment should the tractor malfunction or overturn? Reference [26.2.3.5](#)

26.3.13. Does the operator prohibit other riders from riding on the tractor? Reference [26.2.3.6](#)

26.3.14. Does operator clean the windshield and other transparent surfaces of ice, snow, dirt, grass and other obstructions from tractors equipped with cabs to ensure clear vision prior to use? Reference [26.2.3.7](#)



- 26.3.15. Does the operator ensure cracked or severely scratched windshield or transparent surfaces for vision are reported and repaired or replaced? Reference [26.2.3.7](#)
- 26.3.16. Does the operator keep personnel clear of operating machinery or attachments? Reference [26.2.3.8](#)
- 26.3.17. Does the operator stop the engine, disconnect the power sources, and wait for all machine movement to stop before servicing, adjusting, or cleaning the equipment (except where the machine must be running to properly service or maintain the equipment)? Reference [26.2.3.9](#)
- 26.3.18. Do mowing machine operators refrain from attempting to mow on slopes that exceed 4 inches (20-25°) of drop or rise per foot of travel? Reference [26.2.3.10](#)
- 26.3.19. When using a sickle bar attachment for mowing, does the operator always position the sickle bar on the up-slope side of the tractor? Reference [26.2.3.10](#)
- 26.3.20. Does the operator park the tractor on a level surface, lower the attachment so it rests on the surface, place the transmission in low or reverse after the engine has stopped (automatic transmission in “park”) and shut the engine off, before the operator dismounts the vehicle? Reference [26.2.3.11](#)
- 26.3.21. For flex-winged mowers, does the operator ensure the appendages are folded in the “up” position and the locking pins are securely in place when parking? Reference [26.2.3.11](#)
- 26.3.22. Are all tractors with engines exceeding 20 horsepower fitted with ROPS? Reference [26.2.6](#)
- 26.3.23. Are all ROPS-equipped tractors fitted with seatbelts? Reference [26.2.6](#)
- 26.3.24. Have all tractors and attachments been subjected to a noise hazard survey and those whose noise level exceeds 85 dBA placarded with noise hazard warning? Reference [26.2.7](#)
- 26.3.25. Are approved “Slow Moving Vehicle” emblems and flashing amber light units installed on agricultural tractors used at night in high traffic areas? Reference [26.2.8](#)
- 26.3.26. Are all power takeoff shafts shielded? Reference [26.2.9.1](#)
- 26.3.27. Are guards capable of withstanding 250 pounds of downward or inward force? Reference [26.2.9.2](#)
- 26.3.28. Are guards free of burrs and sharp edges or projections and securely fastened to the unit? Reference [26.2.9.3](#)
- 26.3.29. Are all guards that were removed for servicing and maintenance reinstalled prior to placing units in use? Reference [26.2.9.4](#)
- 26.3.30. Are batteries, fuel tanks, oil reservoirs, and coolant systems constructed and located or sealed to assure that spillage will not occur in the event of an upset? Reference [26.2.10](#)
- 26.3.31. For flight line operations, does the operator ensure a “Slow Moving Vehicle” placard is affixed to the rear of the tractor, have a radio and keep in contact with the tower at all times? Reference [26.2.11](#)

## Chapter 27

### WELDING, CUTTING AND BRAZING

#### 27.1. Hazards and Human Factors.

27.1.1. Welding, cutting and brazing operations present hazardous situations which, if the proper precautions are not taken, can lead to serious injuries and/or death. Many workers have been injured because they failed to use proper personal protective equipment (PPE), used faulty equipment or from personnel error. The use of protective equipment is the least preferred method of controlling hazards and should not be relied on alone to provide protection against hazards. Protective equipment should be used in conjunction with guards, engineering controls and sound manufacturing practices. Refer to [Chapter 3](#) for additional guidance on hazards and controls. Many Air Force welding, cutting and brazing mishaps are caused by:

27.1.1.1. Inadequately trained personnel.

27.1.1.2. Poor housekeeping practices.

27.1.1.3. Poor shop layout.

27.1.1.4. Inadequate lighting and ventilation.

27.1.1.5. Improper storage and movement of compressed gas cylinders.

27.1.1.6. Exposure of oxygen cylinders and fittings to oil or grease creating a fire or explosive hazard.

27.1.1.7. Pointing welding or cutting torches at a concrete surface causing spattering or flying fragments of concrete.

27.1.1.8. Electric shock when motors, generators and other electric welding equipment are not grounded.

27.1.1.9. Inhalation of toxic fumes or vapors from welding metals or alloys.

27.1.2. Numerous hazardous chemicals and metals are used in fluxes, paints, coatings and fillers. Toxic fumes or gases are released into the atmosphere during welding, cutting and brazing operations. Material Safety Data Sheets (MSDS) provide information about the hazards associated with these products. All filler metals and fusible granular materials carry the following caution: *CAUTION - WELDING MAY PRODUCE FUMES AND GASES HAZARDOUS TO HEALTH. AVOID BREATHING THESE FUMES AND GASES. USE ADEQUATE VENTILATION.*

27.1.3. Brazing and welding filler metals containing cadmium carry the following warning: *WARNING - CONTAINS CADMIUM - POISONOUS FUMES MAY BE FORMED ON HEATING.*

27.1.4. Brazing and gas welding fluxes containing fluorine compounds carry the following precautionary wording on tags, boxes or other containers: *CAUTION CONTAINS FLUORIDES.* This flux, when heated, gives off fumes that may irritate eyes, nose and throat.

27.1.5. Cleaning and other operations involving chlorinated hydrocarbons may generate toxic vapors or mists. Refer to paragraph **27.18.6** for additional guidance.

27.1.6. Fires, explosions and injuries can occur from welding operations that are:

27.1.6.1. In the proximity of combustible solids, liquids or dusts.

27.1.6.2. In the presence of possible explosive mixtures of flammable gases and air.

27.1.6.3. In the presence of an oxygen-enriched atmosphere, where hot work is performed.

27.1.6.4. In close proximity of explosive hydrogen gas, which is formed when sulfuric acid comes in contact with mild steel.

## **27.2. Acquisition.**

27.2.1. Only American Welding Society approved apparatus such as torches, regulators, pressure reducing valves, acetylene generators, machines, manifolds, cables and hoses, etc., shall be used. In locations where the acquisition of such apparatus is not feasible, contact the installation Ground Safety office or CE for guidance.

27.2.2. Compressed gases may be purchased in either government-owned or supplier-owned cylinders. In either case, the purchase agreement shall specifically indicate that the compressed gas cylinders meet the marking requirements of 29 CFR 1910.253, *Oxygen Fuel-Gas Welding and Cutting*. In addition, they shall be inspected and shall have a safety relief device installed per the requirements in 29 CFR 1910.101, *Compressed Gases (General Requirements)*. Government-owned cylinders which are not in compliance with the above requirements shall not be used and shall be removed from service. In locations where the adherence of OSHA requirements is not feasible, contact the installation Ground Safety office or CE for guidance.

27.2.3. Only protective clothing and equipment approved by BE and installation Ground Safety office shall be used. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

27.2.4. Contractor activities involving welding, cutting and brazing shall meet requirements of 29 CFR 1910.252, *Welding, Cutting, and Brazing - General Requirements*, which may also be used as a technical reference. The contracting officer shall determine the necessity for specific references to OSHA standards, Air Force fire, safety and health standards, and other guidance as necessary in the contract. In locations where the adherence of OSHA requirements is not feasible, contact the installation Ground Safety office or CE for guidance.

**27.3. Operating Precautions.** The information listed below provides minimum guidance on operating precautions and procedures. It shall be used in conjunction with 29 CFR 1910.252 on all matters involving US Air Force welding operations. Information in 29 CFR 1910.252 may be obtained by contacting your installation Ground Safety office or visiting the OSHA website: <http://www.osha.gov>. Additional information is also available in NFPA 51B, *Standard For Fire Prevention During Welding, Cutting and Other Hot Work*.

27.3.1. Acetylene is extremely flammable and, when mixed with air, is highly explosive. Use and store acetylene cylinders in an upright position. If cylinders have been lying in a horizontal position, they must stand upright for a minimum of two (2) hours prior to use.

Never use acetylene at a pressure in excess of 15 pounds per square inch, gauge (psig); higher pressure may cause the cylinder or equipment to explode.

27.3.2. Follow manufacturer's instructions with respect to the sequence of operations in lighting, adjusting and extinguishing torch flames. Purge hoses in open spaces and away from ignition sources. Light the torch with a friction lighter or stationary pilot flame, keeping a safe distance between the torch and the welder's hands. Point the torch away from persons or combustible materials when lighting. Do not attempt to light a torch from hot metal.

27.3.3. When not in use for extended periods, i.e., 30 minutes or more, or when unattended (no one in the vicinity for observation), shut off fuel gas and oxygen supply at the tank.

27.3.4. Do not open an acetylene valve more than one and one half turns of the spindle and preferably no more than three-fourths of a turn.

27.3.5. Always open the cylinder valve slowly. Do not remove the wrench or handle used to open the cylinder from the stem of the valve while the cylinder is in use.

27.3.6. If cylinders are manifold or coupled, ensure at least one wrench is always available for immediate use.

27.3.7. Provide ventilation in shops or rooms where work is to be performed, but avoid strong drafts directed at the welding operation. Do not use oxygen to provide ventilation; this action shall accelerate combustion. Contact BE on proper ventilation requirements.

27.3.8. Never attempt to preheat or weld jacketed vessels, tanks, containers or covered parts until precautions have been taken to adequately vent/inert the space. Do not weld or cut a container or piping system containing hydrogen gas, flammable or combustible liquids, vapors or other flammable or combustible materials without first inerting the container or system. Take similar precautions for new containers since preservatives or other combustibles may be present. When applicable, ensure that the appropriate technical orders are followed. Refer to paragraph [27.11](#) for additional guidance.

27.3.9. Do not place work to be welded or heated on a concrete floor. Concrete, when heated, may spall and produce projectiles, exposing the welder to injury from flying hot particles.

27.3.10. Provide appropriate fall protection for welders and helpers when on elevated surfaces. Keep welding areas neat, clean and free from tripping hazards. Provide protection for personnel on the ground or rope off area directly below the operation. Refer to [Chapter 13](#), *Fall Protection*, [Chapter 16](#), *Mobile Elevating Work Platforms*, [Chapter 17](#), *Scaffolding*, and 29 CFR 1910.28, *Safety Requirements for Scaffolding*, for additional guidance.

27.3.11. Welding, cutting and brazing operations may produce a toxic or unhealthy atmosphere. Refer to AFI 90-821, *Hazardous Communication*, and BE guidance for ventilation requirements associated with welding operations.

27.3.12. Do not perform cutting and welding operations:

27.3.12.1. In indoor areas not approved by installation Fire Emergency Services (FES) Flight, Ground Safety office and BE. This shall ensure fire, safety and health protection

considerations shall be included in the selection of indoor welding, cutting and brazing operations.

27.3.12.2. In buildings with installed sprinkler systems when the system is inoperable, unless other means of fire detection, reporting and extinguishing have been approved by the installation FES Flight.

27.3.12.3. In explosive atmospheres or where explosive atmospheres may develop.

27.3.12.4. Within 50 feet of flammable liquids, i.e., flashpoint below 100°F.

27.3.12.5. When unable to comply with the above requirements (paragraphs [27.3.12.1](#) thru [27.3.12.4](#)), interim procedures must be established through the installation Ground Safety office, FES Flight and BE.

27.3.13. An **AF Form 592**, *USAF Hot Work Permit*, (see [Figure 27.1](#)) is required whenever there is cutting, welding or brazing being accomplished outside of the designated shop area. The directions for filling out and signing the **AF Form 592** are contained in [Table 27.2](#). The hot work permit must be obtained from the installation FES Flight prior to starting welding operations. The requirements for usage of the **AF Form 592** are outlined in paragraph [27.2](#). **Note:** BE assistance and coordination may be required, i.e., BE survey report, PPE listing/recommendation, etc.

#### **27.4. Welding Equipment Precautions.**

27.4.1. Protect welding torch hoses from damage caused by contact with hot metal, open flames, corrosive agents or sharp edges. Release pressure on hoses at the end of each workday, during lunch or break periods, when not in use for extended periods or when unattended (no one in the vicinity for observation). Visually inspect the entire length of welding hose once per shift and prior to use. This inspection is not required when equipment shall not be used during that shift.

27.4.2. Prior to use, repair or replace hoses exhibiting leaks, cuts, burns, worn spots or other evidence of deterioration. When using acetylene, ensure replacement hoses or fittings are approved for use with acetylene equipment. When parallel lengths of oxygen and acetylene hoses are taped together for convenience and to prevent tangling, not more than 4 inches in each 12 inches shall be covered by tape. Use a soap and water solution to check all recently repaired or replaced hoses for leaks; do not use an open flame. Make sure hoses and hose connections are in serviceable condition. Hose connections shall be of the ferrule type that shall withstand, without leakage, twice the normal service pressure (but not less than 300 psi). Use oil-free air or oil-free inert gas for the test. Welding hoses are color coded: oxygen hoses are green, fuel gases are red and inert-gases or air are black. Hose connections are usually marked STD-OXY for oxygen and STD-ACET for acetylene. The acetylene union nut has a groove cut around the center to indicate left-hand threads. Make-shift repairs to oxygen/acetylene hoses or connections are not authorized.

27.4.3. Provide shielding to protect personnel from heat, sparks, slag, light and ultraviolet (UV) radiation.

27.4.4. To prevent personnel from inadvertently touching hot items, post warning signs around equipment or item(s) that are left unattended during welding operations.

27.4.5. Wear appropriate PPE for the welding operation being performed. Welding in confined spaces, manholes or other restricted areas may require additional or special PPE. Refer to BE's OEH risk assessment for appropriate PPE, and paragraph 27.7 and Chapter 23, *Confined Spaces*.

27.4.6. In case of an emergency, ensure a means to quickly extract the welders is provided. Refer to Chapters 14 and 23, and AFI 90-821, *Hazard Communication*, for additional guidance.

## 27.5. Facilities.

27.5.1. Inside Areas. A specific area shall be designated and approved by the installation FES Flight and BE for welding and cutting operations. It shall be of fire resistant or noncombustible construction appropriate for its hazard classification, free of combustible and flammable materials, and segregated from adjacent areas. This area shall be exempt from requiring an AF Form 592 on a daily basis.

27.5.1.1. Where possible, welding activities shall be isolated from adjacent activities. Workers and other personnel adjacent to the welding areas shall be protected from the radiant energy or spatter of welding and cutting arcs by the use of noncombustible and/or flameproof screens.

27.5.1.2. Welding booth walls, screens and non-rigid heat and spark barriers used to isolate the welding activity shall be finished to limit reflectivity. Booths, screens, etc., shall be arranged to ensure adequate ventilation. Asbestos-containing materials shall not be used as barriers.

27.5.1.3. Where arc-welding is regularly performed adjacent to painted walls, the walls shall be painted with a finish having low reflectivity to UV radiation.

27.5.1.4. Procedures shall be established to prevent personnel entering a welding area from inadvertently being exposed to welding hazards. These procedures shall include, as a minimum, warning signs posted at all personnel entryways of designated welding areas. These signs shall mandate the use of PPE before entering a welding environment.

27.5.1.5. Combustible floors shall be kept wet and covered with damp sand or protected by fire resistant shields. Where floors have been wet down and damp sand applied, rigid control shall be exercised over the grounding of equipment and personnel shall be protected from possible shock. Caution shall be exercised against slips and falls on any wet surfaces.

27.5.1.6. A fully charged and operable fire extinguisher, appropriate for the task, shall be kept at the work area at all times while welding operations are in progress. Consult with the installation FES Flight for additional guidance.

27.5.1.7. Whenever there are cracks or other floor openings that cannot be closed or covered within 35 feet of the welding or cutting operation, precautions shall be taken to remove or otherwise protect combustible materials on the floor below that may be exposed to sparks. The same precautions shall be observed with regard to cracks or openings in walls, open doorways, and open or broken windows.

27.5.1.8. Where a fire protection system exists, the system shall be fully operational while welding or cutting work is being performed and the proper fire extinguishing equipment shall be readily available. If welding or cutting is to be conducted within three (3) feet of automatic sprinkler heads, noncombustible sheet material or damp cloth guards shall be used to temporarily shield the individual sprinkler heads. The type of shielding shall be specified on the **AF Form 592** by the issuing authority. Personnel authorized to issue permits shall:

27.5.1.8.1. Inspect the area before allowing any welding, cutting or brazing activities to begin.

27.5.1.8.2. Ensure a copy of the signed **AF Form 592** is readily available in the immediate area of the welding, cutting and brazing operations.

27.5.1.8.3. Fire watcher procedures shall be implemented whenever welding activities are within 35 feet of combustible materials, regardless of protection provided. A qualified individual proficient in the operation of available fire extinguishing equipment and knowledgeable of fire reporting procedures shall observe welding or cutting activities. Their duty is to detect and prevent the spread of fire produced by welding or cutting activities. An additional fire watcher may be required to observe areas that are hidden from the view of a single fire watcher (other side of partitions, walls, ceilings, etc.).

27.5.1.8.4. Provide a fire watch for a minimum of 30 minutes after completion of all welding, cutting and brazing work. Utilize heat sensing meters to scan for hot spots in the work. Do not leave the work area unattended during breaks in work during a work shift. Walk and scan all areas of application checking for hot spots, fumes or smoldering, especially at wall and curb areas, prior to departure at the end of each work shift. Ensure any and all suspect conditions are eliminated prior to leaving the site each work shift.

27.5.1.8.5. When fire watchers are required, upon completion of their duties they shall sign Line 14 of the hot work permit and return it to the issuing authority. If work continues for more than one day, the area shall be inspected prior to each day's operation to ensure that no conditions have changed and requirements of the original permit are in effect. The permit shall be signed and dated daily in Block 12 at the completion of each day's work until completion of operations or as required by local policy. Only the tasks authorized by the original permit shall be accomplished. Additional tasks shall require a new permit to be issued.

27.5.1.8.6. At the completion of the fire watch, the following areas shall be inspected:

27.5.1.8.6.1. The work area and all areas within five (5) feet of the work area.

27.5.1.8.6.2. If the work area is on a roof or floor above, the ceiling area and floor area on the level below the work area and void areas between the floors/roof.

27.5.1.8.6.3. If the work area is in or above any vertical chase area, the chase area on the floor below, any chase areas in the void between the work area and the

floor below, and the lowest level of the vertical chase.

27.5.2. Outside Areas. When work cannot be moved, the area shall be made fire safe by removing combustibles or protecting combustibles from ignition sources.

27.5.2.1. The welding operation shall be roped off or segregated by physical barrier whenever possible. Placards reading “*WELDING OPERATIONS IN PROGRESS*” shall be prominently displayed for warning purposes. Protective screens, when possible, shall be placed around welding operations. When screens are not feasible, workers and other personnel adjacent to the welding areas shall be required to wear appropriate personal protective goggles.

27.5.2.2. Authorization, including an **AF Form 592**, to perform welding, cutting or brazing shall be obtained from the installation FES Flight prior to the start of such operations. Refer to **Figure 27.1** and **Table 27.2** for additional information regarding **AF Form 592**. Coordination with BE may be required for welding, cutting or brazing operations involving a hazardous task, i.e., BE survey report, PPE listing/recommendation, etc. **Note:** Hazardous tasks performed in an inside area shall comply with paragraph **27.5.1**.

27.5.2.3. Fire watcher procedures shall be implemented per requirements in paragraphs **27.5.1.8.3** through **27.5.1.8.5**.

27.5.2.4. The welding operation environment shall be free of flammable liquids and vapors. Combustible materials within a radius of 35 feet of the operation shall be protected from activity residue (flame, sparks, slag, etc.).

27.5.2.5. Fire extinguishing equipment shall be maintained, ready for use, while welding or cutting operations are being performed. Equipment may consist of pails of water, buckets of sand, a hose or portable extinguisher, depending upon the nature and quantity of the combustible material exposed. The welding permit issuing authority shall identify the required fire extinguishing equipment.

27.5.2.6. MAJCOMs/installations having activities involved in numerous daily welding, cutting and brazing operations are permitted to have a certification process whereby qualified and/or certified welding personnel (other than FES Flight personnel) may issue welding permits. If work continues for more than one day, the area shall be inspected prior to each day’s operation to ensure no conditions have changed and requirements of the original permit are in effect. The permit shall be signed and dated daily in Block 12 at the completion of each day’s work until completion of the operations or as required by local policy. Only tasks authorized by the original permit shall be accomplished. Additional tasks shall require a new permit to be issued. The following procedures are applicable:

27.5.2.6.1. Personnel certified by the installation FES Flight may authorize welding, cutting and brazing operations, using **AF Form 592** for this purpose.

27.5.2.6.2. The installation FES Flight shall instruct and qualify welding shop supervisors and other selected personnel. Upon completing the required training, the



installation FES Flight shall certify the individuals in writing. Upon certification, trained personnel shall be qualified to issue permits.

### **27.6. Installed Equipment.**

27.6.1. Oxygen-Fuel gas system equipment devices or attachments used for the prior mixing of air or oxygen with flammable gases must be approved for that purpose, except devices at the burner or in a standard torch.

27.6.2. When acetylene cylinders are coupled, approved flash arresters shall be installed between each cylinder and the coupler block. For outdoor use only, and where the number of cylinders does not exceed three, one flash arrester installed between the coupler block and regulators is acceptable.

27.6.3. Backflow protection shall be provided by an approved device that shall prevent oxygen from flowing into the fuel-gas system or fuel from flowing into the oxygen system.

27.6.4. Flashback protection shall be provided by an approved device that shall prevent a flame from passing into the fuel-gas system.

27.6.5. Back-pressure protection shall be provided by an approved pressure relief device, set at a pressure not greater than the pressure rating of the backflow or flashback devices, whichever is lower.

27.6.6. These three functions of protective equipment (backflow, flashback and pressure relief devices) may be separate devices or combined into one device.

27.6.7. Clearly marked master shutoff valves shall be provided for installed systems at points where they shall be readily accessible. If a wrench is required to operate the master shutoff valves, then at least one wrench for this specific purpose shall always be readily available in the immediate area of the master shutoff valves.

**27.7. Clothing and Personal Protective Equipment (PPE).** Key portions of 29 CFR 1910.252 covering protective equipment are included here. Personnel engaged in or exposed to welding, cutting or brazing activities shall be provided and use the proper PPE. The appropriate protective clothing required for specific welding operations shall vary with the size, nature and location of the work to be performed. Refer to 29 CFR 1910.132, *Personal Protective Equipment*, AFOSH Standard 48-137, *Respiratory Protection Program*, and **Chapter 14**, for additional guidance.

27.7.1. Clothing shall provide sufficient coverage and be made of suitable materials to prevent skin burns caused by sparks, spatter, ultra violet radiation or electrical shock. Front pockets and upturned sleeves or cuffs shall be prohibited. Sleeves and collars shall be kept buttoned to prevent hot metal slag and sparks from contacting the skin.

27.7.2. All welders and cutters shall wear protective flame-resistant gloves. All gloves shall be in good repair, dry and capable of providing protection from electric shock by welding equipment. Insulated linings shall be used to protect areas exposed to high radiant energy.

27.7.3. Durable flame-resistant aprons made of leather or suitable materials shall be used to protect the front of the body when additional protection against sparks and radiant energy is needed.

27.7.4. For heavy work, flame-resistant leggings or other equivalent means shall be used to provide additional protection for the legs.

27.7.5. Cape sleeves or shoulder covers with bibs made of leather or other flame-resistant materials shall be worn during overhead welding, cutting or other operations, when necessary.

27.7.6. Caps made from flame resistant material shall be worn under helmets, when necessary, to prevent head burns.

27.7.7. Properly fitted flame-resistant plugs in the ear canals, or equivalent protection, shall be used where hazardous noise levels exist. Consult installation BE for additional guidance.

27.7.8. When controls such as mechanical or natural ventilation fail to reduce air contaminants to allowable levels or when the implementation of such controls are not feasible, respiratory protective equipment shall be used to protect personnel from hazardous concentrations of airborne contaminants. Only approved respirator equipment shall be used. Consult BE and AFOSH Standard 48-137 for additional guidance.

27.7.9. Eye Protection Requirements.

27.7.9.1. All welding helmets must meet 29 CFR 1910.252 requirements.

27.7.9.2. Eye and face protective equipment shall be inspected for serviceability prior to each use. For sanitary purposes, eye and face protectors shall not be shared by other employees. Helmets shall be used during all arc-welding or arc-cutting operations, excluding submerged arc-welding. Where the work permits, submerged arc-welders must be enclosed in an individual booth coated on the inside with a non-reflective material. When two or more welders are exposed to the hazards of each other's welding operation, goggles shall be worn under the welder's helmets or use of noncombustible or flameproof screens or shields to provide protection from harmful rays and flying debris. Helpers or attendants shall be provided with the proper PPE, to include eye protection.

27.7.9.3. Goggles or other suitable eye protection shall be used during all gas welding or oxygen cutting operations.

27.7.9.4. All operators and attendants of resistance welding, resistance brazing equipment or while chipping slag shall use transparent face shields or goggles, depending on the particular job, to protect their faces or eyes as required.

27.7.9.5. Eye protection in the form of suitable tinted goggles or spectacles shall be provided for torch brazing operations or soldering operations. Spectacles shall be equipped with side shields.

27.7.10. Specifications for Protectors.

27.7.10.1. Helmets and goggles shall be made of a material which is an insulator for heat and electricity. Helmets, face shields and goggles shall not be readily flammable and shall be capable of withstanding sterilization.

27.7.10.2. Helmets shall be arranged to protect the face, neck and ears from direct radiant energy from the arc.

27.7.10.3. Helmets shall be provided with filter plates and cover plates designed for easy removal.

27.7.10.4. All parts shall be constructed of a material which shall not readily corrode or discolor the skin.

27.7.10.5. Goggles shall be ventilated to prevent fogging of the lenses as much as practicable.

27.7.10.6. Cover lenses or plates shall be provided to protect each helmet or goggle filter lens or plate.

27.7.10.7. All glass for lenses shall be tempered and substantially free from striae, air bubbles, waves and other flaws. Except when a lens is ground to provide proper optical correction for defective vision, the front and rear surfaces of lenses and windows shall be smooth and parallel.

27.7.10.8. Lenses shall bear some permanent distinctive markings by which the source and shade may be readily identified.

27.7.10.9. All filter lenses and plates shall meet the test for transmission of radiant energy prescribed in ANSI Z87.1, *Occupational and Educational Eye and Face Protection Devices*.

27.7.10.10. Hand-held screens for shielding the face and eyes shall not be used, since they may be inadvertently held in the wrong position, thus not providing the proper protection. Refer to National Institute for Occupational Safety and Health (NIOSH) for additional guidance.

**27.8. Training and Qualification.** Trainees may perform welding only under the direct supervision of an instructor. Each person performing welding operations shall be qualified to perform these operations when they have satisfactorily demonstrated their skill or proficiency to their supervisor. Welders performing work on aircraft, aircraft components, missile or missile components shall be certified IAW TO 00-25-252, *Intermediate Maintenance and Depot Level Instructions Aeronautical Equipment Welding*.

27.8.1. Prior to commencing a welding operation outside the welding shop, supervisors shall brief the welder on safety, health, weather and fire protection concerns or issues applicable to the specific job.

27.8.2. Commanders shall ensure that supervisors and employees who handle, use or are potentially exposed to hazardous materials in the course of official Air Force duties are provided information and training on the AFHCP and specific hazards in the workplace. Refer to AFI 90-821 for additional guidance.

27.8.3. If a welding operator requires specialized safety, health or fire protection guidance not addressed in this standard or in appropriate technical data, the supervisor shall instruct the welder prior to commencement of the job. Assistance may be requested from the installation Ground Safety office, FES Flight or BE.

### **27.9. Gas Leaks.**

27.9.1. Check gas line connections for tightness after assembly and before lighting the torch. Use soapy water or the equivalent, not a flame.

27.9.2. If a leak is found around the valve stem when the valve is opened on a fuel-gas cylinder, the valve shall be closed and the gland nut tightened. If this does not stop the leak,

discontinue the use of the cylinder, remove it to the outdoors, and mark it with a DD Form 1577-2, *Unserviceable (Reparable) Tag*. Place the cylinder in an upright manner well away from an ignition source and secure it to prevent falling. In the immediate area within a 50 foot radius of the leaking cylinder, place a sign warning personnel not to approach the leaking gas cylinder with any ignition source, such as a lighted cigarette or lighter. In addition, place similar signs in locations which shall notify personnel of the danger before entering into the area. These signs are intended to prevent personnel from entering into a danger zone while attempting to read the sign on the cylinder. Refer to **Chapter 29, Mishap Prevention Signs and Tags**, for danger signs specifications. Immediately notify the installation FES Flight of any fuel gas leaks.

27.9.3. If the fuel gas should leak from the cylinder valve and cannot be shut off with the valve seat, follow the instructions in paragraph **27.9.2**.

27.9.4. If a leak should develop at the fusible plug or other safety device on the fuel-gas cylinder, follow the instructions in paragraph **27.9.2**. In addition, slightly open the cylinder valve to allow the fuel gas to escape slowly and immediately notify the installation FES Flight. **Note:** Emergency cylinder repair kits are available and may be used to contain the leak until it can be moved outside. Signs warning personnel not to approach the leaking gas cylinder with any ignition source, such as a lit cigarette or lighters, shall be placed near the leaking cylinder.

## **27.10. Welding Safety.**

27.10.1. The welder shall never permit the live metal parts of an electrode holder to touch their bare skin.

27.10.2. Welding gloves shall be dry.

27.10.3. Electrode holders shall not be cooled by immersion in water.

27.10.4. Water-cooled holders for gas tungsten-arc, gas metal-arc, and carbon arc-welding shall not be used if there is a water leak or condensation which would adversely affect the safety of the operator.

27.10.5. The welding machines supplying power to the arc shall always be electrically disconnected when changing electrodes in gas tungsten-arc electrode holders.

27.10.5.1. A mechanical switching device (disconnecting or isolating switch) used for changing the connections in a circuit or for isolating a circuit and/or equipment from a source of power, serves the same purpose as removing a plug from an outlet.

27.10.5.2. Never change electrodes with bare hands or wet gloves or when standing on wet floors or other grounded surfaces.

27.10.6. Filter Lenses for Protection Against Radiant Energy. **Table 27.1** is a guide for the selection of the proper shade numbers. These recommendations may be varied to suit the individual's needs. Refer to 29 CFR 1910.252 and 29 CFR 1910.133, *Eye and Face Protection*, for additional guidance.

27.10.7. Inert Gas Welding and Brazing. When inert gas welding or brazing is performed in large chambers or furnaces, ensure workers are aware of and trained on dangers of inert gas

asphyxiation. Supervisors shall ensure chambers are completely ventilated and cooled prior to entry. Also, ensure mechanical ventilation or approved positive pressure air supplied respiratory protection is provided. Personnel shall comply with confined space requirements outlined in [Chapter 23](#).

27.10.8. Electron Beam Welding. Refer to manufacturer's instructions and applicable TOs. Centers, bases or installations performing electron beam welding shall develop operating instructions covering the specific equipment used.

27.10.9. Plasma Arc-Cutting. Plasma arc-cutting operations are hazardous because of the high heat, brilliant light and fumes given off. Molten metal splatter and noise are also potential hazards. Engineering controls to mitigate these hazards should be considered during equipment installation. Because of the hazards involved, centers, bases and installations shall at a minimum:

27.10.9.1. Provide shielding and non-reflective surfaces (walls, floors, ceilings, etc.).

27.10.9.2. Ensure adequate ventilation is provided or that positive pressure air supplied respiratory equipment is used.

27.10.9.3. Install equipment of this type in an isolated area to prevent exposing workers of other operations.

27.10.10. Air-Carbon-Arc-Cutting. In addition to normal protective equipment required for welding and cutting, air-carbon-arc-cutting requires shielding so molten slag shall not be blown by compressed air onto personnel or combustibles.

27.10.11. Induction Welding and/or Brazing. Because of potential burns, induction welders shall pre-place filler materials within induction coils and shall not attempt to adjust the placement while the welding and/or brazing equipment is activated. Inspect induction coil insulation prior to use to ensure serviceability. Replace or repair damaged or deteriorated insulation.

27.10.12. Magnesium-Thorium Welding, Cutting and Grinding. Coordinate proposed welding, cutting or grinding operations on magnesium-thorium and other potentially radioactive materials in advance with the installation Radiation Safety Officer (usually the BE or assigned to BE). All personnel must comply with the Air Force requirements for handling and processing radioactive materials. Refer to AFI 40-201, *Managing Radioactive Materials In The US Air Force*, for additional guidance.

27.10.13. Electric Arc-Welding. Arc-welding is the fusion process based on the principle of generating heat with an electric arc jumping an air gap to complete an electrical circuit. When an electrode is touched to metal, the electrical circuit is completed and the current flows. Tremendous heat is concentrated at the point of contact. Hazards involved in this process are electrical shock-particularly in hot weather when the welder is perspiring, burns to the skin and eyes, and inadequate ventilation.

27.10.13.1. Safety Precautions. Many mishaps are caused by defective equipment, deliberate violation of safety precautions and/or neglect of safety rules or practices. Consequently, prior to use, welders need to inspect welding equipment to ensure the electrode connections and insulation on holders and cables are in good condition. They must keep hands and body parts insulated from the work, metal electrode and insulation

on holders and avoid standing on wet floors or coming in contact with grounded surfaces. They must never perform welding operations outside the rated capacity of the welding cables. When welding must be performed in the open, persons working nearby shall wear goggles or be warned against the hazard of exposing themselves to, or looking directly at, the arc.

27.10.13.2. Inspection of Equipment. The welder shall inspect the cables periodically for looseness at the connections, defects due to wear or other damage. Defective or loose cables are a shock and fire hazard. Defective electrode holders shall be replaced and connections to the holder tightened prior to use.

27.10.14. Oxyacetylene Welding. This is one of the most common and widely used welding processes available. It can be used for fusion welding, brazing, soldering, cutting and hard surfacing. Hazards include burns to the skin and eyes, gas or oxygen leaks, flashbacks, cut hose whipping, improper handling and storage of cylinders and the potential for a cylinder to become a missile if it is punctured or if the valve should break off. Both oxygen and acetylene cylinders are stored according to instructions in TO 42B5-1-2, *Gas Cylinders (Storage Type) Use, Handling, and Maintenance*.

27.10.15. Gas-Shielded Welding. Gas-shielded welding is a fusion-welding process that uses the heat produced by an electric arc between a metal electrode and the work. An inert gas (helium or argon) is used to shield the electrode. The shielding gas flowing from the orifices in the torch head forms a protective blanket over the weld area. This prevents the air from coming in contact with the molten metal and contaminating the weld.

27.10.15.1. Tungsten-Inert Gas Welding (TIG). TIG welding is a type of gas-shielded welding especially adapted for light gage metal because of its good concentration of heat, precise heat control and the ability to weld with or without filler metals. It is generally used with such metals as aluminum, magnesium and titanium. The principle hazards are the same as electric arc-welding (possible shock, ventilation and burns), except TIG welding takes place with little or no spatter, sparking or fumes.

27.10.15.2. Metal-Inert Gas Welding (MIG). MIG welding is a type of gas-shielded welding similar to TIG, except it uses a wire fed electrode and is used for heavier gage metals. MIG welding has the same hazards as TIG welding, except it does create sparks, spattering and can easily cause UV radiation burns to exposed skin.

27.10.16. Aircraft Welding.

27.10.16.1. Gas shielded tungsten arc-welding is the approved method for welding on aircraft. Welding on aircraft should be performed outside of hangars, if possible. An **AF Form 592** shall be issued prior to all aircraft welding operations IAW **Figure 27.1** and **Table 27.2** Welding shall only be performed on aircraft system components specified in the appropriate aircraft technical data. Specific hazards associated with the task and emergency procedures shall be listed in Block 10 of the welding permit. If more space is required to list all precautions, a welding fire safety checklist shall be prepared and attached to the form. The welding supervisor shall ensure identified precautions and/or checklist items are followed. The welding supervisor shall ensure the senior flight line

supervisor (line chief and/or production supervisor) is cognizant of the restrictions in paragraphs 27.10.16.2 through 27.10.16.11 below.

27.10.16.2. Ensure the senior flight line supervisor (production supervisor) is thoroughly briefed on the planned welding operation. This supervisor is responsible for informing other senior flight line supervisors if aircraft from different units are on the ramp.

27.10.16.3. Do not weld on an aircraft while work is in progress on any system or component that contains or did contain fuel or other flammable or combustible liquids.

27.10.16.4. Prior to the start of welding operations, fuel tank, engine fuel vents and any fuel tank opening shall be closed/plugged on all aircraft within 50 feet from the point of any welding. All fuel lines, valves, manifolds and other fuel components on the aircraft where welding is being performed shall be in place, secured or capped prior to the start of and during such welding operations.

27.10.16.5. Do not perform any other work within a 25 foot radius of any gas-shielded arc-welding operation.

27.10.16.6. Do not weld on an aircraft while work is in progress on the fuel system of any other aircraft within 50 feet from the point of welding.

27.10.16.7. Whenever welding is being performed in the vicinity of flammable vapors, a qualified person shall conduct an atmosphere analysis with a combustible gas analyzer to assure that flammable vapors do not reach 20 percent of the lower explosive limit (LEL). Such analysis shall be conducted prior to the start of welding and at least every 15 minutes during the welding operation. For confined spaces the LEL is lowered to 10 percent. Additionally, when welding in a hangar, check floor drains in the same manner. Refer to NFPA 410, Chapter 6, *Aircraft Welding Operations*, and 29 CFR 1910.146, *Permit-Required Confined Space*, for additional guidance. NFPA standards are normally available for review at the installation Ground Safety office or FES Flight.

27.10.16.8. Rope off or segregate the welding operation by physical barriers. Prominently display warning signs reading: “*WELDING OPERATIONS IN PROGRESS.*” Place screens, when possible, around welding operations.

27.10.16.9. Keep electrical welding equipment components (other than flexible lead cables) at least 18 inches above the floor. Position all ground leads or cables as close as possible to the area being welded. The ground leads shall be as close to the weld area as possible, and clamps used on such ground leads shall be of the “C” clamp type.

27.10.16.10. Assign a trained fire guard to monitor the welding operation and halt the welding operation if a hazardous condition develops. Provide the fire guard a 20 BC (minimum) rated fire extinguisher in the immediate area and a back-up wheeled extinguisher of 80 BC rating. Ensure the fire watch is maintained for at least 30 minutes after completion of the welding operation to detect and extinguish smoldering fires. Operations on combustible metals shall include the availability of a MET-X type fire extinguisher. Refer to TO 00-25-252 for additional guidance.

27.10.16.11. Aircraft welding operations performed in hangars shall conform to **Chapter 6** of this standard and NFPA Standard 410, *Standard on Aircraft Maintenance*.

27.10.17. Welding and Cutting Tanks, Cylinders or Containers. The following procedures apply only to tanks too small to be entered (compressed gas cylinders and pipelines are excluded). Ensure welding and cutting operations on containers that have held flammable liquids or gases are under the direct supervision of a trained and knowledgeable supervisor.

27.10.17.1. Inspection. All containers should be considered unsafe for welding or cutting unless they have been rendered safe or declared safe by a qualified person. When welding or cutting containers, possibilities exist for explosions, fires and the release of toxic vapors or fumes. Before any tank, cylinder or other container is cut, welded or other hot work is performed, ensure the container is purged or the item is inert. Also, ensure there are no substances such as grease, tars or acids present that might produce explosive or toxic vapors when heated. Disconnect or blank any pipe lines or connections to the drums, cylinders, tanks or other containers. Prior to work within, on or near the tank or container, test for flammable vapors with the appropriate combustible gas indicator (1) before commencing alterations; (2) immediately before and after starting any welding, cutting or heating operations; and (3) frequently during the course of the operation. All work shall be stopped immediately if the concentration of flammable vapors exceeds 10 percent of the lower flammable limit. The source of vapors shall be located and removed. **Warning:** New containers must also be inert or purged; they may contain a flammable preservative which could form explosive vapors when heated.

## 27.11. Purging and Inert.

27.11.1. Purging with Steam. Steam may be introduced into the tank or container through a pipe inserted through an opening and bonded to the container, or by connecting a steam hose directly to one of the vessel nozzles. The rate of supply of steam should be sufficient to exceed the rate of condensation so the whole tank or container is heated close to the boiling point of water. The vessel must be steamed long enough to vaporize the residues from all portions of the walls (shell and heads). When testing the atmosphere in the vessel with a combustible gas indicator, the sample should be drawn through a drying tube filled with calcium chloride or other drying agent to ensure that water vapor does not enter the instrument. If a drying agent is not available, the container must be allowed to cool off until excess water vapor has condensed. Hazards inherent with steam operations require the use of PPE. Supervisors must ensure PPE is serviceable and enforce its wear. Refer to NFPA 326, *Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, for additional guidance. **Warning:** Steam cleaning, chemical cleaning and high pressure water blasting can generate static electric charges.

27.11.2. Purging with Water. Where the liquid or gas previously contained is known to be readily displaced or easily soluble in water, it can be removed by completely filling the container with water and then draining, repeating this operation several times until clean. When hot work is performed on containers filled with water, extreme care shall be used to eliminate any possible vapor accumulation by the proper venting or positioning of the container during the filling operation. Consult the installation Environmental Management office for disposal guidelines of purged materials.

27.11.3. Purging with Air. Hazardous vapors may be displaced from inside containers by purging with air. A safe atmosphere shall be maintained by continuous ventilation. Every



precaution shall be taken to ensure all ignition sources have been removed from the vicinity since the concentration of vapor in the tank or container might reach the flammable range before a safe atmosphere is obtained. The air mover shall be electrically bonded to the tank or container being cleaned.

27.11.4. Inert With Gas. Inert gas may be used to displace flammable gas from the container. Adequate ventilation shall be maintained during the operation to ensure gas concentrations remain below hazardous levels. Supervisors of this operation shall be thoroughly familiar with the limitations and characteristics of the inert gas being used. Examples of inert gases are carbon dioxide, nitrogen and argon.

27.11.5. Venting. All hollow spaces, cavities or containers shall be vented to permit the escape of air or gases before preheating, cutting or welding.

27.11.6. Atmospheric Monitoring. In all cases, during welding or cutting operations, continuous monitoring of the vessel's atmosphere with a properly calibrated combustible gas indicator is mandatory.

**27.12. Vehicle Maintenance Shops.** Welding or cutting in vehicle maintenance activities shall only be conducted in areas approved by the installation FES Flight. Maintenance shop supervision shall evaluate each welding or cutting task to determine if batteries or fuel tanks require removal and/or need to be made inert.

**27.13. Portable Gas Welding Units.** Ensure portable gas welding, cutting and brazing equipment is a type designed for the use intended.

27.13.1. Cylinders of compressed gas must have pressure reducing regulators installed.

27.13.2. Cylinders in use or transport must be stored in an upright position and be secured to prevent them from falling.

27.13.3. Gaseous systems and containers shall be color coded. Refer to TO 42B5-1-2 for additional guidance.

27.13.4. Oxygen cylinders and fittings shall be kept free of grease and oil at all times.

27.13.5. Cylinders shall be kept away from external sources of heat at all times.

27.13.6. Cylinders shall not be dropped or handled roughly. Cylinders or welding sets in excess of 40 pounds total weight shall be transported to and from work sites by cart or motorized vehicle. When cylinders or welding sets are moved by crane or derrick, suitable cradles, boats or platforms shall be used. Slings or electric magnets shall not be used to move cylinders or welding sets.

27.13.7. Flashback protection shall be provided by an approved device that shall prevent a flame from passing into the fuel-gas system.

27.13.8. Backflow protection shall be provided by an approved device that shall prevent oxygen from flowing into the fuel-gas system or fuel from flowing into the oxygen system.

27.13.9. The flashback and backflow protection may be combined in one device or may be provided by separate devices. If one device is used, such as an approved mixing handle, additional backflow devices installed on the oxygen and fuel hoses near the regulator may be advisable should the mixing handle malfunction.

27.13.10. An acetylene valve shall not be opened more than one and one-half turns of the spindle and preferably no more than three-fourths of a turn.

27.13.11. The cylinder valve shall always be opened slowly. The wrench used to open the cylinder shall be left in position on the stem of the valve while the cylinder is in use.

27.13.12. If cylinders are manifold or coupled, at least one wrench shall always be available for immediate use.

#### **27.14. Portable Electric Welding Units.**

27.14.1. Circuits shall be de-energized before testing, checking or transporting.

27.14.2. Motor-generator sets and other electrical welding equipment shall be grounded prior to use.

27.14.3. Rotary and polarity switches shall not be operated while the equipment is under an electrical load.

27.14.4. Arc-welding equipment shall be inspected periodically and prior to use following relocation. Power cables and electrode holders shall be inspected prior to every use.

27.14.5. These units shall be repaired by qualified electricians only.

#### **27.15. Arc-Welding.**

27.15.1. Arc-welding equipment shall conform to the design and installation criteria of 29 CFR 1910.254, *Arc-Welding and Cutting*. The frame or case of the welding machine, except engine driven machines, shall be grounded IAW 29 CFR 1910, Subpart S, *Electrical*.

27.15.2. Before starting operations.

27.15.2.1. All connections to the arc-welding machine shall be checked and the work lead shall be firmly attached to the work.

27.15.2.2. Contact surfaces of magnetic work clamps shall be free of metal spatter particles.

27.15.2.3. Coiled welding cable shall be spread out before use to avoid overheating and damage to insulation.

27.15.2.4. Work and electrode lead cables shall be inspected for damage and wear before use. Cables with damaged insulation or exposed conductors shall be repaired or replaced.

27.15.2.5. Electrode cables shall be joined and installed IAW applicable manufacturer's instructions or technical data.

27.15.3. Grounding of the welding machine frame shall be checked. Special attention shall be given to the ground connections of portable machines.

27.15.4. When not in use, electrode holders shall be placed where they cannot make electrical contact with persons, conducting objects, fuel or compressed gas cylinders.

27.15.5. Cables with splices within 10 feet of the electrode holder shall not be used. The welder shall not coil or loop welding electrode cables around parts of their body.

27.15.6. Welders shall not place welding cable and other equipment where it shall obstruct passageways, ladders and stairways.

27.15.7. Machines which have become wet shall be thoroughly dried and tested before being used.

27.15.8. When welders are working close to each other, where they may touch the exposed parts of more than one electrode holder simultaneously, the machines shall be connected to minimize shock hazard as follows:

27.15.8.1. All direct current (DC) machines shall be connected with the same polarity.

27.15.8.2. All alternating current (AC) machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity.

### **27.16. Resistance Welding.**

27.16.1. Thermal Protection. Every pair of ignition tubes used in resistance welding equipment shall be equipped with a thermal protection switch. When used in a series-connected water line, a single switch shall be adequate if related to the downstream tube.

27.16.2. Control Safeguards. Controls, such as push buttons, foot switches, retraction and dual-schedule switches on portable guns, etc., shall be arranged or guarded to prevent inadvertent activation.

27.16.3. Guarding Welding Machines. Multi-gun welding machines shall be effectively guarded at the point of operation. Devices such as electronic eyes, latches, blocks, barriers or two-handed controls shall be installed. All chains, gears, operating bus linkages and belts shall be protected by adequate guards.

27.16.4. Electrical Hazards. All external weld-initiating control circuits shall operate on low voltage, not more than 120 volts for stationary equipment and not more than 36 volts for portable equipment. All electrical equipment shall be suitably interlocked and insulated to prevent access by unauthorized persons to live portions of the equipment. Only nonferrous welding clamps should be used to prevent magnetic induction during actuation of the equipment.

### **27.17. Welding in Confined Spaces.**

27.17.1. When a welder must enter and/or perform a welding, cutting or brazing operation in a confined space, the requirements for confined space entry in **Chapter 23, Confined Spaces**, and AFOSH Standard 48-137, *Respiratory Protection Program*, shall be strictly adhered to. Additionally, any welding, cutting or brazing in a confined space requires an **AF Form 592, USAF Hot Work Permit**, obtained from the installation FES Flight, with coordination by the installation Ground Safety office and BE. Refer to **Figure 27.1** and **Table 27.2** for additional guidance. All welding, cutting or brazing equipment shall be inspected for leaks, abrasions or defective equipment prior to inserting into the confined space. Equipment which fails the inspection process shall not be authorized within the space.

27.17.2. When working in a confined space, conduct a leak test of all joints in any gas lines (oxygen-acetylene) to prevent introducing gases into the confined space. Before a welder enters a confined space, a visual inspection shall be conducted on all electrical cables and connections that shall be taken into the confined space. Also, position the fuel gas cylinders,

oxygen supply and welding machines outside of the confined space in a manner which shall not interfere with egress. When possible, remove unused torches and hoses from the confined space. Before operations are started, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement. In addition, strictly adhere to all requirements in [Chapter 23](#).

27.17.3. All welding and cutting operations performed within confined spaces shall be adequately ventilated to prevent the accumulation of toxic materials or possible oxygen deficiency. This applies not only to the welder, but also to helpers and other personnel in the immediate vicinity. As the existing air is withdrawn, it shall be replaced with fresh air which is clear and respirable. A continuous monitoring system, with audible alarms, shall be used for confined space work. Gases such as argon, propane and carbon dioxide are heavier than air. Gases such as helium and natural gas are lighter than air. Oxygen shall never be used for ventilation.

27.17.4. In such circumstances, where it is impossible to provide such ventilation, BE shall determine the appropriate level of respiratory protection required. Only positive pressure air supplied respirators approved for use by BE are authorized.

27.17.5. Where welding operations are performed within confined spaces, a trained attendant with a pre-planned rescue procedure shall be stationed outside the confined space(s) to ensure the safety of those working within the space.

27.17.6. When gas welding or cutting, the torch valves shall be closed and the fuel-gas and oxygen supply to the torch positively shut off outside the confined area whenever the torch is not to be used for a substantial period of time, i.e., when left unattended for 30 minutes or more. Where practicable, torches and hoses shall also be removed from the confined space.

27.17.7. When arc-welding is to be stopped for any substantial period of time, such as during lunch or overnight, all electrodes shall be removed from the holders and holders carefully located so that accidental contact cannot occur. Also, the machine shall be disconnected from the power source.

**27.18. Hazards Associated with Fluxes, Coverings, Filler Metals and Base Metals. Note:** If any process has not already been evaluated, contact BE for an OEH risk assessment. Refer to paragraph [2.3](#) for additional guidance.

27.18.1. Fluorine Compounds. The need for local exhaust ventilation or air supplied respirators for welding or cutting in other than confined spaces shall depend upon the individual circumstances. However, such protection is desirable for fixed-location production welding and for production welding on stainless steel. Where air samples indicate that fluorides liberated are below the maximum allowable concentration, such protection is not necessary. However, before use, read and understand the manufacturer's instructions, always consult the MSDSs and BE when handling fluorine compounds. Even when air samples are below the allowable levels, ensure employees are aware of the following:

27.18.1.1. The worker shall keep their head out of the fumes.

27.18.1.2. Use sufficient ventilation or exhaust at the work, or both to keep fumes and gases from the breathing zone.

27.18.1.3. Avoid contact of flux with eyes and skin.

27.18.2. Zinc. Indoor welding or cutting involving zinc-bearing base or filler metals coated with zinc-bearing materials shall require mechanical ventilation to remove the fumes.

27.18.3. Lead. In confined spaces or indoors, welding or cutting involving metals containing lead, other than as an impurity, or involving metals coated with lead-bearing materials including paint, shall be performed using local mechanical exhaust ventilation. Workers in the immediate vicinity of the cutting operation shall be protected, as necessary, by ventilation, or respiratory protection, as directed by BE's OEH risk assessment.

27.18.4. Beryllium. Welding or cutting involving beryllium-containing base or filler metals shall be performed using local mechanical exhaust ventilation and positive pressure airline respirators unless atmospheric tests, under the most adverse conditions, have established that the worker's exposure is within permissible concentrations. Workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local mechanical exhaust ventilation or respiratory protection, as directed by BE's OEH risk assessment.

27.18.5. Mercury. Welding or cutting indoors or in a confined space involving metals coated with mercury-bearing materials, including paint, shall be performed using local exhaust ventilation or positive pressure air supplied respirators unless atmospheric tests, under the most adverse conditions, have established that the worker's exposure is within permissible concentrations.

27.18.6. Cleaning and Other Operations Involving the Use of Chlorinated Hydrocarbons. Do not locate these operations in areas where vapors or mists may reach the vicinity of welding operations. In addition, keep trichloroethylene and perchloroethylene away from the UV radiation of welding operations. **Note:** Refer to MSDSs associated with specific chemical hazards and BE for determining exposures and adequacy of ventilation systems, and recommending appropriate respiratory protective devices where chemical hazards exist or may be believed to exist.

27.18.7. Hexavalent Chromium. Welding or cutting on materials containing chromium, such as stainless steel and painted surfaces, to include the use of welding rods, may generate hazardous levels of hexavalent chromium. Contact BE for an OEH risk assessment.

**Table 27.1. Selection of Proper Shade Number for Welding Operations.**

<b>Selection of Proper Shade Number for Welding Operations</b>			
<b>Filter Lenses for Protection against Radiant Energy</b>			
Minimum		*Protective	
<b>Operations</b>	<b>Electrode Size 1/32 in.</b>	<b>Arc Current</b>	<b>Shade</b>
<b>Shielded Metal Arc-Welding</b>			
	Less than 3	Less than 60	7
	3-5	60-160	8
	5-8	160-250	10
	More than 8	250-550	11

<b>Selection of Proper Shade Number for Welding Operations</b>			
<b>Filter Lenses for Protection against Radiant Energy</b>			
Minimum		*Protective	
<b>Operations</b>	<b>Electrode Size 1/32 in.</b>	<b>Arc Current</b>	<b>Shade</b>
<b>Gas Metal Arc-Welding and Flux Cored Arc-Welding (MIG)</b>			
		Less than 60	7
		60-160	10
		160-250	10
		250-500	10
<b>Gas Tungsten Arc-Welding (TIG)</b>			
		Less than 50	8
		50 – 150	8
		150 – 500	10
<b>Air Carbon</b>	(Light)	Less than 500	10
<b>Arc Cutting</b>	(Heavy)	500 – 1000	11
<b>Plasma Arc Welding</b>			
		Less than 20	6
		20 – 100	8
		100 – 400	10
		400 – 800	11
<b>Plasma Arc-Cutting</b>			
	(Light)**	Less than 300	8
	(Medium)**	300 – 400	9
	(Heavy)**	400 – 800	10
<b>Torch Brazing</b>			3
<b>Torch Soldering</b>			2
<b>Carbon Arc-Welding</b>			14
<b>Operation</b>	<b>Plate Thickness (Inches)</b>	<b>Plate Thickness (mm)</b>	<b>Minimum Protection Shade</b>
<b>Gas Welding:</b>			
Light	Under 1/8	Under 3.2	4
Medium	1/8 to 1/2	3.2 to 12.7	5
Heavy	Over 1/2	Over 12.7	6
<b>Oxygen Cutting:</b>			
Light	Under 1	Under 25	3
Medium	1 to 6	25 to 150	4
Heavy	Over 6	Over 150	5

\*As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives a sufficient view of the weld zone without going below the minimum. In oxy-fuel gas welding or cutting, where the torch produces a high yellow light, use a filter lens that absorbs the yellow or sodium line in the visible light spectrum of the operation.

\*\*These values apply where the actual arc is clearly seen. Lighter filters may be used when the arc is hidden by the item being welded.

**Figure 27.1. AF Form 592, USAF Hot Work Permit.**

<b>USAF HOT WORK PERMIT</b> (See instructions on reverse)		1. Control Number
2. Date Permit Issued	3. Time Permit Issued	4. Expiration ( <i>Date and Time</i> )
5. Company/Organization		6. Company/Organization Phone Number
7. Location <input type="checkbox"/> Facility Number _____ <input type="checkbox"/> Floor Number _____ <input type="checkbox"/> Aircraft Tail Number _____ <input type="checkbox"/> Inside Hanger <input type="checkbox"/> Outside Hanger <input type="checkbox"/> Other: _____		
8. Description of Work		
9. Is Fire Watch required? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Performed by: <input type="checkbox"/> Permit Authorizing Individual (PAI) <input type="checkbox"/> Operator/Supervisor <input type="checkbox"/> Fire Watch		
10. Before approving any hot work permit, the PAI shall inspect the work area and confirm that precautions have been taken to prevent fire IAW AFI 91-203 and NFPA 51B.		
<input type="checkbox"/> Sprinklers in service <input type="checkbox"/> Adequate ventilation <input type="checkbox"/> Hot work equipment in good repair <input type="checkbox"/> Pressure cylinders are secured properly <input type="checkbox"/> Portable fire extinguishers are provided (20 BC rated - immediate area / 80 BC rating back-up wheeled extinguisher) <input type="checkbox"/> Explosive atmosphere eliminated (WITHIN 16 M (50 FT) OF WORK) <input type="checkbox"/> Flammable liquids, vapors and gases removed <input type="checkbox"/> Remove combustibles where possible. Otherwise protect with fire-resistant tarpaulins or metal shields <input type="checkbox"/> Floors swept clean of combustibles <input type="checkbox"/> Appropriate shields are used <input type="checkbox"/> Wall and floor openings are covered <input type="checkbox"/> Combustible floors wet down, covered with damp sand, or fire-resistant shields <input type="checkbox"/> Any special precautions needed _____		
11. The location where the work is to be performed has been examined, necessary precautions taken and permission is granted for stated work.		
Name: _____		
Signed: _____ Contact Number: _____		
Permit Authorizing Individual (PAI)		

12. I am fully qualified to perform this operation, understand my responsibilities and my equipment meets all requirements as outlined in AFI 91-203 and NFPA 51B.  Name: _____  Signed: _____ <div style="text-align: center;">Operator or On-scene supervisor</div>	
13. Has this process been evaluated by installation Bioenvironmental Engineering? If "Yes," attach documentation (BE Survey Report, PPE List, etc.). If "No," obtain BE coordination below. Name: _____  Signed/Date: _____ Duty Title: _____	
14. FINAL CHECK: Work area and all adjacent areas to which sparks and heat might spread, including floors above and below and opposite side of walls, were inspected at least 30 minutes or later after the work was completed and were found fire safe.  Name: _____  Signed: _____	
AF Form 592 (Supersedes OCT 80) 07	SEP

**Table 27.2. How To Fill Out AF Form 592, USAF Hot Work Permit.**

Block 1.	Control Number. Control numbers should be kept in a log so duplicate numbers are not assigned. A control number consists of the year, a dash, and the number from the log. Example: 03-001 would be the first control number assigned in the year 2003.
Block 2.	Date Permit Issued. (Self-Explanatory)
Block 3.	Time Permit Issued. (Self-Explanatory)
Block 4.	Expiration (Date and Time): Date and Time the Permit Expires.
Block 5.	Company/Organization: Name of Company/Organization Issued Permit.
Block 6.	Company/Organization Phone Number: Contact Phone Number of Company/Organization Issued Permit.
Block 7.	Location: Is it located in a Facility? What Floor? Is work being done on an Aircraft? What is the Aircraft Tail Number? Is the Aircraft Inside or Outside a Hanger?
Block 8.	Description of Work: Give a brief description of the work.
Block 9.	Is Fire Watch required? Answer Yes or No. Performed by: Who is performing the Fire Watch?
Block 10.	Permit Authorizing Individual (PAI) fills out Inspection Checklist prior to execution of hot work.
Block 11.	PAI signature granting permission to execute work.
Block 12.	Operator/On-scene supervisor signature stating understanding of responsibilities under AFI 91-203 and NFPA 51B.
Block 13.	Installation BE signature confirming coordination, as required.
Block 14.	Fire Watch signature confirming Final Check completion.



**27.19. Welding, Cutting and Brazing Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

27.19.1. Are only approved apparatuses purchased for use? Reference [27.2.1](#).

27.19.2. Do personal protective clothing and equipment meet or exceed the requirements of [Chapter 14, Personal Protective Equipment \(PPE\)](#)? Reference [27.2.3](#)

27.19.3. Are contractors advised that they must comply with appropriate fire, safety and health requirements when welding, cutting or brazing on Air Force facilities? Reference [27.2.4](#)

27.19.4. Are acetylene cylinders used and stored in an upright position? Reference [27.3.1](#)

27.19.5. Is the fuel gas and oxygen supply to the torch shut off when left unattended or not used for extended periods of time, i.e., when left unattended for 30 minutes or more? Reference [27.3.3](#)

27.19.6. Are welders aware that welding on concrete floors may cause the concrete to spall and produce projectiles? Reference [27.3.9](#)

27.19.7. Are welders provided appropriate fall protection when working on elevated surfaces? Reference [27.3.10](#)

27.19.8. Does the welding operation supervisor ensure installed fire protection sprinkler systems are operational before the welding operation begins, or, if not, ensure other means of fire detection, reporting and extinguishing have been approved by the installation FES Flight? Reference [27.3.12.2](#)

27.19.9. Are welding hoses visually checked for damage once a shift, before each use? Reference [27.4.1](#)

27.19.10. Are warning signs posted to prevent personnel from inadvertently touching hot items when left unattended? Reference [27.4.4](#)

27.19.11. Have workers and other personnel adjacent to the welding areas been protected from radiant energy or spatter by use of noncombustible and/or flameproof screens? Reference [27.5.1.1](#)

27.19.12. Are walls, screens, and non-rigid heat and spark barriers finished to limit reflectivity? Reference [27.5.1.2](#)

27.19.13. Have procedures been established to prevent personnel from entering an inside welding area and inadvertently being exposed to welding hazards? Reference [27.5.1.4](#)

27.19.14. Where floors have been wet down or damp sand applied, have rigid controls been established to ensure proper grounding of equipment, and are personnel protected from possible electrical shock? Reference [27.5.1.5](#)

27.19.15. Is a fully charged and operational fire extinguisher, appropriate for the task, kept in the work area at all times? Reference [27.5.1.6](#)

- 27.19.16. Are welding operations roped off or segregated by physical barriers to prevent unauthorized entry into the area? Reference [27.5.2.1](#)
- 27.19.17. Are outside welding operations placarded to warn bystanders that welding operations are in progress? Reference [27.5.2.1](#)
- 27.19.18. Has a written permit been obtained from the installation FES Flight prior to the start of welding operations? Reference [27.5.2.2](#)
- 27.19.19. Whenever welding activities are within 35 feet of combustible materials, are firewatcher procedures implemented? References [27.5.2.3](#) and [27.5.1.8.3](#)
- 27.19.20. Has a fire watch been assigned to monitor the operation for 30 minutes after completion of cutting or welding operations, to detect and extinguish possible smoldering fires? References [27.5.2.3](#) and [27.5.1.8.4](#)
- 27.19.21. Is the welding operation environment free of flammable liquids and vapors? Reference [27.5.2.4](#)
- 27.19.22. While welding and cutting operations are being performed, is fire extinguishing equipment available and ready for use? Reference [27.5.2.5](#)
- 27.19.23. Are approved flash arresters installed between each cylinder and the coupler block when acetylene cylinders are coupled? Reference [27.6.2](#)
- 27.19.24. Has backflow protection been provided that shall prevent oxygen from flowing into the fuel-gas system or fuel from flowing into the oxygen system? Reference [27.6.3](#)
- 27.19.25. Has flashback protection been provided by an approved device? Reference [27.6.4](#)
- 27.19.26. Has back-pressure protection been provided by an approved relief device, set at a pressure not greater than the pressure rating of the backflow or flashback device, whichever is lower? Reference [27.6.5](#)
- 27.19.27. Are clearly marked master shutoff valves provided for installed systems at points which are readily accessible? Reference [27.6.7](#)
- 27.19.28. Does clothing provide sufficient coverage to prevent skin burns? Reference [27.7.1](#)
- 27.19.29. Are front pockets and upturned sleeves or cuffs prohibited? Reference [27.7.1](#)
- 27.19.30. Are flame resistant gloves, in good condition, used to protect welder's hands? Reference [27.7.2](#)
- 27.19.31. When additional protection is needed, are durable flame-resistant aprons made of leather or suitable materials provided to protect the front of the body? Reference [27.7.3](#)
- 27.19.32. For heavy work, are flame-resistant leggings or other equivalent means used to give added protection to the legs? Reference [27.7.4](#)
- 27.19.33. When necessary, are cape sleeves or shoulder covers used during overhead welding, cutting or other operations? Reference [27.7.5](#)
- 27.19.34. When necessary, are flame-resistant caps worn under helmets to prevent head burns? Reference [27.7.6](#)

- 27.19.35. Is only approved respirator equipment used when working in atmospheres of hazardous concentrations of airborne contaminants? Reference [27.7.7](#)
- 27.19.36. Do all welding helmets meet 29 CFR 1910.252, *Welding, Cutting, and Brazing - General Requirements*, requirements? Reference [27.7.8.1](#)
- 27.19.37. When two or more welders are exposed to each other's arc, are filter lens goggles worn under the welders' helmets to protect them from the harmful rays? Reference [27.7.8.2](#)
- 27.19.38. Are goggles or other suitable eye protection used during all gas welding or oxygen cutting operations? Reference [27.7.8.3](#)
- 27.19.39. Is eye protection in the form of suitable tinted goggles or spectacles provided for brazing operations? Reference [27.7.8.5](#)
- 27.19.40. Are workers trained to arrange helmets to protect the face, neck and ears from the arc's radiant energy? Reference [27.7.9.2](#)
- 27.19.41. Are ventilated goggles used to prevent fogging of the lenses? Reference [27.7.9.5](#)
- 27.19.42. Are hand-held shields, designed to shield the face and eyes, prohibited from use? Reference [27.7.9.10](#)
- 27.19.43. Does the commander ensure workers who handle, use or are potentially exposed to hazardous materials provided training IAW the AFHCP? Reference [27.8.2](#)
- 27.19.44. Do welders check gas line connections after assembly and before lighting the torch? Reference [27.9.1](#)
- 27.19.45. Is the tungsten-arc welding machine's power supply always disconnected before changing electrodes? Reference [27.10.5](#)
- 27.19.46. Are welders trained to never change tungsten-arc electrodes with bare hands or wet gloves? Reference [27.10.5.2](#)
- 27.19.47. Is welding on aircraft accomplished outside of hangars whenever possible? Reference [27.10.16.1](#)
- 27.19.48. Does the welding supervisor ensure the senior flight line supervisor is thoroughly briefed on the planned welding operation? Reference [27.10.16.2](#)
- 27.19.49. Prior to the start of welding operations, are fuel tank and engine fuel vents closed/plugged on any aircraft within 50 feet of the welding operation? Reference [27.10.16.4](#)
- 27.19.50. Does the welder rope off or segregate the welding operation by a physical barrier prior to starting the welding operation? Reference [27.10.16.8](#)
- 27.19.51. Is the fireguard informed to stop the welding operation if a hazardous condition develops? Reference [27.10.16.10](#)
- 27.19.52. Do aircraft welding operations performed in hangars conform to the requirements of [Chapter 6](#) of this standard and NFPA 410, *Standard on Aircraft Maintenance*? Reference [27.10.16.11](#)
- 27.19.53. Has the tank, cylinder, or other container which is to be cut, welded or have other hot work performed on it been purged or inert? Reference [27.10.17.1](#)

- 27.19.54. Are new containers inert or purged prior to cutting, welding or other hot processes being applied to it? Reference [27.10.17.1](#)
- 27.19.55. Are welding or cutting operations only conducted in vehicle maintenance approved by the installation FES Flight? Reference [27.12](#)
- 27.19.56. Does maintenance shop supervision evaluate each welding or cutting task to determine if batteries need to be removed or fuel tanks require removal and/or need to be made inert? Reference [27.12](#)
- 27.19.57. Do cylinders of compressed gas have pressure-reducing regulators installed? Reference [27.13.1](#)
- 27.19.58. Are oxygen cylinders and fittings kept free of grease and oil at all times? Reference [27.13.4](#)
- 27.19.59. Have circuits been de-energized before testing? Reference [27.14.1](#)
- 27.19.60. Are power cables and electrode holders inspected prior to every use? Reference [27.14.4](#)
- 27.19.61. Before starting operations, has the work lead been firmly attached to the work? Reference [27.15.2.1](#)
- 27.19.62. Have cables with damaged insulation or exposed conductors been repaired or replaced? Reference [27.15.2.4](#)
- 27.19.63. Are electrode holders, when not in use, placed where they cannot make electrical contact with personnel, conducting objects, fuel or compressed gas cylinders? Reference [27.15.4](#)
- 27.19.64. Does the welding supervisor ensure all welders meet the requirements of [Chapter 23, Confined Spaces](#), prior to entry into confined spaces? Reference [27.17.1](#)
- 27.19.65. Has a written permit (**AF Form 592**) been obtained from the FES Flight, with coordination by the installation Ground Safety office and BE, prior to starting welding operations in a confined space? Reference [27.17.1](#)
- 27.19.66. When welding or cutting operations are conducted in confined spaces, is there adequate ventilation to prevent the accumulation of toxic materials or possible oxygen deficiency? Reference [27.17.3](#)
- 27.19.67. Before operations are started, is heavy portable equipment mounted on wheels securely blocked? Reference [27.17.2](#)

## Chapter 28

### INTERIOR SPRAY FINISHING

**28.1. General Information.** Painting, doping and paint removal hazards include exposure to toxic materials and flammable or explosive mists, particulates and vapors. Inhalation of mists and vapors from paints, solvents, thinners, cleaning chemicals, strippers and epoxies can be injurious depending upon the agent's toxic characteristics and the amount and method of exposure. Many can injure the skin and eyes, or be absorbed through the skin. Three of the more toxic pigment ingredients are lead, antimony and chromates. Their use shall be avoided. In addition, paints containing epoxy or polyurethanes can cause respiratory sensitization. Respiratory sensitization results from an allergic reaction to a given substance. This sensitivity develops during the induction period, which may be a few days to a few months. After sensitivity is established, exposure to even a small amount of the sensitizing material can produce a severe reaction. Refer to AFI 90-821, *Hazard Communication*, and **Chapter 3**, *Physical Hazards*, and BE workplace evaluations for additional guidance and information.

#### **28.2. Safety.**

28.2.1. Equipment used in painting operations is hazardous. Therefore, functional managers shall ensure spray painting operations are closely supervised and equipment is in serviceable condition.

28.2.2. Other Equipment. Painter's ladders, scaffolds, lifelines and other equipment shall be inspected prior to use to ensure all equipment is in a safe condition. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, **Chapter 14**, *Personal Protective Equipment (PPE)*, and **Chapter 22**, *Flammables and Combustibles*, for additional guidance and information. Powered industrial trucks, man lifts and other AGE shall meet the requirements of 29 CFR 1910.178, *Powered Industrial Trucks*, for Class I, Division I locations.

28.2.3. Paint Mixing. Paint or dope mixing shall be performed in designated areas, which will be adequately ventilated rooms constructed of fire-resistant materials. The mixing of paint may be accomplished out of doors with approval of the installation Environmental Management office. Otherwise, paint shall only be mixed in a covered, dust-controlled area and shall not exceed local air emission standards. All sources of ignition shall be prohibited in mixing areas. All electrical fixtures or equipment within 20 feet of designated paint preparation areas shall meet the requirements of NFPA 70, *National Electrical Code*, for Class 1, Division 1 locations. Mixing rooms shall have spill control and cleanup measures in place for cleaning up large and small spills.

28.2.4. Housekeeping. Good housekeeping is essential in paint and dope shops to control leakage and prevent the accidental escape of flammable, combustible or toxic liquids. Spills shall be cleaned up promptly. Work clothing shall be stored in metal lockers that are vented at top and bottom. Street clothing and protective clothing shall be kept in separate lockers. Paint rooms, booths, etc., shall be kept clean with equipment stored in a proper and orderly manner. Rags or waste soiled with sprayed materials shall be deposited in approved self-closing metal waste containers immediately after use. IAW AFPAM 32-7043, *Hazardous Waste Management Guide*, and 29 CFR 1910.107(g) (3), *Residue Disposal*, the contents of

waste containers shall be disposed of at the end of each shift or at least once daily. Contact the installation Environmental Management office for waste disposal guidance. Paint stored in workshops shall be kept in tightly covered metal containers and meet the requirements of [Chapter 22](#).

28.2.5. Personal Protective Equipment (PPE). Personnel engaged in painting and paint removal shall wear protective clothing, respiratory devices (if required) and appropriate face, eye and hand protection. Clothing shall be changed, as needed, to minimize body contamination and reduce the fire hazard. Personnel engaged in the application of dopes and paints will wear an apron or equivalent protection impervious to paints, solvents and dopes. These aprons and clothing shall be kept clean and, when not in use, shall be hung in ventilated metal lockers. Refer to [Chapter 14](#) for additional guidance.

28.2.6. Eye Protection. Personnel using abrasive techniques to prepare surfaces for painting shall wear suitable eye protection to protect their eyes from chips and flying particles. Eye protection and rubber gloves shall be worn when using acids, lye or noxious cleaning materials. Refer to [Chapter 14](#) for additional guidance.

28.2.7. Respiratory Protection. BE's OEH risk assessment determines respiratory protection. Refer to paragraph [2.3](#) and [Chapter 14](#) for additional guidance.

### **28.3. Health/Environmental Protection.**

28.3.1. Radioactive Luminous Paint. This paint presents a potential health hazard and shall not be used without approval of the installation Radiation Safety Officer (usually the BE or assigned to BE). Refer to AFI 40-201, *Managing Radioactive Materials In The US Air Force*, for additional guidance.

28.3.2. Protective Creams. Hand protective creams are available and may be used by workers engaged in cleaning and painting. These creams, when applied to the skin prior to painting operations, help protect the skin and facilitate the removal of contaminants by washing in water. Refer to BE's OEH risk assessment and paragraph [2.3](#) for additional guidance.

28.3.3. Personal Hygiene. IAW 29 CFR 1910.134(g)(1)(i)(A), personnel required to wear tight fitting respiratory protection shall be clean shaven so facial hair will not interfere with the face-piece seal of the respirator. Workers shall keep hands and faces clean, clothes shall be changed when contaminated, and hands and soiled objects shall be kept out of the mouth. No food or drink shall be brought into or consumed in paint and dope shops. Workers shall wash their hands prior to smoking or consuming food outside the work area.

28.3.4. Air and Water Pollution. Painting and paint removal operations can cause air and water pollution problems impacting both the installation and local community. Liquid, solid and gaseous waste products from painting and paint removal operations shall be disposed of IAW AFI 32-7040, *Air Quality Compliance and Resource Management*, AFI 32-7041, *Water Quality Compliance*, AFI 32-7042, *Waste Management*, and as specified and approved by the installation CE.

## 28.4. Fire Prevention and Protection.

28.4.1. Fire Prevention. Some painting operations may pose fire hazards, i.e., paint removal, solvent wipe and paint application by means of spray apparatus. Refer to **Chapter 6**, *Fire Protection and Prevention*, NFPA 10, *Standard for Portable Fire Extinguishers*, NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 33, *Spray Applications Using Flammable and Combustible Materials*, for additional guidance.

28.4.2. Paints. Certain paints, lacquers, dopes, varnishes, shellacs, solvents, thinners and dilutants are very flammable. Other paints, under certain conditions, will burn violently. These paints, for control purposes, are classified as flammable, unless specifically stated by the manufacture as being combustible.

28.4.3. Paint Remover. Paint removers are corrosive and are considered flammable or combustible based on their flash point. They may contain volatile ingredients and the residue after evaporation may also be flammable or combustible.

28.4.4. Solvents. Solvent materials used for residual cleanup, after the initial removal, will have a flashpoint of 140°F or above. Cleaning operations using flammable or combustible solvents shall be conducted inside spray areas with ventilating equipment operating.

28.4.5. Methyl Ethyl Ketone (MEK). MEK is used as a solvent wipe-down on aircraft just prior to painting. MEK is extremely flammable with a flashpoint of 21°F. At normal working temperatures, MEK presents a constant fire hazard. Use extreme caution to ensure there are no ignition sources in the area and ventilation is adequate to remove flammable vapors. Workers shall use approved respiratory protection IAW AFOSH Standard 48-137 and minimize skin contact.

28.4.6. Storage. Paints and solvents shall be stored IAW **Chapter 22**.

28.4.7. Spray Painting. Spray painting presents varying degrees of fire hazards, depending on the materials used. Some are particularly dangerous, and the same precautions pertaining to solvent wipe-down apply. Any material having a flashpoint below 140°F shall be handled carefully, and precautions are in order even for those having a flashpoint higher than this.

28.4.8. Housekeeping. Solvent or paint-soiled rags, paper towels and kraft paper can produce spontaneous ignition. Contaminated materials shall be removed and placed in approved self-closing metal containers plainly marked to indicate the contents. At the end of each shift or at least once daily, these containers shall be emptied or removed to an approved location outside the shop for pickup and disposal. Contact the installation Environmental Management office for waste disposal guidance. Refer to AFPAM 32-7043 and OSHA 29 CFR 1910.107(g)(3) for additional guidance.

28.4.9. Sprinklers. Fire suppression sprinklers installed in spray finishing areas shall conform to NFPA 13. Dry chemical or carbon dioxide extinguisher systems may be installed where automatic sprinkler protection is not available. Refer to NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, and NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, for additional guidance.

28.4.10. Extinguishers. Portable fire extinguishers shall be installed near all paint spraying areas. Refer to **Chapter 6** for additional guidance.

## 28.5. Ventilation Systems.

28.5.1. Ventilation. Each spray area shall be provided with mechanical ventilation capable of confining and removing vapors and mists to a safe location and capable of confining and controlling combustible residues, dusts and deposits. Mechanical ventilation shall be kept in operation whenever spray operations are conducted and for a sufficient time thereafter to allow ventilation of vapors from drying coated objects or material and residues. An adequate supply of makeup air shall be provided. BE shall be consulted for questions concerning makeup air requirements. Ventilation and exhaust systems shall be installed and conform to the provisions of this chapter and NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids*. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance.

28.5.2. Exhaust and Ventilation Units. The rotating elements of the exhaust fan shall be of nonferrous materials or the fan shall be constructed so that a shift of the impeller or shaft shall not permit two ferrous parts to rub or strike together. There shall be ample clearance between the rotating element and fan casing to avoid a fire caused by friction. Necessary allowances shall be made for ordinary expansion and loading, and to prevent contact between moving parts and the duct or fan housing. Fan blades shall be mounted on a shaft rigid enough to maintain alignment when the fan is operating under full load. All bearings shall be of the self-lubricating type or shall be lubricated from a point outside the duct and, preferably, shall be located outside the duct and the booth.

28.5.3. Exhaust Ducts. Exhaust ducts shall be protected against mechanical damage, properly supported and shall normally have a separation of at least 18 inches from combustible materials. Ducts shall be periodically inspected for accumulation of paint deposits and shall be cleaned as needed.

28.5.4. Exhaust. Exhaust air from spray operations shall be directed so it shall not contaminate makeup air introduced into the spraying area or other ventilation intakes. Unless the spray booth exhaust is from a water wash spray booth, the terminal discharge point shall be at least 6 feet from any combustible exterior wall or roof and will not discharge within 25 feet of any combustible construction or unprotected opening in any noncombustible exterior wall.

28.5.5. Drying. Freshly sprayed articles shall only be dried in spaces with adequate ventilation to prevent the accumulation of explosive vapors. If adequate and reliable ventilation is not provided, such drying spaces shall be considered as spraying areas.

28.5.6. Motors. Unless approved for use in a flammable vapor/dust environment, electric motors driving exhaust fans shall be placed outside of booths or ducts. Drive belts shall not enter the duct or booth unless the belt and pulley within the duct or booth are enclosed and guarded.

28.5.7. Minimum safety, fire prevention and occupational health requirements pertaining to ventilation are addressed in this chapter. Ventilation and exhaust systems details, including information on flow-rate requirements, and the design of ventilation and exhaust systems are in the most current edition of the American Conference of Governmental Industrial



Hygienists' (ACGIH) *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. BE will determine what, if any, periodic testing of ventilation systems is required.

## **28.6. Storage and Handling.**

28.6.1. Storage. Limit the quantity of paints, lacquers, thinners, solvents and other flammable and combustible liquids kept near spraying operations to the minimum required for operations, but not to exceed one day's supply. Storage in process areas shall be no more than three (3) approved flammable liquids storage cabinets in any single process area without the approval of the authority having jurisdiction. Storage shall be listed or designed and constructed to meet the requirements of NFPA 30. Any single cabinet shall contain no more than 454 liters (120 gallons) of Class I, Class II or Class IIIA liquids, of which no more than 227 liters (60 gallons) shall be Class I and Class II liquids. Bulk storage of these liquids shall be in a separate detached building or in rooms specifically designed and constructed to meet flammable storage requirements, i.e., inside smaller paint booth installations. Operations involving water-base latex paints are exempt from the above requirements. Refer to [Chapter 22](#) for additional guidance and information.

28.6.2. Containers. Flammable or combustible liquids brought into spray finishing rooms shall be in original closed containers, approved portable tanks, approved safety cans or by a properly arranged system of piping. Containers shall be marked IAW AFI 90-821. Open or glass containers shall not be used.

28.6.3. Liquid Transfer. The withdrawal of liquids from containers and the filling of containers, including portable mixing tanks, shall be done only in a mixing room or in a spraying area. The ventilating system shall be in operation. Precautions shall be taken to prevent liquid spillage.

28.6.4. Grounding. Whenever flammable or combustible liquids are transferred from one container to another, both containers shall be effectively bonded and grounded. Piping systems used to transfer fluids shall also be properly bonded and grounded.

## **28.7. Electrical.**

28.7.1. Electrical Wiring. Electrical wiring and equipment shall conform to the provisions of NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*. Electrical wiring located in spray areas must be in rigid metal conduit, Type MI cable, or in metal boxes or fitting containing no taps, splices or terminal connections. There are alternative electrical wiring options when the location is adjacent to, rather than inside, a spray area. Refer to NFPA 33 for additional guidance.

28.7.2. Electrical Equipment. Electrical equipment outside, but within 20 feet horizontally and 10 feet vertically, of any spraying area and not separated from it by partitions extending at least to the boundary of the Division 2 location shall be of a non-spark-producing design. This equipment shall also conform to the provisions of the NEC for Class 1 or Class 1, Division 2 locations, as applicable. Refer to the illustrations in NFPA 33 for examples of how these space limitations apply. If spraying operations are confined to an enclosed spray booth or room, the space adjacent to the booth or room shall be considered non-hazardous except for the space within three (3) feet (in all directions) of any opening in the booth or room.

28.7.3. Electric Lamps. Electric lamps outside of, but within 20 feet, of any spraying area and not separated by a partition, shall be totally enclosed to prevent hot particles from falling should breakage occur, and shall be protected from mechanical damage by guards or by location. Portable electric lamps shall not be used in any spraying area during spraying operations.

28.7.4. Grounding. All metal parts of spray booths, exhaust ducts and piping systems conveying flammable or combustible liquids or aerated combustible solids shall be electrically grounded in an effective and permanent manner.

28.7.5. Heaters. If a heater is used to heat the liquid being sprayed, it shall be low-pressure steam, low-pressure hot water or electricity. If electric, it shall be approved and listed for the specific location in which it is used. Heaters shall not be located in spray booths or other locations subject to the accumulation of combustible residue. Agitators, if used, shall be driven by compressed air, water, low-pressure steam or electricity. If powered by an electric motor, the motor shall meet the requirements of NFPA 33.

## **28.8. Location of Paint Shops, Dope Shops and Spray-Finishing Operations.**

28.8.1. Paint Shops. Paint and dope shops shall be located in separate one-story buildings with fire-resistant floors, walls and ceilings. They may be located in specially constructed rooms if separated from other operations by fire-resistant walls. Paint and dope shops shall be provided with automatic sprinkler protection. Supervisors will avoid locating these shops near ignition sources. Refer to NFPA 33 for additional guidance.

28.8.2. Spray Booths. When possible, paint spray booths shall be located in the paint and dope shop. In industrial facilities, spray-finishing operations shall be located and protected to minimize possible damage to other property by fire or by extinguishing agents. All spray booths shall be installed and conform to the requirements in NFPA 33, the BE OEH risk assessment and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*.

28.8.3. Prohibited Locations. Spray-finishing operations shall not be conducted in an administrative, educational or public assembly facility, unless in a room specifically designed for the purpose, protected with an automatic sprinkler system and separated vertically and horizontally from such occupancies by not less than 2-hour fire-resistance construction.

## **28.9. Paint Spray Booths.**

28.9.1. Construction. ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, provides guidance on construction and installation of ventilating systems for paint spraying operations and includes illustrations of both dry and water wash paint spray booths.

28.9.2. Exhaust Filters.

28.9.2.1. Filter pads and filter rolls shall be inspected after each painting operation and replaced when necessary or from a tracking log based on the number of hours in use. Consult the manufacturer's manual or the installation Environmental Management office for the proper replacement interval.

28.9.2.2. Automatic-advance roll filters shall be equipped with interlocks to stop the spraying operation should the roll advance mechanism fail.

28.9.2.3. Filter pads and rolls shall be made of noncombustible materials.

28.9.2.4. Both filter pads and rolls shall be changed when changing coating materials if the two materials are susceptible to spontaneous combustion when in contact with each other.

28.9.2.5. Discarded filter pads and rolls shall be removed from the area daily unless water-filled metal containers are provided to hold them immersed until disposal.

28.9.3. Baffle Plates. Baffle plates, if used, shall be made of noncombustible material and readily removable or accessible on both sides for cleaning. Such plates shall be grounded.

28.9.4. Extinguishers. The appropriate type and size portable fire extinguishers shall be located within the work area IAW NFPA 10 and the installation Fire Emergency Services (FES) Flight. Refer to [Chapter 6](#) for additional guidance.

28.9.5. Floor Covering. The floor of paint spray booths shall be covered with a noncombustible mat, removable for cleaning or disposal. If an overspray covering is not feasible, consult the installation Ground Safety office for additional guidance.

28.9.6. Flame-Producing Devices. Using or carrying of matches, lighters or other spark or flame-producing devices in or adjacent to paint spray booths is prohibited.

28.9.7. Containers. Containers supplying spray nozzles shall be a closed type or provided with metal covers, which shall be kept closed. Original shipping containers shall not be subjected to air pressure above atmospheric for supplying spray nozzles. Containers under pressure exceeding atmospheric pressure shall be designed and approved for such use, shall be provided with a visible pressure gauge and shall be provided with both a relief valve and a shutoff valve.

28.9.8. Hoses and Couplings. Pressure hoses and couplings shall be regularly inspected for condition and shall be replaced, as needed. When positive displacement pumps are used, a relief valve shall be installed in the discharge line to prevent overpressure.

## 28.10. Compressed Air Paint Spraying.

28.10.1. On compressed air spraying equipment, a pressure regulator valve shall be installed in the air line between the compressor and painting equipment. A pressure relief valve and a pressure gauge shall be installed between the pressure regulator and pressurized paint containers and/or spray guns. Pressure relief valves shall be set to open at pressures not more than 10 pounds above the required working pressure. **Warning:** Compressed air shall not be directed toward a fellow worker.

28.10.2. Air Hoses. All hoses shall be checked prior to each shift to ensure they are properly connected to both their pipe outlets and the equipment to be used. Air hoses shall not be connected to a pipe outlet unless the loose end is secured, since a loose hose connected to a compressed air outlet will whip. Hose couplings shall be incompatible with airline respiratory protection hoses and/or respirators. **Note:** Quick release fittings or similar devices that prevent flow or air when hose is not attached to a tool or other equipment, may be used in place of securing the loose end of an air hose.

28.10.3. Any hose showing signs of deterioration, leakage or weakness in its carcass or at the coupling shall be withdrawn from service and repaired or discarded.

28.10.4. Portable Paint Spray Equipment.

28.10.4.1. Description. Equipment usually consists of an air compressor, paint spray gun and hose. The paint reservoir on most portable spray guns holds one quart of fluid or less. When a considerable amount of paint is to be applied, a 2-1/2 or 5-gallon pressure tank is usually employed.

28.10.4.2. Compressor. The air compressor shall be equipped with an ASME-rated air tank, a visible pressure gauge on the tank, a pressure reducer with its own gauge, a guard fully enclosing the drive belt and pulleys and a pressure-limiting switch to shut down the compressor when the system's working pressure has been reached. The equipment shall be securely mounted on a wheeled carriage for portability. For interior painting, where the compressor shall be located inside the facility, only electric motor-driven equipment shall be used.

28.10.4.3. Overpressure Protection. When separate paint pressure tanks are used, they shall be equipped with a gauge and a relief valve to prevent overpressure. Hoses shall be rated for the maximum working pressure of the system.

28.10.5. Maintenance.

28.10.5.1. A preventive maintenance program covering periodic inspection and testing of all components shall be implemented by all organizations using this equipment.

28.10.5.2. Compressors, hoses, paint pressure tanks and spray guns shall be stored in areas designated and approved by the installation FES Flight.

28.10.5.3. All paint pressure tanks and spray guns shall be cleaned after use and before the equipment is stored. If solvents are used in the cleaning process, provisions of [Chapter 22](#) shall be followed.

28.10.6. Respiratory Protection. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph [2.3](#) for additional guidance. Respiratory protective devices shall meet the requirements of AFOSH Standard 48-137.

## 28.11. Drying Ovens.

28.11.1. Principle. Most drying ovens use gas or electricity to heat air which is blown across the components being dried, although infrared and microwave drying ovens are also used. Refer to the MSDS for the specific equipment to use.

28.11.2. Fire Prevention. When used to dry flammable finishes, the ovens must meet or exceed NFPA 86, *Standard for Ovens and Furnaces*, requirements for Class A ovens. Avoid using spray booths or rooms for drying purposes. Raising the temperature of a spray booth increases the chance of spontaneous combustion of paint residues. Do not install drying ovens in a spraying area if the oven contains an open flame or a spark-producing element. Never conduct spraying operations in proximity to an operating drying oven.

28.11.3. Ventilation. Adequately vent the exhaust air from the oven. The oven shall have its own ventilation system. If spray booth ventilation systems are utilized, the oven vent shall

enter the system downstream from filters and baffles. In addition, an interlock shall be installed which will automatically start the blower when the oven is turned on and automatically shut down the oven if the blower stops operating, either by accident or intentionally.

28.11.4. Electrical Wiring. Make sure electrical wiring for drying ovens and associated equipment conforms to the NEC.

28.11.5. Grounding. Ensure metal parts of drying ovens are bonded and grounded.

28.11.6. Warning Signs. Post signs in the vicinity of operating drying ovens to warn of heat and to caution against conducting spraying operations.

## **28.12. Spray Painting of Aircraft.**

28.12.1. Aircraft Painting. Spray painting of an entire aircraft is permitted only in hangars specifically designed for this purpose.

28.12.2. Fire Prevention. When painting aircraft, the aircraft shall be isolated and adequate fire prevention measures taken. Solvents used for cleaning operations shall have flashpoints at or above 100° F. The aircraft shall be properly grounded and all sources of ignition removed from the area. All electrical devices and equipment shall be of an approved explosion-proof type. Except when essential to perform concurrent operations, all aircraft electrical systems shall be de-energized during cleaning, painting and paint removal. Smoking shall be prohibited. To prevent the accumulation of static charges, all materials or objects shall be effectively grounded. Refer to **Chapter 6** for additional guidance.

28.12.3. Ventilation. Ventilation shall be provided and BE shall periodically check the adequacy of ventilation IAW paragraph **28.5.7**.

28.12.4. Housekeeping. All spraying areas shall be kept free from the accumulation of deposits of combustible residues. Cleaning shall be conducted daily. Scraping tools shall be non-sparking. Roof trusses, light fixtures and other overhead equipment shall be checked for accumulation of over-spray at least annually. Rags or waste soiled with sprayed materials shall be deposited in approved self-closing metal waste containers immediately after use. IAW AFPAM 32-7043 and 29 CFR 1910.107(g) (3), the contents of waste containers shall be disposed of at the end of each shift or at least once daily. Refer to AFPAM 32-7043 for waste disposal guidance.

28.12.5. Limited Painting. Refer to TO 1-1-8, *Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment*, for additional guidance and information.

28.12.6. Grounding. Aircraft surfaces shall be grounded to preclude the build-up of static electricity whenever operations involving sanding, rubbing, painting or wiping surfaces are performed.

## **28.13. Painting Radio and Radar Equipment.**

28.13.1. Fire Prevention. The paints used to spray coat radio and radar equipment are very flammable and shall not be used near any open flames. IAW **Chapters 6** and **22**, smoking shall be prohibited within 50 feet of painting operations.

28.13.2. These paints are toxic and shall only be used in ventilated spray booths IAW ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*.

28.13.3. Personal Protective Equipment. Paint shop personnel shall wear PPE as identified in BE's OEH risk assessment. While painting, personnel shall wear gloves to guard against skin irritation, and shall wear any other necessary PPE needed to complete the task. Refer to paragraph 2.3 and **Chapter 14** for additional guidance.

28.13.4. Drying. Radio and radar equipment that has been spray painted, shall be placed in the open air for several hours or, if possible, for a full day. This will prevent vapors from off gassing during the drying process and from being ignited by sparks generated when the equipment is put into operation. Emery paper or steel wool shall not be used on radio or radar equipment until the vapors have totally dissipated.

#### **28.14. Electrostatic Paint Spraying.**

28.14.1. Principle. In electrostatic paint spraying, low velocity particles of paint are passed through a negatively charged electrostatic field. The particles of paint assume the negative polarity of the electrodes and are then attracted to the work, which is positively charged, usually by being attached to a grounded conveyor.

28.14.2. Fire Prevention. Fire hazards involved in electrostatic paint spraying include solvents used with the paint, possible sparking of the unit and the use of oil-filled transformers. Fire-protective equipment shall be checked regularly with particular attention given to automatic sprinkler heads. Sprinklers protecting spraying areas shall be kept free from deposits by frequent or, if necessary, daily cleaning. Portable fire extinguishers shall be available for use. Refer to **Chapter 6** for additional guidance.

28.14.3. Daily Inspection. Spraying equipment, including spray gun tips, shall be checked daily. The entire electrostatic unit shall also be checked daily, including the electrical terminals, electrodes and insulators. On humid days, condensation shall be carefully removed from insulators. The conveyor system shall be checked for jerky operation, loose hooks or other defects that could permit swinging of the units being painted. Moisture shall be removed from the compressed air storage tanks. Refer to the manufacturer's operating instructions or **Chapter 25**, *Civil Engineering*, for drainage requirements.

28.14.4. Insulators. The insulators on electrodes and conductors shall be kept dry and cleaned frequently to prevent flashover.

28.14.5. Maintenance. Before cleaning a nozzle or attempting any work on a spray gun, the power unit shall be turned off and the nozzle shall be grounded to discharge any static charge remaining in the system. Maintenance shall not be completed until enough time has elapsed to permit the solvent vapors to be drawn out of the area. In the absence of automatic grounding equipment, sufficient time shall be allowed to permit any remaining electrical charge to drain off. Only approved spark-resistant tools shall be used during cleaning operations, unless other type tools are permitted by the equipment manufacturer or TO.

28.14.6. Grounding. All metal parts, including guard rails, shields, barriers and enclosures in the vicinity of a unit, shall be grounded to prevent static build-up. Manual grounding wires

shall be available and workers shall be familiar with their use. Grounding shall be IAW AFI 32-1065, *Grounding Systems*.

28.14.6.1. Items being painted in an interior spray booth shall be bonded or grounded to lessen possibility of static discharge and explosion.

28.14.7. Manual Spraying. To prevent build-up of a static charge on the operator's body, the spray gun handle shall be electrically connected to ground so the operator, in normal operating position, is in contact with the handle by a resistance of not more than 1 megohm to ground. 28.14.8. Personnel. Only properly trained, qualified and physically-fit persons shall be permitted to work around electrostatic apparatus. Medical examinations shall be scheduled with base medical services, as needed.

28.14.8. Warning Signs. Signs shall be conspicuously posted, designating the process zone as dangerous and indicating the necessity for grounding personnel entering the spray area. A red *ON* light shall be installed to the interlocked power transformer circuit.

### 28.15. Airless Paint Spraying.

28.15.1. Principle. The principle of the airless spray method is to force paint through a small orifice at pressures from 1,800 to 4,000 pounds per square inch (psi). An electric or air-powered pump increases the hydraulic pressure of the paint in the hose and pressure vessel, if so equipped, and forces the paint, which may be heated to decrease its viscosity, from the spray gun. When the paint is forced through the orifice under high pressure, it expands and breaks into small particles. The atomized particles have enough velocity to carry them to the surface to be painted, but not enough to rebound. A spray pattern of wide coverage is created rapidly and with very little mist. Since the pattern has unusually sharp edges, masking and shielding are not necessary on most jobs. **Warning:** Never point an airless spray gun at any part of the body.

28.15.2. Operation.

28.15.2.1. Paint can be hypodermically injected into the body by high operating pressures. Injected paint may be life threatening and requires immediate medical treatment.

28.15.2.2. Do not disconnect the gun from the fluid hose or the hose from the pump until the pressure has been released from the hose and other components. This is accomplished by first closing off the electric power or air pressure to the pump and then bleeding off pressure in the fluid hose, by triggering the gun, before disconnecting it.

28.15.2.3. When handling the gun, but not actually spraying (e.g., when changing parts or work position), hold the gun by the grip and remove the fingers from the trigger. This shall prevent the gun from being activated if the operator's hold shall inadvertently tighten due to slipping or stumbling. **Note:** Guns shall be equipped with trigger guards and a safety lock. The lock shall be positioned to prevent operation, except when the gun is actually in use.

28.15.2.4. Ensure all hoses connections and fittings are tight and not leaking. **Note:** The fluid hose shall be designed to withstand the high pressure of the system. The hose, gun and pressure vessel, if so equipped, shall be equipped with special fittings that are not interchangeable with low pressure fittings or any other fittings.

28.15.2.5. Workers will inspect hoses prior to use to ensure they have no weak or worn spots. Make certain the hoses do not contact moving parts of machinery, lie over or around sharp edges and corners, or come into contact with objects that would damage them. Check for deterioration caused by exposure to chemicals and ordinary wear and tear. **Warning:** High-pressure leaks from hoses or connections may also cause hypodermic injection of paint. Injected paint may be life threatening and requires immediate medical treatment.

28.15.2.6. Cleaning. Consult the manufacturer's operating instructions for cleaning procedures. Never pass a finger over the gun orifice to clean it, as this can result in hypodermic injection of paint into the finger. Injected paint may be life threatening and requires immediate medical treatment.

28.15.2.7. Ground the object being sprayed, as well as the spray gun, to prevent accumulating of static electricity. A static electricity discharge may ignite vapors in the confined atmosphere. Fluid hoses with a ground wire will prevent the accumulation of a static charge if the airless unit is grounded and the object being sprayed is also grounded. Periodic continuity checks shall be performed to ensure hose grounding is intact.

28.15.2.8. Operators shall wear eye protection and gloves to guard against accidental contact with the spray. Also, BE-approved respiratory protective equipment shall be worn if exhaust ventilation is inadequate or not available.

## **28.16. Aerosol Cans of Spray Paint.**

28.16.1. Availability. Pressurized cans of general purpose spray lacquers or enamels are available through the GSA and commercial supply systems. The lacquers are available in acrylic, styrene/acrylic and nitrocellulose bases in a variety of colors.

28.16.2. Precautions. The same general safety and health precautions apply to spray painting from pressurized cans as to spray painting by other means.

28.16.3. Storage. Cans of spray paint shall be considered flammable materials and stored IAW criteria in [Chapter 22](#). Office desks shall not be used to store cans of spray paint. Office storerooms shall not be used to store cans of spray paint, unless the storage area has been approved by the installation FES Flight.

28.16.4. Disposal.

28.16.4.1. Dispose of empty and malfunctioning cans IAW AFPAM 32-7043, 29 CFR 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. Contact the installation Environmental Management office for local guidance.

28.16.4.2. Wiping rags and other hazardous waste materials shall be disposed of in self-closing metal containers labeled to indicate the contents and IAW the procedures established by the installation Environmental Management office, AFPAM 32-7043, 29 CFR 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. Do not dispose of cans of spray paint, wiping rags and other hazardous waste materials in office waste receptacles.



28.16.4.3. Personal Protective Equipment. The same general rules governing the use of PPE apply to painting with pressurized cans. Refer to other sections of this chapter and [Chapter 14](#) for additional guidance.

### **28.17. Powder Coating.**

28.17.1. Principle. These operations deposit air suspended powders on components in specially constructed containers called fluidized beds. Some beds are designed to place an electrostatic charge on the powder and the opposite charge on the component being coated. These aerated solid powders must be trapped and not allowed to escape to the atmosphere. Refer to manufacturer's specifications and NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, for fluidized bed use.

28.17.2. Fire Prevention. Electrostatic fluidized beds and associated equipment shall be approved types. The maximum surface temperature of equipment in the coating area shall not exceed 150° F. The high voltage circuits shall be designed to not produce a spark of sufficient intensity to ignite any powder-air mixtures or result in an appreciable shock hazard upon contact with a grounded object, under normal operating conditions. Transformers, power packs, control apparatus and all other electrical portions of the equipment, with the exception of the charging electrodes and their connections to the power supply, shall be located outside the powder coating area.

28.17.3. Ventilation. Forced exhaust ventilation is mandatory to maintain a safe atmosphere. Dust collectors shall be incorporated within the ventilation system to trap all excess powder. Where applicable, exhaust ventilation shall be sufficient to maintain the atmosphere below the lowest explosive limits for the materials being applied. The electrical equipment shall be interlocked with the ventilation system so the equipment cannot be operated unless the ventilation fans are in operation.

28.17.4. Housekeeping. All areas shall be kept free of the accumulation of powder coating dusts, including horizontal surfaces such as ledges, beams, pipes, hoods, booths and floors. Surfaces shall be cleaned in a manner that does not scatter powder or create dust clouds. Vacuum sweeping equipment, where used, shall be of a type approved for use in hazardous locations. Water-saturated cleaning cloths shall be used to remove powder dust and to preclude scattering dust deposits.

28.17.5. Grounding. Objects being coated shall be maintained in contact with the conveyor or other support to insure proper grounding. Hangers shall be regularly cleaned to ensure effective electrical contact and areas of contact shall be sharp points or knife edges where possible. The powder coating equipment shall carry a prominent, permanently installed warning regarding the necessity for bonding and grounding all metal parts of the fluidized bed and the objects being coated.

### **28.18. Organic Peroxide Coating.**

28.18.1. Principle. This type coating is applied using a special purpose spray gun. The peroxide acts as a catalyst and is introduced through one nozzle of the gun. A second material, a polyester, is introduced through a second nozzle. When the two mix at the application point, a chemical reaction occurs producing a plastic polymer coating. Refer to the manufacturer's label for the specific material in use and NFPA 33 for additional guidance.

28.18.2. Training. Only designated personnel, trained to use and handle organic peroxide formulations, shall be permitted to use these materials.

28.18.3. Fire Prevention. Do not interchange equipment used for organic peroxide coating with that used for any other application. Peroxides are oxidizers and shall not be mixed with other materials. Promptly clean up any overspray or spills. Use noncombustible absorbent material for cleanup purposes. Do not store or place organic peroxide materials near any source of heat. Avoid rough handling, since these materials are sensitive to shock. Smoking is prohibited and *NO SMOKING* signs shall be posted in any area where organic peroxides are stored, mixed or applied. Use non-sparking tools in areas where these materials are stored, mixed or applied. (**Note:** Copper beryllium tools must not be purchased, kept or dressed. If a copper beryllium tool is found that has lain undisturbed for more than three (3) years, notify BE for assistance in removal. If there is no copper beryllium non-sparking tool substitute, consult with BE to determine how to apply for an exception to this requirement.) Dispose of this material IAW AFPAM 32-7043, 29 CFR 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. Contact the installation Environmental Management office for local guidance.

28.18.4. Protective Equipment. Ensure respirators, gloves and protective clothing are used, as recommended or required in BE's OEH risk assessment.

28.18.5. Ventilation. Ensure all spraying operations involving the use of organic peroxides are conducted in spray booths meeting the requirements of the BE OEH risk assessment, ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance* and NFPA 13.

28.18.6. Storage of Organic Peroxides. Ensure personnel keep only the minimum quantity of peroxides needed for daily operations in the processing area. Organic peroxide formulations shall be stored IAW NFPA 42, *Code for the Storage of Organic Peroxide Formulations*, and the manufacturers' recommendations.

28.18.7. Mixing of Organic Peroxides with Promoters. Organic peroxide formulations shall not be mixed directly with any cobalt compounds or other promoters or accelerations, as violent decomposition or explosion can result. To minimize the possibility of such accidental mixing, these materials shall not be stored adjacent to each other.

**28.19. Interior Spray Finishing Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

28.19.1. Do functional managers ensure spray painting operations are closely supervised and equipment is in serviceable condition? Reference [28.2.1](#)

28.19.2. Are painters' ladders, scaffolds, lifelines and other equipment inspected prior to use to be certain they are in safe condition? Reference [28.2.2](#)

28.19.3. Is paint or dope mixing done in designated, adequately ventilated rooms constructed of fire-resistant materials? Reference [28.2.3](#)

- 28.19.4. Are all sources of ignition prohibited in mixing areas? Reference [28.2.3](#)
- 28.19.5. Do mixing rooms have spill control and cleanup measures? Reference [28.2.3](#)
- 28.19.6. Are soiled wiping rags kept in self-closing metal waste containers? Reference [28.2.4](#)
- 28.19.7. Is paint stored in work shops kept in tightly covered metal containers? Reference [28.2.4](#)
- 28.19.8. Do personnel engaged in painting and paint removal wear protective clothing, respiratory devices (if required) and appropriate face, eye and hand protection? Reference [28.2.5](#)
- 28.19.9. Do personnel engaged in preparing surfaces for painting by abrasive techniques, wear eye protection? Reference [28.2.6](#)
- 28.19.10. Are goggles and rubber gloves worn while acids, lye or noxious cleaning materials are used? Reference [28.2.6](#)
- 28.19.11. Are all respirators used during painting operations approved by BE? Reference [28.2.7](#)
- 28.19.12. Has the use of radioactive paint been approved by the installation RSO prior to its use? Reference [28.3.1](#)
- 28.19.13. Are liquid, solid and gaseous waste products from painting and paint removal operations disposed of IAW AFIs 32-7040, 32-7041 and 32-7042? Reference [28.3.4](#)
- 28.19.14. Do solvent materials used for residual clean up have a flashpoint of 140° F or above? Reference [28.4.4](#)
- 28.19.15. Is extreme caution employed to ensure there are no ignition sources in the area and ventilation is adequate to remove flammable vapors when using Methyl Ethyl Ketone (MEK)? Reference [28.4.5](#)
- 28.19.16. Is storage of paints and solvents IAW [Chapter 22](#)? Reference [28.4.6](#)
- 28.19.17. Are contaminated materials, i.e., solvent or paint-soiled rags, paper towels and kraft paper, removed and placed in approved self-closing metal containers? Reference [28.4.8](#)
- 28.19.18. At the end of each day or shift, are the contents of these containers disposed of? Reference [28.4.8](#)
- 28.19.19. Are portable fire extinguishers installed near all paint spraying areas? Reference [28.4.10](#)
- 28.19.20. Is mechanical ventilation in operation while spraying operations are conducted and for a sufficient time thereafter to ensure vapors are completely exhausted? Reference [28.5.1](#)
- 28.19.21. Are ducts periodically inspected for accumulation of paint deposits and cleaned as needed? Reference [28.5.3](#)
- 28.19.22. Is air exhaust from spray operations directed so it will not contaminate makeup air being introduced into the spraying area or other ventilation intakes? Reference [28.5.4](#)

- 28.19.23. Are freshly sprayed articles dried only in spaces with adequate ventilation to prevent the formation of explosive vapors? Reference [28.5.5](#)
- 28.19.24. Are ventilation systems periodically evaluated as identified in BE's OEH risk assessment? Reference [28.5.7](#)
- 28.19.25. Are the quantity of paints, lacquers, thinners, solvents and other flammable and combustible liquids kept near spraying operations limited to a one day's supply? Reference [28.6.1](#)
- 28.19.26. Is bulk storage of these liquids in a separate building, detached from other buildings, or in rooms specifically designed and constructed to meet flammable storage room requirements? Reference [28.6.1](#)
- 28.19.27. Is the withdrawal of liquids from containers and the filling of containers including portable mixing tanks done only in a mixing room or in a spraying area when the ventilating system is in operation? Reference [28.6.3](#)
- 28.19.28. Are precautions taken to protect against liquid spillage? Reference [28.6.3](#)
- 28.19.29. When flammable or combustible liquids are transferred from one container to another, are both containers effectively bonded and grounded? Reference [28.6.4](#)
- 28.19.30. Are piping systems used to transfer fluids properly bonded and grounded? Reference [28.6.4](#)
- 28.19.31. Are portable electric lamps prohibited in spray areas during spraying operations? Reference [28.7.3](#)
- 28.19.32. Are all metal parts of spray booths, exhaust ducts, and piping systems conveying flammable or combustible liquids or aerated combustible solids electrically grounded? Reference [28.7.4](#)
- 28.19.33. Are filter pads and filter rolls inspected after each painting operation and replaced when necessary? Reference [28.9.2.1](#)
- 28.19.34. Are interlocks used with automatic-advanced roll filters to stop the spraying operation should the roll advance mechanism fail? Reference [28.9.2.2](#)
- 28.19.35. Are both filter pads and rolls changed when changing from one type coating material to another if the two materials are susceptible to spontaneous combustion on contact with each other? Reference [28.9.2.4](#)
- 28.19.36. Are discarded filter pads and rolls removed from the area daily unless water-filled metal containers are provided to hold them immersed until disposal? Reference [28.9.2.5](#)
- 28.19.37. Is the appropriate size and type of portable fire extinguisher available within the spray areas? Reference [28.9.4](#)
- 28.19.38. Is the use or carrying of matches, lighters or other spark or flame-producing devices prohibited in or adjacent to spray booths? Reference [28.9.6](#)
- 28.19.39. Are pressure hoses and couplings regularly inspected for poor condition and replaced, as needed? Reference [28.9.8](#)

- 28.19.40. Are pressure relief valves set to open at pressures not more than 10 pounds above the required working pressure? Reference [28.10.1](#)
- 28.19.41. Are all air hoses checked prior to each shift to ensure they are properly connected to both their pipe outlets and the equipment to be used? Reference [28.10.2](#)
- 28.19.42. To prevent hose whipping, is the loose end secured prior to connecting hose to a compressed air outlet? Reference [28.10.2](#)
- 28.19.43. Are hose lines checked for evidence of wear and replaced as needed? Reference [28.10.3](#)
- 28.19.44. Is the compressor and tank equipment securely mounted on a wheeled carriage for portability? Reference [28.10.4.2](#)
- 28.19.45. Are all paint pressure tanks and spray guns cleaned after each use and before being stored? Reference [28.10.5.3](#)
- 28.19.46. Is the exhaust air adequately vented from drying ovens? Reference [28.11.3](#)
- 28.19.47. Are metal parts of drying ovens bonded and grounded? Reference [28.11.5](#)
- 28.19.48. Is spray painting of an entire aircraft permitted only in hangars specifically designed for this purpose? Reference [28.12.1](#)
- 28.19.49. When spray painting aircraft, are the aircraft isolated and adequate fire prevention measures taken? Reference [28.12.2](#)
- 28.19.50. Are all aircraft properly grounded and all sources of ignition removed from the area prior to spray painting an aircraft? Reference [28.12.2](#)
- 28.19.51. Is smoking prohibited in the area where the aircraft will be spray painted? Reference [28.12.2](#)
- 28.19.52. Are all aircraft electrical systems de-energized during cleaning, painting and paint removal operations? Reference [28.12.2](#)
- 28.19.53. Is proper ventilation provided when spray painting aircraft? Reference [28.12.3](#)
- 28.19.54. Are all aircraft spray paint areas kept free from the accumulation of deposits of combustible residues? Reference [28.12.4](#)
- 28.19.55. Are all scraping tools used during spray paint of aircraft operations non-sparking? Reference [28.12.4](#)
- 28.19.56. Are containers emptied daily or after each shift? Reference [28.12.4](#)
- 28.19.57. Are aircraft surfaces grounded to preclude the build-up of static electricity whenever operations involving sanding, rubbing, painting or wiping surfaces are performed? Reference [28.12.6](#)
- 28.19.58. Is smoking prohibited within 50 feet of painting operations? Reference [28.13.1](#)
- 28.19.59. While painting, do personnel wear gloves or other BE-approved PPE needed to complete the task? Reference [28.13.3](#)
- 28.19.60. Is fire prevention equipment checked regularly, with particular attention given to automatic sprinkler heads? Reference [28.14.2](#)

- 28.19.61. Are sprinklers protecting spraying areas kept free from deposits by frequent or daily cleaning? Reference [28.14.2](#)
- 28.19.62. Is the entire electrostatic unit checked daily? Reference [28.14.3](#)
- 28.19.63. Are insulators on electrodes and conductors kept dry and cleaned frequently to prevent flashover? Reference [28.14.4](#)
- 28.19.64. Are the power unit and ground nozzle turned off, to discharge any remaining charge within the system before cleaning a nozzle or attempting to work on any gun? Reference [28.14.5](#)
- 28.19.65. Are only non-copper beryllium spark-resistant tools used during cleaning operations? Reference [28.14.5](#)
- 28.19.66. Are all metal parts, including guard rails, shields, barriers, and enclosures in the vicinity of a unit, grounded to prevent static build-up? Reference [28.14.6](#)
- 28.19.67. Is the handle of the spray gun electrically connected to ground? Reference [28.14.7](#)
- 28.19.68. Are only properly trained, qualified and physically-fit personnel permitted to work around electrostatic apparatus? Reference [28.14.8](#)
- 28.19.69. Are warning signs posted designating the spray process zone as dangerous ? Reference [28.14.9](#)
- 28.19.70. Is a red “ON” light installed in the interlocked power transformer circuit? Reference [28.14.9](#)
- 28.19.71. Do workers make sure they do not disconnect the airless paint spray gun from the fluid hose, or the hose from the pump, until the hose and other components have been depressurized? Reference [28.15.2.2](#)
- 28.19.72. Is the safety lock positioned to prevent operation, except when the gun is actually in use? Reference [28.15.2.3](#)
- 28.19.73. Are all hose connections and fittings tight and not leaking? Reference [28.15.2.4](#)
- 28.19.74. Are all hoses checked for weak or worn spots? Reference [28.15.2.5](#)
- 28.19.75. Are the object being sprayed and the spray gun grounded to prevent accumulation of static electricity? Reference [28.15.2.7](#)
- 28.19.76. Are periodic continuity checks performed to ensure the hose grounding is intact? Reference [28.15.2.7](#)
- 28.19.77. Does the operator wear eye protection and gloves to guard against accidental contact with the spray? Reference [28.15.2.8](#)
- 28.19.78. Is BE-approved respiratory protective equipment worn if exhaust ventilation is inadequate or not available? Reference [28.15.2.8](#)
- 28.19.79. Are cans of spray paint stored IAW [Chapter 22](#)? Reference [28.16.3](#)
- 28.19.80. Do supervisors ensure office desks are not used to store spray paint? Reference [28.16.3](#)

- 28.19.81. Are empty and malfunctioning cans of spray paint disposed of IAW AFPAM 32-7043? Reference [28.16.4.1](#)
- 28.19.82. Are wiping rags and other waste materials disposed of in self-closing metal containers labeled to indicate the contents? Reference [28.16.4.2](#)
- 28.19.83. Do supervisors ensure office waste cans are not used for the disposal of spray paint cans, wiping rags or other hazardous waste materials? Reference [28.16.4.2](#)
- 28.19.84. Is the powder coating area free of accumulations of powder coating dust? Reference [28.17.4](#)
- 28.19.85. Are all metal parts of the fluidized bed electrically bonded and grounded? Reference [28.17.5](#)
- 28.19.86. Is equipment used for organic peroxide coating prevented from interchange with that used for any other application? Reference [28.18.3](#)
- 28.19.87. Are noncombustible absorbent materials used for clean-up purposes during organic peroxide coating operations? Reference [28.18.3](#)
- 28.19.88. Do supervisors ensure organic peroxide materials are not stored near any source of heat? Reference [28.18.3](#)
- 28.19.89. Is smoking prohibited and are “*NO SMOKING*” signs posted in areas where organic peroxides are stored, mixed or applied? Reference [28.18.3](#)
- 28.19.90. Are non-sparking tools used in areas where organic peroxide coating materials are stored, mixed or applied? Reference [28.18.3](#)
- 28.19.91. Is the quantity of organic peroxides kept in the processing area the minimum required for daily operations? Reference [28.18.6](#)

## Chapter 29

### MISHAP PREVENTION SIGNS AND TAGS

#### 29.1. General Information.

##### 29.1.1. Hazards.

29.1.1.1. Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, and AFI 91-202, *The US Air Force Mishap Prevention Program*, for further information on the JSA and job safety training guide. **Note:** A JSA is not required when existing guidance adequately covers all safety requirements of an operation or process. Example: TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

29.1.1.2. Refer to **Chapter 2**, *Human Factors*, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

29.1.1.3. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph **2.3** for additional information.

**29.2. Specific Information.** This chapter outlines Air Force requirements for safety, health and fire prevention signs and tags. It applies to all work environments, but is not intended to cover signs or tags unique to aircraft, motor vehicle, railroad or marine operations.

29.2.1. This chapter establishes requirements for hazard-information devices (signs and tags) at facilities and workplaces with conditions that pose significant hazards to personnel or property. Such conditions include, but are not limited to, areas with flammable or toxic materials, lethal electrical sources and other potentially hazardous equipment and materials. Rapid identification and warning of existing and potential hazards to workers is important, especially for individuals not routinely in these work areas.

29.2.2. Interior and other installation specific signs shall be designed IAW UFC 3-120-01, *Air Force Sign Standard*, where applicable. This chapter also adopts occupational safety and health signs in 29 CFR 1910.144, *Safety Color Code for Marking Physical Hazards*, and 29 CFR 1910.145, *Specifications for Accident Prevention Signs and Tags*. Where OSHA has specific requirements, they shall be followed in addition to applicable federal, state or municipal regulations. In the absence of OSHA requirements, ANSI standards shall be followed, including ANSI Z535.1, *Safety Colors*, ANSI Z535.2-2007, *Environmental and Facility Safety Signs*, ANSI Z535.3-2007, *Criteria for Safety Symbols*, and ANSI Z535.4-2007, *Product Safety Signs and Labels*.

29.2.3. This chapter establishes and prescribes general hazard identification tags for Air Force use. These tags satisfy AFI 91-202 hazard notification requirements and shall be used when notification is required.

29.2.4. Availability of Safety Signs and Tags. The functional manager or supervisor shall ensure an adequate supply of safety signs and tags is available to workers.



29.2.5. Other signs or tags prescribed by Air Force directives for site-specific hazards shall be brought to the attention of HQ AFSEC/SEG, i.e., signs or tags that may be included in this instruction or clarification of usage.

**29.3. Requirements.** Signs and tags are an effective means for communicating hazard information to workers to prevent injuries. They provide additional safety guidance and increase workers' awareness of potentially hazardous conditions. However, signs and tags are not substitutes for abatement action such as engineering controls, substitution, isolation or safe work practices. Wording on signs and tags shall be concise, accurate, easily read, contain sufficient information to be easily understood and make a positive, rather than negative, statement.

29.3.1. Specifications and Use of Safety, Fire Prevention and Health Signs. Signs shall be uniform, properly worded and located, with a meaning immediately and clearly understood as an automatic warning, caution or notice to all personnel no matter where they work.

29.3.1.1. Standard Proportions for Signs. Commercially manufactured signs are designed and proportioned for uniformity and legibility and shall be used, if available. If not available, signs may be manufactured locally IAW [Table 29.1](#) through [Table 29.6](#)

29.3.1.2. Sign Placement. Signs shall be located to alert personnel in time to avoid the hazard, not be in harm's way before seeing the sign. Signs may provide directions to eliminate or reduce the hazard and may state consequences of not avoiding the hazard.

29.3.1.2.1. Signs shall be placed so they are visible, do not cause distractions and are not a hazard themselves; for example, avoid low-hanging signs or ones that protrude into a walkway.

29.3.1.2.2. Signs shall have rounded corners and be free of burrs and splinters. Sign fasteners shall have no protruding parts that could cause abrasions or lacerations.

29.3.1.2.3. To prevent confusion, avoid grouping too many signs together in the same location.

29.3.1.2.4. Signs shall not be placed on moveable objects or adjacent to moveable objects like wheeled equipment, removable partitions, on doors, etc., which, if moved, will obscure the sign.

29.3.1.2.5. Signs shall have adequate illumination. If illumination is inadequate under emergency conditions, signs shall be equipped with emergency (battery operated) illumination, be luminescent or both. Consult the local CE facility design section for lighting guidance for specific locations.

29.3.2. Lettering. Lettering shall be of sufficient size and contrast to be readily visible and legible. Legibility of text is influenced by letter height, the ratio of letter height to width (stroke width), and spacing between letters, words and lines. Refer to UFC 3-120-01 for guidance on lettering size. [Table 29.1](#) shows distances that well-proportioned letters of different heights can be read by persons with 20/40 visual acuity under good lighting conditions.

29.3.2.1. Overall lettering size shall be determined by the distance from which the sign can be safely and easily read. Letters shall be adequately spaced, not crowded and the message as concise as practical.

29.3.2.2. A safe viewing distance shall be determined for each location where a safety sign is needed. The message panel text shall also meet safe viewing distance legibility criteria. **Figure 29.7** shows examples of signs with pictograph and message panels. **Note:** A rule-of-thumb of 35-40 feet viewing distance per inch of letter height may be used.

29.3.3. Safety Symbols. Safety symbols may be used to clarify, supplement or as a substitute for part or all words in the message panel. A symbol may only be used if it is comprehensible. Training materials and manuals can be used to train workers on a symbol's meaning.

29.3.3.1. Safety symbols are pictorials, pictographs or other graphic representations chosen to clearly convey a specific safety message. Ideally, a symbol should be graphically simple, readily understood, make a strong impact and be easily remembered.

29.3.3.2. A symbol shall illustrate the type of hazard, potential consequences or evasive/avoidance actions needed and be compatible with the word message(s).

29.3.3.3. Well designed safety symbols cross language and literacy barriers and communicate hazard information quickly. Although standards allow for word-messages-only, safety symbols are encouraged when practical. **Figure 29.6** and **Figure 29.7** show examples of signs with pictographs and messages.

29.3.3.4. Multi-lingual signs. The effectiveness of word-only signs is complicated by workers whose native language is not English. Whenever possible, use international signs and ensure all workers understand warnings. If additional languages are needed on safety signs, it is strongly encouraged to use symbols, in addition to words, to better communicate hazard information across language barriers.

29.3.4. Criteria for Warning Colors. Safety color coding for warning signs and markers helps alert persons to the presence of hazards. Refer to **Table 29.6** and **29.7** for examples of color use. Color specifications in this standard are IAW 29 CFR 1910.144. and 29 CFR 1910.145.

29.3.4.1. Black or White. Black or white lettering provides contrast with basic warning and cautionary colors. Black lettering shall be used on a yellow, white or orange background. White lettering shall be used on a red, green or black background.

29.3.4.2. Green. Green shall be the basic color for safety and first-aid equipment locations. Solid green, green and white stripes, green cross on white background, or white cross on green background can be used. Green is also used for identifying compressed gas cylinders and piping systems containing oxidizing materials.

29.3.4.3. Magenta. Magenta is used to letter piping systems containers, housings, equipment, etc., containing radioactive substances. Approved tags and signs exhibiting the standard, 3-bladed magenta radiation symbol on a yellow background shall be used to identify the nature and magnitude of the radiation hazard, together with specific hazard control instructions.

29.3.4.4. Orange. Orange, with the exception of fluorescent orange or orange-red used to designate biohazards, shall be used to designate electrical conduit and unguarded, dangerous parts of machines or energized equipment which may cut, crush, shock or

otherwise injure, and to emphasize such hazards when equipment guards are open or removed.

29.3.4.5. Red. Red shall be used to mark danger and stop.

29.3.4.6. Yellow. Yellow shall be used to designate caution, flammable materials and to mark physical hazards, such as strike against, stumble, trip, fall and caught-between types.

29.3.4.7. Solid Yellow, Yellow and Black Stripes, and Yellow and Black Checks. These colors and color combinations may be used interchangeably. Using combination colors creates the most attention for housekeeping or aisle markings.

29.3.5. Types of Signs - Color Identification, and Use. **Note:** For laser hazard warning signs and labels refer to AFOSH Standard 48-139, *Laser Radiation Protection Program*, and ANSI Z136.1-2007, *Standard for the Safe Use of Lasers*. DoDI 6055.1., *DoD Safety and Occupational Health (SOH) Program*, outlines the military exemption for laser HAZCOM.

29.3.5.1. Signs For Fire Hazards of Materials. A standardized system exists for identifying the hazards of materials. Explained in detail in NFPA 704, *Standard System for the Identification of the Hazards of Material for Emergency Response*, and used by CONUS installation Fire Emergency Services (FES) Flights, it uses three categories: health hazard, flammability hazard and reactivity hazard. This simple, readily recognized and easily understood system provides general information on the hazards of a material and the severity of these hazards to emergency responses. The installation FES Flight can provide additional information on fire hazards of materials.

29.3.5.2. Signs and Symbols Used to Identify Explosive Materials. The AF and North Atlantic Treaty Organization (NATO) identifies items and substances assigned to United Nations (UN) dangerous goods Class I (explosives, munitions, propellants and pyrotechnics) according to the hazard they present IAW AFMAN 91-201, *Explosives Safety Standard*.

29.3.5.3. AF Form 1118, *Notice of Hazard*. The *Notice of Hazard* is considered a sign. It is posted at or near the identified hazard until the hazard is corrected. Standard colors for these signs are black letters on a white background with a red border.

29.3.5.4. Asbestos Warning Signs. Asbestos warning signs shall meet requirements of 29 CFR 1910.1001, *Asbestos*.

29.3.5.5. Lead Warning Signs. Lead warning signs shall meet requirements of 29 CFR 1910.1025, *Lead*.

29.3.5.6. Danger Signs. Danger signs shall indicate an immediate hazard. The sign shall be red, black and white as shown in [Figure 29.1](#) and sized IAW [Table 29.1](#) Examples of messages for Danger signs are shown in [Table 29.7](#)

29.3.5.7. Warning Signs. Warning signs shall be used to warn of hazards which could cause damage to equipment, death or serious injury to personnel. Warnings represent a hazard level between “Danger” and “Caution.” The sign shall be orange and black and designed as in [Figure 29.2](#)

29.3.5.8. Caution Signs. Caution signs shall be used to warn of potential hazards. The sign shall be yellow and black and designed as in **Figure 29.3** with dimensions as given in **Table 29.2**

29.3.5.9. Radio Frequency Radiation Warning Signs. Radio frequency radiation warning signs signify the presence of hazardous electromagnetic energy frequencies from 10 megahertz to 100 gigahertz. These signs shall define specific radio frequency hazards and provide warning data or instructions about the hazard. "WARNING - RADIO FREQUENCY HAZARD," or appropriate instructional or warning statements, shall be inserted on the sign's lower half of the triangle as specified in AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*.

29.3.5.10. Exit Signs. Exit signs shall clearly identify the means of egress from facilities when required. These signs shall conform to design and color requirements in ETL 99-4, *Fire Protection Engineering Criteria - Emergency Lighting and Marking of Exits*, and NFPA 101, *The Life Safety Code*, and have lettering on an opaque background. Each sign shall be provided with adequate lighting to illuminate the sign's surface. Incandescent lighting may be used in existing fixtures, but new internally illuminated exit signs shall be a light emitting diode (LED), electroluminescent (LEC), or cold cathode type. Illumination of exit signs shall be continuous whenever building occupancy may require the means of egress be available for use. Refer to UFC 3-600-01 for further guidance. Exit signs containing radioactive material shall not be procured.

29.3.5.11. Directional Signs. Directional signs, other than emergency exit signs, indicate the way to stairways, medical offices, health stations, emergency showers, etc., and shall be designed IAW UFC 3-120-01, *Air Force Sign Standard*.

29.3.5.12. Instruction and Identification Signs. Instruction and identification signs, designed IAW UFC 3-120-01, shall be used to convey general instructions or identify PPE or systems.

29.3.5.13. Biological Hazard Signs. Biological hazard signs shall signify the actual or potential presence of a biological hazard and identify equipment, containers, rooms, experimental animals, etc., which contain or are contaminated with viable hazardous agents. The sign symbol shall be the standard fluorescent orange or orange-red color, with background color optional, provided there is sufficient contrast to clearly define the symbol. The symbol may be used on signs, warning tags or identification labels along with appropriate wording to indicate the nature or identity of the hazard. Wording shall include precautionary information and the name or job classification of the individual responsible (such as chemical or laboratory supervisor) for control of the biological hazard, but this information shall not be superimposed on the symbol. These signs shall be designed IAW **Figure 29.6** with letters sized IAW UFC 3-120-01.

29.3.5.14. Ionizing Radiation Warning Signs, Placards and Forms. Refer to AFI 48-148, *Ionizing Radiation Protection*, AFI 40-201, *Managing Radioactive Materials in the U.S. Air Force*, and 10 CFR 20, *Standards for Protection Against Radiation*.

29.3.6. Electrical equipment labeling and placarding shall comply with UFC 3-560-01, *Electrical Safety O&M*.

#### 29.4. AF Form 1118 and AF Form 979.

29.4.1. Use AF Form 1118, *Notice of Hazard*, to post notices for facilities or AF Form 979, *Danger Tag*, for equipment. **Note: AF Form 979** may be used temporarily until an AF Form 1118 is issued.

29.4.2. AF Forms 1118 are issued only by Ground Safety office, FES Flight and BE to permanently identify a hazardous condition that could result in serious injury, disability or death. These 8" x 10" red bordered forms (**Figure 29.9**) identify hazardous conditions, any interim control measures in effect and permanent corrective actions underway or programmed. AF Forms 1118 are issued for hazards assigned a Risk Assessment Code (RAC) of 1, 2 or 3. See AFI 91-202 for instructions on RACs and preparing the AF Form 1118.

29.4.2.1. Once issued, the AF Form 1118 shall be posted by the workplace supervisor as near as possible to the hazard. In areas where this is not practical, the AF Form 1118 shall be posted in a prominent location visible to all affected workers and shall remain posted until the hazardous condition is abated, or for three (3) days, whichever is greater. Removal is authorized only after correction of hazard and verification by the issuing authority.

29.4.3. The **AF Form 979**, *Danger Tag*, a temporary means of identifying hazardous conditions, can be issued by the supervisor as an interim device until an AF Form 1118 is posted. The *Danger Tag* provides a means for supervisors to immediately alert workers to existing and/or potential hazards. The AF Form 979 may be removed once an AF Form 1118 is posted.

#### 29.5. Specifications For and Use of Safety, Fire Prevention and Health Tags.

29.5.1. Tags are a temporary means of warning workers of hazardous conditions, defective equipment, etc., including hazards that are out of the ordinary, unexpected or not readily apparent. Tags are not a complete warning method and shall only be used until a positive means can be used to eliminate the hazard. For example, a "Do Not Start" tag is affixed to a machine until the machine can be locked out, de-energized or inactivated. "Do Not Start" tags shall be placed in conspicuous locations and, if possible, block the starting mechanism that would cause hazardous conditions if equipment was energized.

29.5.1.1. Supervisors shall ensure workers are informed of the meaning of the various tags used throughout the workplace and what special precautions are necessary.

29.5.1.2. Tags shall be affixed as close as safely possible to their respective hazards by a positive means such as string, wire or adhesive that prevents their loss or unintentional removal.

29.5.1.3. Tags shall be used until the identified hazard is eliminated or hazardous operation is completed.

29.5.2. All safety tags shall contain a signal word and a major message such as "DANGER," "WARNING," "CAUTION" or "BIOHAZARD."

29.5.2.1. *Danger* tags shall only be used where an immediate hazard (RAC 1 through 3) exists and specific precautions are required to protect personnel or property or when required by TOs or other manuals. RACs assigned by the installation Ground Safety

office, FES Flight or BE shall be included in the “Hazard” description block on the front side of the tag.

29.5.2.2. *Warning* tags shall identify items which could cause damage to equipment or death or serious injury to personnel. Some events that pose a hazard to personnel and equipment can also be identified/classified as a warning. Warnings represent a hazard level between “Caution” and “Danger.” When in doubt, contact the unit supervisor or installation Ground Safety office, FES Flight or BE for guidance on the appropriate tag to use.

29.5.2.3. *Caution* tags shall only be used where a hazard can damage equipment, or a non-immediate, potential hazard or unsafe practice presents a lesser threat of worker injury.

29.5.2.4. *Biohazard* tags shall identify the actual or potential presence of a biological hazard and to identify equipment, containers, rooms, experimental animals or combinations thereof, that contain or are contaminated with hazardous biological agents.

29.5.2.5. Other tags may be used in addition to those required or in situations that do not require tags, provided they do not detract from the impact or visibility of the signal word and major message of any required tags.

29.5.3. Major messages shall indicate the specific hazardous condition or the instruction being communicated to workers. Major messages shall be presented in pictographs, written text or both. The major message portion of a tag’s inscription shall be more specific than the signal word. Example: “High Voltage,” “Do Not Start,” etc., or a corresponding pictograph used with a written text or alone.

29.5.4. Signal words, used to call attention to the tag and designate the level of hazard seriousness, shall be readable at a minimum distance of five feet (1.52m) or a greater distance if warranted by the hazard.

29.5.5. Recommended Color Coding. While not mandatory, colors may be used on accident prevention tags. Color schemes should follow standard color schemes of signs. OSHA recommends the following color scheme:

DANGER – Red, or predominately red, with lettering or symbols in a contrasting color.

WARNING – Orange, or predominately orange, with lettering or symbols in a contrasting color.

CAUTION – Yellow, or predominately yellow, with lettering or symbols in a contrasting color.

BIOHAZARD – Fluorescent orange or orange-red, or predominately so, with lettering or symbols in a contrasting color.

## **29.6. General Requirements for Use of Tags.**

29.6.1. The following apply to all Air Force tags prescribed by this standard. Requirements unique to a particular tag appear in the tag’s instructions. All mishap prevention tags used to warn of specific hazards shall be standardized Air Force forms with no variation in design of tags.

29.6.1.1. User Instructions. Workers shall immediately advise supervisors of unsafe conditions.

29.6.1.2. Notification. Supervisors shall evaluate the situation, ensure an appropriate tag is attached, if needed, and coordinate placement of tags and assignment of RACs with the installation Ground Safety office, FES Flight or BE, as appropriate. The supervisor, or person in charge at the time, is responsible for issuing tags; if unavailable, the worker shall contact the installation Ground Safety office, FES Flight or BE, as appropriate.

29.6.1.3. RACs shall be assigned by installation Ground Safety office, FES Flight or BE, as appropriate. A RAC shall not be assigned to equipment issued during routine maintenance or servicing. For example, TO-directed tagging of the starter switch during engine maintenance does not require a RAC.

29.6.1.3.1. Verification of RAC, when required by AFI 91-202, shall be accomplished as soon as possible and shall not exceed 10 days from hazard identification.

29.6.1.3.2. Tag placement shall not be delayed awaiting RAC verification. Changing an initial tag from *Danger* to *Caution*, *Out of Order*, *Do Not Start*, etc., or vice-versa, is the responsibility of the supervisor upon verification of RAC by the installation Ground Safety office, FES Flight or BE.

29.6.1.4. Notification requirements do not apply when *Danger* tags are installed IAW applicable TOs, AF instructions or other directed requirements, including routine maintenance functions on aircraft or missile systems. For example, ground safety personnel need not be notified when tagging out the circuit breaker of an air compressor where the motor has been removed for bearing replacement, or when machines or equipment are locked out for maintenance or servicing.

29.6.1.5. Equipment records, when maintained, shall be annotated to reflect current tag status. Tag logs may be maintained to identify tags currently in use in a work area.

29.6.1.6. Local commanders shall implement internal procedures to ensure coordination of tags between supervisors and installation Ground Safety office, FES Flight and BE.

29.6.1.7. Removal of *Danger* and *Caution* Tags. The supervisor, with coordination from the installation Ground Safety office, FES Flight or BE, as appropriate, is responsible for removing the tag after the hazardous condition has been corrected. Maintenance logs, if maintained, shall be annotated that the hazardous condition has been corrected and tag removed. The installation Ground Safety office shall be notified, during normal duty hours, that the tag has been removed. Notification shall not be later than the following duty day. Refer to paragraphs [29.7.2.1](#) and [29.7.2.2](#) for additional guidance.

**29.7. Specific Requirements For Use of Tags.** Tag Identification and Use. Mishap prevention tags prescribed below (*Danger*, *Caution*, *Out of Order* and *Do Not Start*) meet requirements of AFI 91-202 and 29 CFR 1910.145.

29.7.1. **AF Form 979, *Danger* Tag** ([Figure 29.10](#)).

29.7.1.1. *Danger* tags shall only be used where an immediate hazard (RAC 1 through 3) exists and specific precautions are required to protect personnel or property—or as required by TOs, AF instructions or other requirements.

29.7.1.2. All workers shall be instructed that *Danger* tags indicate immediate danger and special precautions are necessary.

29.7.1.3. A *Danger* tag shall be placed on damaged equipment and immediate arrangements made to take the equipment out of service until repaired. Tag wording shall read, “DO NOT USE THIS EQUIPMENT” or “DEFECTIVE EQUIPMENT, DO NOT USE.”

29.7.1.4. Removal. Only the worker, or their supervisor, responsible for installing the *Danger* tag may remove the tag only if the hazard has been abated. The installation Ground Safety office shall be notified of tag removal, during normal duty hours, no later than the following day.

29.7.1.4.1. Removal of *Danger* tags prescribed by TOs or AF instructions for routine aircraft or missile/munitions maintenance actions need not be coordinated with the installation Ground Safety office, FES Flight or BE. Refer to paragraphs 29.6.1.7 for additional information.

29.7.1.4.2. Text and Reverse Side. Tag text shall be provided by, and reverse side completed by, the responsible on-duty supervisor. Refer to paragraph 29.7 for additional information.

29.7.2. **AF Form 980, Caution Tag (Figure 29.11).**

29.7.2.1. AF Form 980, *Caution Tag*, shall be used by any AF worker, in coordination with the work area or activity supervisor, only to warn against potential hazards, caution against unsafe practices and to prescribe precautions to protect personnel and property. Assignment of RAC shall be coordinated with the installation Ground Safety office, FES Flight or BE, as appropriate. Tags for routine maintenance actions, required by TOs or AFI 32-1064, *Electrical Safe Practices*, need not be coordinated with Ground Safety office, FES Flight or BE.

29.7.2.2. Removal. *Caution* tags shall only be removed by the work area or activity supervisor when the hazard is abated. If tag placement was coordinated with the installation Ground Safety office, FES Flight or BE, the supervisor shall coordinate with these agencies prior to removal.

29.7.2.3. Text and Reverse Side. Tag text shall be provided by, and the reverse side completed by, the responsible on-duty supervisor. Refer to paragraph 29.7 for additional information.

29.7.3. **AF Form 981, Out of Order Tag (Figure 29.12).** *Out of Order* tags shall only be used to indicate a piece of equipment, machinery, utility or system is out of order and its use might be hazardous. If reparable, a TO prescribed green tag may be used in place of the AF Form 981.

29.7.3.1. Applicable equipment records, when available, shall be annotated in addition to completing the *Out of Order* tag. The energy source shall be locked out per **Chapter 21, Hazardous Energy Control (Lockout and Tagout)**, if turning on the equipment could result in an injury or damage

29.7.3.2. Removal. *Out of Order* tags shall only be removed by the supervisor assuming responsibility for the tag after the hazard is corrected.



29.7.3.3. Text and Reverse Side. Tag text shall be provided by, and reverse side completed by, the responsible on-duty supervisor. Refer to paragraph 29.8 for additional information.

**29.7.4. AF Form 982, Do Not Start Tag (Figure 29.13).**

29.7.4.1. AF Form 982, *Do Not Start Tag*, shall only be used to alert personnel of hazards associated with restarting the equipment and only for a very short time until the energy isolating device can be locked out. *Do Not Start* tags shall be placed in conspicuous locations or in a manner that they effectively block the starting mechanism should the equipment be energized.

29.7.4.1.1. The *Do Not Start* tag may be used in conjunction with AF Form 979, *Danger* tag. If a *Danger* tag is attached to equipment, it is not always necessary use a *Do Not Start* tag. It is the on-duty supervisor's responsibility to attach the *Do Not Start* tag on the equipment in question. If in doubt, contact the installation Ground Safety office, FES Flight or BE, as appropriate.

29.7.4.2. Removal. *Do Not Start* tags shall be removed by the supervisor only after the condition has been corrected.

29.7.4.3. Text and Reverse Side. The text shall be provided by, and reverse side completed by, the responsible on-duty supervisor. Refer to paragraph 29.8 for additional information.

**29.8. Guidance for Completing Reverse Side of AF Forms 979, 980 and 982 (Figure 29.10 , 29.11 and 29.13).**

29.8.1. Shop supervisors shall ensure workers are trained to properly fill out reverse side of AF Forms 979, 980 and 982.

29.8.2. Installation or Facility. Name of installation, facility or annex where form will be used.

29.8.3. Safe Clearance Number. Used for electrical work procedures. Refer to AFI 32-1064.

29.8.4. Line or Equipment Involved. A brief description of equipment or machine involved. Refer to AFI 32-1064 for additional information.

29.8.5. Abnormal or Special Conditions. For electrical work procedures. Refer to AFI 32-1064.

29.8.6. Time and Date. Self-explanatory. Time shall consist of local time in hours and minutes. Date shall include day, month and year.

29.8.7. Name, Organization, and Phone Number. Print name of supervisor placing tag and see AFI 32-1064 for information required of individual directing placement of tags.

**29.9. Guidance for Completing Reverse Side of AF Form 981 (Figure 29.12 ).**

29.9.1. Shop supervisors shall ensure shop personnel are trained to properly fill out the reverse side of AF Forms 981.

29.9.2. Part I, items 1 through 4, shall be completed by the individual who identified the hazard. Part II, items 5 through 7, shall be completed by the responsible supervisor.

29.9.3. MAJCOMs may supplement these procedures as needed. Prior to completing Part II, the supervisor shall coordinate situations requiring over 30 calendar days to correct with the responsible functional manager (refer to AFI 91-202). Hazards assigned RAC 1, 2 or 3 requiring over 30 calendar days to correct shall be entered in the installation's formal hazard abatement plan using AF Form 3, *Hazard Abatement Plan*, and may require posting an AF Form 1118.

29.9.4. Time. Self-explanatory.

29.9.5. Date. Self-explanatory.

29.9.6. Shop or Office symbol. Example: 36 ABW/LGMM.

29.9.7. Grade, Name, and Phone. Print grade, name and phone number of person placing the tag. Example: TSgt J. Smith, 1810. Add supervisor's name and phone number underneath.

29.9.8. Risk Assessment Category (RAC). Include hazard severity and mishap probability. Example: RAC 2 (IIB) coordinated with Ground Safety office, FES Flight and BE.

29.9.9. Verification Date. Date verified by Ground Safety office, FES Flight and BE.

29.9.10. Functional Manager Number. Functional manager number assigned on AF Form 3. Example: 36 ABW/LGM. Refer to AFI 91-202 for additional guidance. **Note 1:** Items 8, 9 and 10 may be left blank. **Note 2:** When AF Forms 979, 980 and 982 are used by CE personnel IAW AFI 32-1064, coordination and notification with installation Ground Safety office, FES Flight and BE is not required.

**Figure 29.1. Danger Sign.**



**Note 1:** Upper panel: DANGER in white within a red oval outlined in white on a black rectangular background.

**Note 2:** Lower panel: Words and/or symbols in black or red on a white background.

**Figure 29.2. Warning Sign.**



**Note 1:** Upper panel: WARNING in orange within a black rectangle on an orange background.

**Note 2:** Lower panel: Words and/or symbols in black on an orange background.

**Figure 29.3. Caution Sign.**



**Note 1:** Upper panel: CAUTION in yellow within a black rectangle on a yellow background.

**Note 2:** Lower panel: Words and/or symbols in black on a yellow background.

**Figure 29.4. Directional Signs.**



**Note 1:** Upper panel: White arrow on black background.

**Note 2:** Lower panel: Black letters on white background.

**Figure 29.5. Instruction and Identification Signs.**



**Note:** White lettering on green background (preferably).

Figure 29.6. Examples of Symbol/Pictograph with a Major Message.



Figure 29.7. Examples of Signs with Symbols/Pictographs and Message Panel.





Figure 29.8. Standard Biological Hazard Symbol.



Note 1: Upper panel: WARNING in orange within a black rectangle on an orange background.

Note 2: Lower panel: Words and symbols in black on an orange background.

Figure 29.9. AF Form 1118, Notice of Hazard.

The image shows the AF Form 1118, Notice of Hazard form, which is a white document with a red border. The form is divided into several sections:
 

- NOTICE OF HAZARD** (Section Header)
- LOCATION** (Text field)
- DATE POSTED** (Text field)
- HAZARDOUS CONDITION** (Section Header)
- INTERIM CONTROL MEASURES** (Section Header)
- PERMANENT CORRECTIVE ACTION** (Section Header)
- FOR ASSESSMENT GUIDE** (Text field)
- FOR FURTHER INFORMATION CONTACT** (Text field)
- EXPECTED COMPLETION DATE** (Text field)

Figure 29.10. AF Form 979, Danger Tag.

DANGER - EMPLOYEES AT WORK (Do Not Operate)		
INSTALLATION/FACILITY <i>Bldg 24499, Carpentry Shop</i>		SAFE CLEARANCE NO. <i>NA</i>
LINE/EQUIPMENT INVOLVED <i>Radial Saw</i>		
TIME	DATE	NAME/ORG (PRINT)
<i>0935</i>	<i>3 Apr 97</i>	INDIVIDUAL ORDERING TAG ON EQUIPMENT <i>T. Sgt Canyon / 18th OES/DP: 3-7942</i>
<i>0945</i>	<i>3 Apr 97</i>	INDIVIDUAL PLACING TAG ON EQUIPMENT <i>SrA Norton / 13th OES/DP: 3-1810</i>
		INDIVIDUAL ORDERING TAG REMOVED FROM EQPT.
		INDIVIDUAL REMOVING TAG FROM EQPT.

AF Form 979

Note: The AF Form 979, Danger Tag, and AF Form 982, Do Not Start Tag, have the same reverse side (will be fixed when reprinted).

Figure 29.11. AF Form 980, Caution Tag.

CAUTION—ABNORMAL CONDITIONS		
INSTALLATION/FACILITY <i>Kirtland / Hangar 14</i>		SAFE CLEARANCE NO.
LINE/EQUIPMENT INVOLVED <i>BA Stand</i>		
ABNORMAL CONDITIONS <i>One brake inoperative</i>		
SPECIAL CONDITIONS		
TIME	DATE	NAME/ORG (PRINT)
<i>0245</i>	<i>1 Jul 97</i>	INDIVIDUAL ORDERING TAG ON EQUIPMENT <i>SSgt Johnson / 18th OG, DP: 3791</i>
		INDIVIDUAL ORDERING TAG REMOVED FROM EQPT.
		INDIVIDUAL REMOVING TAG FROM EQPT.

AF Form 980, (REVERSE)

Figure 29.12. AF Form 981, Out of Order Tag.

**OUT OF ORDER**

**HAZARD**  
*Ladder missing anti-skid tips.  
Do not use until replaced.*

**CONTROL MEASURE**  
*Replace - Remove from work area.*

AF FORM 901

**HAZARD IDENTIFICATION/NOTICE OF HAZARD**  
ITEMS 1 THRU 4 TO BE COMPLETED BY INDIVIDUAL PLACING TAG  
*(Last entry in these items is individual currently responsible for tag)*

1. TIME	2. DATE	3. SHORT DESCRIPTION	4. REPORTING ORIGIN, NAME AND PHONE NO.

ITEMS 5 THRU 7 MUST BE COMPLETED BY RESPONSIBLE SUPERVISOR  
*(Prior to completing these items, the supervisor must coordinate with the responsible functional manager to ensure elimination of AF Form 981 USAF Hazard Abatement Log. See AFI 91-203)*

5. HAZARD IDENTIFICATION CATEGORY	6. HAZARD SEVERITY	7. FUNCTIONAL NUMBER

DO NOT REMOVE UNTIL HAZARD IS ABATED/CORRECTED

Figure 29.13. AF Form 982, Do Not Start Tag.

**DO NOT START**

**HAZARD**  
*Guards removed from radial saw  
for maintenance.*

**CONTROL MEASURE**  
*Main energy source, master  
switch, LOCKED OUT*

AF FORM 982

**DANGER - EMPLOYEES AT WORK (Do Not Operate)**

INSTALLATION/FACILITY	SAFE CLEARANCE NO.
<i>Bldg 24499, Carpentry Shop</i>	<i>NA</i>

LINE/EQUIPMENT INVOLVED *Radial Saw*

TIME	DATE	NAME/ORIG/PHONE (PRINT)
<i>0935</i>	<i>3 Apr 97</i>	<i>INDIVIDUAL ORDERING TAG ON EQUIPMENT TSgt Canyon/18th OES/DP: 3-7942</i>
<i>0945</i>	<i>3 Apr 97</i>	<i>INDIVIDUAL PLACING TAG ON EQUIPMENT SrA Norton/18th OES/DP: 3-1810</i>
		<i>INDIVIDUAL ORDERING TAG REMOVED FROM EQPT.</i>
		<i>INDIVIDUAL REMOVING TAG FROM EQPT.</i>

AF Form 982, (Reverse) • GPO: 1992-525-787

**Note:** The AF Form 979, *Danger Tag*, and AF Form 982, *Do Not Start Tag*, have the same reverse side (will be fixed when reprinted).

**Table 29.1. Standard Criteria & Proportions for Locally Manufactured Signs (Letter Size Versus Legibility Distance).**

Height of Letters (Inches)	Distance Visible (Feet)	Height of Letters (Inches)	Distance Visible (Feet)
3 1/2	105	1	33
3	90	7/8	28
2 1/2	75	3/4	23
2	60	5/8	18
1 3/4	52	1/2	15
1 1/2	45	3/8	12
1 1/4	40	1/4	10

**Note:** Whenever possible, commercially manufactured signs shall be procured. When it is necessary to locally manufacture signs, the following criteria and proportions are recommended.

1. Crowding of letters and words reduces legibility and shall be avoided.
2. A rule-of-thumb of 35-40 feet viewing distance per inch of letter height may be used.
3. Above letter size versus legibility distance values assume at least 20/40 visual acuity of viewer, adequate lighting of sign and does not include allowance for color combinations.

**Table 29.2. Standard Proportions for Danger Signs.**

Sign Size, Inches Height Width	Black Rectangular Panel, Inches Height/Width	Red Oval, Inches Height/Width	Wording <b>DANGER</b> , Inches/Height	Minimum Space Available for Sign Wording, Inches
<b>Horizontal Pattern</b>				
7 x 10	3 1/4 x 9 3/8	2 7/8 x 8 1/2	1 7/16	2 3/4 x 9 3/8
10 x 14	4 5/8 x 13 3/8	4 1/8 x 11 7/8	2 1/16	4 1/4 x 13 3/8
14 x 20	6 1/2 x 19 3/8	5 3/4 x 17	2 7/8	6 1/4 x 19 3/8
20 x 24	9 1/4 x 27 3/8	8 1/4 x 23 7/8	4 1/8	9 1/2 x 27 3/8
<b>Upright Pattern</b>				
10 x 7	2 3/8 x 6 3/8	2 1/8 x 5 7/8	1 1/16	6 3/8 x 6 3/8
14 x 10	3 1/4 x 9 3/8	2 7/8 x 8 1/2	1 7/16	9 1/2 x 9 3/8
20 x 14	4 5/8 x 13 3/8	4 1/8 x 11 7/8	2 1/16	14 x 13 3/8
28 x 20	6 1/2 x 19 3/8	5 3/4 x 17	2 7/8	20 1/4 x 19 3/8



**Table 29.3. Standard Proportions for Caution Signs.**

Sign Size, Inches Height Width	Black Rectangular Panels, Inches/Height/ Width	Wording CAUTION, Inches/Height	Maximum Space Available For Sign Wording, Below Panel; Inches/Height/Width
<b>Horizontal Pattern</b>			
7 x 10	2 ¼ x 9 ¾	1 ⅝	3 ¼ x 9 ¾
10 x 14	3 ¼ x 13 ¾	2 ¼	5 ½ x 13 ¾
14 x 20	3 ¾ x 19 ¾	2 ¾	9 x 19 ¾
20 x 28	4 ¼ x 27 ¾	3 ¼	14 ½ x 27 ¾
<b>Upright Pattern</b>			
10 x 7	1 ⅝ x 6 ¾	1 ⅛	7 x 6 ¾
14 x 10	2 ¼ x 9 ¾	1 ⅝	10 ½ x 9 ¾
20 x 14	3 ¼ x 13 ¾	2 ¼	15 ½ x 13 ¾
28 x 20	3 ¾ x 19 ¾	2 ¾	24 x 19 ¾

**Table 29.4. Standard Proportions for Instruction and Identification Signs.**

<b>Standard Proportions for Instruction and Identification Signs</b>				
Sign Size, Inches/ Height/Width	Height of Letters, Inches For One Line	Height of Letters, Inches For Two Lines	Height of Letters, Inches For Three Lines	Maximum Space Available for Sign Wording, Inches/ Height/Width
<b>Horizontal</b>				
7 x 10	3	1 ½	1 ½	6 x 9
10 x 14	6	2 ½	2	9 x 13
9 x 20	3	2 ½	1 ½	8 x 19
14 x 20	N/A	3	3	13 x 19

**Table 29.5. Standard Proportions for Directional Signs.**

Sign Size, Inches, Height, Width	Black Rectangular Panel, Inches, Height, Width	Overall Length	Arrow Head Height, Width	Arrow Shaft Height	White Arrow, Arrow Tail, Height, Width	Maximum Space Available for Inches Sign Wording Below Panel, Inches, Height, Width
6 ½ x 14	3 ¼ x 13 ¾	12 ⅝	2 ¾ x 3	1 ⅛	2 ¾ x 3 ¼	2 ¼ x 13 ¾
9 x 20	4 ½ x 19 ¾	18 ⅝	3 ¾ x 4 ⅛	1 ⅝	3 ¼ x 4 ½	3 ¾ x 19 ¾
12 x 28	6 x 27 ¾	26 ⅞	5 ⅛ x 5 ⅝	2 ⅛	4 ¾ x 6	4 ¾ x 27 ¾
15 x 36	7 ½ x 35 ¾	34 ⅝	6 ¾ x 6 ⅞	2 ⅝	5 ½ x 7 ½	6 ¼ x 35 ¾

Table 29.6. Examples of Color Applications.

<b>Black and White</b>		
Dead-ends of aisles	Location of aisle ways	Direction Signs
Location of refuse cans	Lettering on piping systems and compressed gas cylinders	Piping systems containing raw or potable water
<b>Orange</b>		
Inside of movable guards (solid panel)	Lower traveling blocks on cranes and hoists	Exposed edge of pulley, gears, rollers, cutting devices, power jaws, etc.
<b>Green</b>		
Location of health station	Location of personal protective equipment	Location of emergency showers
Safety bulletin board	Piping system containing oxidizing materials	Compressed gas cylinders containing oxidizing materials
<b>Magenta</b>		
Radioactive filter housings	Radiation ion exchanger	Radioactive waste containers
Radioactive sampling connections	Radiation signs	Lettering on piping systems containing radioactive substances
<b>Red</b>		
Danger Signs	Stop Signs	Stop Buttons and Bars equipment
<b>Yellow</b>		
Corner markers for storage piles	Coverings or guard for guide wires	Fixtures extending into operating area
Guardrails on top and bottom	Horizontal lips of vertically sliding, counterbalanced elevator doors	Pillars or posts which might be struck
Cautions signs	Piping system containing radioactive substance	Flammable liquid container
Piping systems containing flammable materials	Compressed gas containing flammable materials	

**Table 29.7. Examples of Wording for Mishap Prevention Signs.**

Caution	Danger
Close Clearance	Acid
Electrical Fence	Ammonia
Electrical Trucks, Go Slow	Crane Overhead
Eye Protection Required	Cyanide
Goggles Must Be Worn When Operating This Machine	Do Not Energize Switch, Personnel Working on Line
Hearing Protection Required	Do Not Operate, Personnel Working on Equipment
Keep Aisles Clear	Energized Equipment
Keep Door Closed	Explosives—Keep Out
Keep This Space Clear at All Times	Explosives Magazine
Operators of This Machine Will Wear Snug-Fitting Clothing – No Gloves	Explosives –Turn Off Two-Way Radios
	Keep Away
Respirator Required in This Area	Keep Off, Electric Current
Safety Fuse, Burning Rate 40 Feet Per Second, Plus or Minus 10 Percent	Employees in Boiler
Step down	Employees on Cars
Stop Machinery to Clean, Oil, or Repair	Employees Working Above
Use Ladder Climbing Safety Devices	Employees Working on Machines, Do Not Start
Watch Your Step	Not Room Enough to Clear
Do Not Enter Room When Alarm Sounds Halon 1301 (or CO2) Being Discharged	No Smoking, Matches, or Open Flames
When Alarm Sounds, Vacate Room Halon 1301 (CO2) Being Discharged	Test in Progress
<b>Directional</b>	<b>Instructional and Identification</b>
Fire (inside arrow) Extinguisher (below arrow panel)	Compressed Breathing Air Station
Walkway (below arrow panel)	Do Not Eat or Drink in This Area
This Way to (inside arrow) First-Aid Room (below arrow panel)	Emergency Shower
This Way Out (below arrow panel)	Eyewash Fountain
This Way (inside arrow) Out (below arrow panel)	Make Your workplace Safe Before Starting the Job
To (inside arrow) First Aid (below arrow panel)	Report All injuries No Matter How Slight
	Report All Unsafe Conditions to Your Supervisor
	Respirator
	Wash Hands Before Eating

**29.10. Mishap Prevention Signs and Tags Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

29.10.1. Is an adequate supply of safety signs and tags available for use? Reference [29.2.4](#)

29.10.2. Do exit signs clearly identify the means of egress from facilities? Reference [29.3.5.10](#)

29.10.3. Are tags used as intended, as a temporary means of warning workers of hazardous conditions, defective equipment, etc.? Reference [29.5.1](#)

29.10.4. Do supervisors coordinate placement of tags and assignment of RACs, with the installation Ground Safety office, FES Flight or BE, as appropriate? Reference [29.6.1.2](#)

29.10.5. Is verification of a RAC, when required by AFI 91-202, accomplished as soon as possible but not later than 10 days from hazard identification? Reference [29.6.1.3.1](#)

29.10.6. Are **AF Forms 979**, *Danger Tag*, used only to identify immediate danger situations? Reference [29.7.1.1](#)

29.10.7. Are **AF Forms 980**, *Caution Tag*, used to identify or warn of potential hazards? Reference [29.7.2.1](#)

29.10.8. Are **AF Forms 981**, *Out of Order Tag*, used to warn of a hazard if the equipment, machinery, tool, utility or system is used? Reference [29.7.3](#)

29.10.9. Are **AF Forms 982**, *Do Not Start Tag*, used to warn personnel of a potential hazard if equipment is restarted? Reference [29.7.4.1](#)

29.10.10. Do shop supervisors ensure their personnel are trained to properly fill out the reverse side of AF Forms 979, 980, 981 and 982? Reference [29.8.1](#) and [29.9.1](#)

## Chapter 30

### COMMUNICATION CABLE, ANTENNA AND COMMUNICATION SYSTEMS

#### 30.1. General Information.

30.1.1. Housekeeping. Good housekeeping shall be maintained, with all flammable wastes disposed of in approved self-closing metal waste containers. At the end of each day or shift, these containers shall be emptied or removed to an approved location outside the shop for pickup and disposal. If solvents are required, use only approved and authorized solvents. Provide adequate ventilation IAW MIL-HDBK-1190, *Facility Planning and Design Guide*. Storage is not allowed in electrical and/or electronic areas. Storage is only permitted in areas approved by the installation Fire Emergency Services (FES) Flight. Consult BE for guidance on safe use of solvents and the adequacy of the ventilation system, and the installation Environmental Management office for waste disposal guidance. Refer to **Chapter 5, Housekeeping**, for additional guidance and information.

30.1.2. Food and beverages shall not be stored or consumed in the immediate area of communications equipment where spills or foreign particles could present a hazard to personnel or cause damage to equipment.

30.1.3. Electromagnetic Interference Sensitive Medical Implants. Workers with pacemakers and other electrically active implanted medical devices must not be allowed to work in areas where the function of their device may be adversely affected by exposure to known non-ionizing radiation or electromagnetic fields. All communications equipment workers should be made aware of this requirement. If there are questions, refer the worker for a medical assessment, in coordination with BE.

#### 30.2. Specific Hazards.

##### 30.2.1. Electrical Hazards.

30.2.1.1. 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 will seek immediate medical attention. Some effects of electrical exposure to the body are:

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

30.2.1.1.2. 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.

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

30.2.1.1.4. Serious internal injuries to nerve and bone can occur with the passage of electrical current through limbs. Externally, apparent damage does not always appear

severe. If pain, loss of sensation or function occur, seek medical attention immediately.

30.2.1.2. Arcing. When a metal object, such as a tool, comes in contact with an electric current, it will become a conductor. The electric current may result in an arc, which may cause serious burns to the body and temporary or permanent blindness.

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

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

30.2.2.1. 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.

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

30.2.2.3. Tower conditions such as cracks, rust, corrosion, loose/missing hardware, ice on climbing surfaces, bent/broken steps, improper grounding, dirt and excessive grease and oil.

30.2.2.4. 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.

30.2.2.5. 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.

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

30.2.2.7. Wearing climbers while working on wooden poles and tower structures.

30.2.2.8. Failure to maintain good physical condition.

30.2.3. Radiation Hazards.

30.2.3.1. Non-ionizing Radiation. Non-ionizing radiation produces heat 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 non-ionizing radiation in deep tissue and organs with little or no sensation of skin heating. Refer to AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, and 29 CFR 1910.97, *Nonionizing Radiation*, for additional guidance on management of hazards associated with non-ionizing radiation.

30.2.3.2. Ionizing Radiation. Radioactive material contained in electron tubes presents no significant hazard as long as the tube is intact. The level of radiation from 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 emit ionizing radiation. Refer to 29 CFR 1910.1096, Ionizing Radiation, for additional guidance .

30.2.3.3. Electron Tubes. Many electron tubes such as spark gap, glow lamp, cold cathode, transmit-receiver and anti-transmit-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. If breakage does occur, do not touch the tube or the immediate area. Seek immediate medical attention if personnel are exposed to broken electron tube material. Notify the immediate supervisor plus the installation Radiation Safety Officer. 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. Control of the disposition operations, i.e., packaging, marking, identifying temporary storage and shipping, is the responsibility of assigned radiological monitors with guidance from the installation Radiation Safety Officer.

30.2.3.4. Chemical. Chemicals used in conjunction with communications 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 office. **Note:** Ensure all personnel receive hazard communication training IAW AFI 90-821, *Hazard Communication*, and have access to material safety data sheets (MSDS) for chemicals used in work processes. Refer to CFR 1910.1200, *Hazard Communication*, for additional guidance.

30.2.4. Fabrication with Lead. Maintain a clean working area free of combustible materials. Ensure fire extinguishers are accessible in the work area. Set lead pots on a noncombustible level surface to prevent turnover and do not leave them unattended. Do not drop cold lead or any cold liquid into molten lead. This action may cause splashing, rapid separation and serious burns. Wear a face shield or safety goggles and gloves when fabricating in place. Ensure the work area is well ventilated IAW the requirements in the BE OEH risk assessment and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. Consult with the installation Public Health office or BE for appropriate training on working with lead and to determine if medical examinations are required.

30.2.5. Compressed Gases. When using or transporting compressed gas cylinders (such as dry nitrogen cylinders) in a horizontal position, special compartments, racks or adequate blocking shall be provided to prevent cylinder movement and the cylinders shall be secured with safety straps or chains. Regulators shall be removed and safety caps installed before a cylinder is transported or when not in use.

30.2.5.1. Compressed gas cylinders shall be kept away from excessive heat and protected from direct rays of the sun, and shall not be stored where they might be damaged or knocked over by passing or falling objects. Cylinders shall 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.

30.2.5.2. Cylinders shall be stored and used in a vertical position only, valve-end up.

30.2.5.3. Dispose of compressed gas cylinders in a manner consistent with approved hazardous waste disposal procedures and applicable environmental regulations. Contact the installation Environmental Management office for guidance.

### **30.3. General Safety Practices.**

30.3.1. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from the direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. Specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards and comply with **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, requirements. Workers near exposed electrical circuits or maintenance and installation activities, regardless of location, shall not wear rings, watches or other conductive objects that may increase the shock risk or be the source of potentially severe burns when energized. Do not use or carry in pockets metallic measuring rules, tools or metal-cased objects. Metal-framed eyeglasses may be worn if secured with a nonmetallic cord to prevent them from falling into an energized circuit. Additionally, avoid working in wet clothes. Never attempt adjustments on a potential ground when any portion of the body may come into contact with equipment frames or other ground connections. 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.

30.3.2. Two qualified technicians or one qualified technician and one safety observer will work together when exposed to high voltage of 600 volts, nominal, or more or current flow of 50 milliamperes or more. All necessary PPE and special tools shall be available and used.

30.3.3. Protect the hearing of assigned personnel by ensuring protective engineering controls, administrative controls and PPE are used correctly by all workers; ensure workplace complies with all OSHA, DoD and Air Force Hearing Conservation Program requirements. When exposed to potentially hazardous noise levels, consult BE for guidance on hearing protection. Refer to AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, for additional information.

30.3.4. Supervisors shall consult installation medical services personnel to determine if first aid equipment should be available and determine the type and quantity of supplies needed.

30.3.5. Electrical circuits shall always be de-energized and locked and tagged out before attempting any work, unless the nature of the work requires the circuits remain energized. Do not rely on safety devices such as interlocks, high voltage disconnect relays, or automatic circuit grounds. Each of these is subject to failure. When working on exposed circuits of 50 volts or more, arc-fault protective clothing shall be worn IAW UFC 3-560-01, *Electrical Safety, O&M*.

30.3.6. All workers, including safety observers, will know the location and on-off operation of the power distribution panels, power control switches and stations, and electrical danger areas in their work area. This knowledge is essential to de-energize equipment in the event of

a fire or accidental electrical contact. In addition, emphasis shall be placed on the need to maintain clear, unrestricted access to these controls at all times. Workers will open and close all equipment switches quickly and positively. The doors to high voltage racks shall be closed at all times except for authorized maintenance and repairs.

30.3.7. Interlocks shall not be permanently disconnected or bypassed. Interlocks can be disconnected during maintenance or adjustments only when prescribed by applicable TOs. During these periods, AFVA 91-305, *DANGER—INTERLOCKS DISABLED*, or a sign, either locally manufactured or the nearest commercially available equivalent, shall be placed on the equipment or nearest available equipment. If the equipment has a defective interlock, all workers shall be made aware of the hazardous condition, and a warning sign or tag shall be posted on the equipment.

30.3.8. Grounded railings, barriers or enclosures shall be used to protect workers from shock resulting from contact with conductors, bus bars, switches, control panels, etc. 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 shall be completely enclosed from the remainder of the assembly. The barrier, guard, or enclosure shall be marked to indicate the approximate highest normal voltage (nearest round number) which may be encountered upon its removal.

30.3.9. Suitable eye protection shall be worn during unpacking, removal and installation of transformers, capacitors and diode stacks or when the potential for exposure to arc flash exists. Workers shall be especially watchful for any sign of oil or fluid leakage, as it is possible this oil or fluid is Askarel. Askarel, used for many years as a dielectric, contains high concentrations of polychlorinated biphenyl (PCB), which is extremely toxic. Any sign of leakage from components mentioned above shall be reported to the nearest BE and Environmental Management office. Workers shall not touch or disturb the leaking fluid without the approval of the appropriate medical activity.

30.3.10. Safety Observers. When installing or repairing C&I systems, communication cables and antenna systems that may expose workers to energized equipment, high voltage circuits, 600 volts or above, or low voltage power if it has a high current flow, work shall not begin until a qualified safety observer is present. An individual shall not be assigned other duties while serving as safety observer. Normally, the supervisor is also the safety observer.

30.3.10.1. When repairing or troubleshooting energized high voltage communications equipment, the safety observer does not have to be proficient in the task being observed.

30.3.10.2. Safety observers shall be trained IAW paragraph **30.4.1**, current in CPR procedures and familiar with local installation procedures to obtain medical assistance.

30.3.10.3. While the task is being performed, the safety observer shall stand where he or she can plainly see all personnel who are working on the equipment, have access to the main power switch, and give a positive warning of potential danger to anyone approaching the equipment. If unable to maintain visual contact with the main power switch, the lockout and/or tagout procedure shall be used. Additionally, the safety observer will have ready access to safety equipment when high voltage is involved.

30.3.10.4. When performing aerial work on communication cable and antenna systems, safety observers must be qualified to operate the equipment in use and shall have a current climbing aerial rescue certification, be proficient in CPR and administering emergency first aid treatment that involves control of bleeding, shock, open wounds and burns and procedures for obtaining medical assistance.

30.3.10.5. Ensure a means of communication is available in remote locations.

30.3.11. Provide the installation FES Flight and the emergency response units with maps indicating routes to locations of remote sites. Where practical, establish a letter of agreement with the installation FES Flight and emergency rescue units to conduct actual tests to evaluate the route suitability and response times. Ensure all areas containing flammable materials have appropriate fire prevention signs posted and fire extinguishers available. **Note:** Off-base facilities/sites shall coordinate and plan with the nearest local area medical facility for emergency medical services, if the host installation medical facility is too far to provide immediate emergency medical attention.

30.3.12. Ensure all grounding of electrical and electronic equipment is sized IAW NFPA 70, *National Electrical Code*. Where possible, use a copper strap or heavy gauge copper wire as the ground connection. Ensure water or cooling pipes meet the requirements of UFC 3-520-01, *Interior Electrical Systems*, AFI 32-1065, *Grounding Systems*, and NFPA 70, NEC 250.52(A)(I). Never use nonmetallic water or cooling pipes as the grounding electrode. Where equipment is installed to meet red and/or black criteria, ensure grounding of the electrical and electronic equipment follows the applicable installation requirements in the National Agency Communications Security (COMSEC) Installation Manual (NACSIM) 5203, *Guidelines for Facility Design and RED/BLACK Installation, National Security Agency*. 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. Install an earth electrode subsystem, consisting of a ring ground or interconnected ground rods, for lightning protection purposes and for grounding of all communications systems equipment utilizing high voltages. If possible, provide duplicate bleeder circuits on high voltage capacitors to reduce the voltage to a non-hazardous level as rapidly as practical. Dual resistor banks are recommended.

30.3.13. Grounding or Shorting Sticks. Electronic equipment with high voltage shall have grounding sticks installed for discharging capacitors in case of automatic discharge circuit failure. They shall be used to check for and discharge residual and stray high voltage. Where physical size precludes using a permanently attached grounding or shorting stick, a portable grounding or shorting stick shall be used. At least one grounding stick shall be provided at every communications equipment area and shall be supplied in addition to any that may be included as integral components of electronics equipment. If an electrical safety board is utilized, the grounding stick provided with the electrical safety board shall suffice if readily accessible.

30.3.14. Grounding and Bonding. 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 neutral or ground wire and a hot wire. The neutral or ground wire for the system shall be 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 (2) 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. For specific guidance, refer to TO 31-10-24, *Communications Systems Grounding, Bonding, and Shielding*.

30.3.14.1. Electrical and electronics equipment shall be grounded so a potential cannot exist between the unit and the ground. Fixed electrical equipment shall be electrically bonded to a grounding connector. Special protection shall 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 shall be grounded. The size and type of material for grounding conductors will be selected according to the NFPA 70, *National Electric Code*, Article 250, *Grounding*. All workbenches used for “power on” maintenance of any electronic equipment shall be provided with a means for grounding the equipment. This shall be interconnected to the facility ground system.

30.3.14.2. Grounding circuits, as a minimum, shall have a separate circuit for each chassis, cabinet and frame. Each chassis ground may terminate at its cabinet or frame ground. Additionally, ground circuits shall have a neutral circuit and connections that are mechanically secured by:

30.3.14.2.1. A spot-welded terminal lug.

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

30.3.14.2.3. The use of a terminal on the ground wire by a lock washer and screw or a lock washer and nut.

30.3.14.2.4. Grounding braids installed on panels and cabinets that are removable or hinged so bonding is not accomplished through hinges, slides or mounting hardware. Nonconductive panels and cabinets that are removable or hinged need not be equipped with grounding braids.

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

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

30.3.15. Soldering Precautions. Ensure fire extinguishers are accessible in the soldering area. Remove combustible materials from the work area to prevent fires. Never sling excess solder from a soldering iron; wipe it off with a damp cloth or sponge. Always place the soldering iron in the proper holder when not in use, and never leave the iron plugged in and unattended.

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

30.3.15.2. Ensure the work area where soldering is performed is well ventilated IAW the requirements in the BE OEH risk assessment and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. Ensure all power unit exhausts are vented to the building exterior. Use approved respiratory devices when working in permit-required confined spaces that are not adequately ventilated. Refer to AFOSH Standard 48-137, *Respiratory Protection Program*, and **Chapter 23**, *Confined Spaces*, for additional guidance and information.

30.3.16. Heaters and Torches Used in Ground and Aerial Tents. Flame-type heaters shall 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. Torches may be used on aerial splicing platforms or in buckets enclosed by tents, provided the material is constructed of fire-resistant material and the torch is turned off when not in actual use. The tent shall be adequately ventilated while torch is in use.

#### **30.4. Training.**

30.4.1. First Aid, Cardiopulmonary Resuscitation (CPR) and Bloodborne Pathogen (BBP) Training. Refer to paragraph **1.12** for guidance.

30.4.2. Rescue Training.

30.4.2.1. Climbing. Pole Top rescue shall only be attempted by personnel who are certified or in a training status under the supervision of an instructor. A record of climbing certification shall 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, or an approved computer automated system. 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 shall be determined by the climbing instructor. Records shall be updated whenever re-certification is accomplished. Consult the installation FES Flight for all other rescues. Refer to paragraph **30.9** for additional guidance.

30.4.2.2. Confined Spaces. Workers required to enter confined spaces, such as manholes or underground vaults, shall be trained in self-rescue. Safety observers or attendants shall be trained in rescue procedures for each type of confined space to be entered. Refer to **Chapter 23**, applicable TOs and 29 CFR 1910.146, *Permit-Required Confined Spaces*, for additional information.

30.4.2.3. Hazard Communication Training. All workers who may be potentially exposed to chemical hazards during the course of work shall require hazard communication training IAW AFI 90-821, *Hazard Communication*, upon initial assignment and refresher training annually. Additionally, training shall be required when a new hazard or chemical is introduced into the work area/shop or a worker is assigned new or different tasks with new hazards. Prior to any task requiring the use of or exposure to hazardous materials, safety precautions for materials shall be covered in the pre-task safety briefing.

30.4.3. Training Documentation. All training shall be documented on the AF IMT Form 55 or AF Form 623 for military and AF Form 971 for civilian personnel or an approved computer automated system. Additionally, initial safety-related training shall be documented on the individual's training records IAW AFI 91-202, *The US Air Force Mishap Prevention*

*Program.* Recurring safety-related training may be documented in a computer automated system.

### 30.5. Safety Equipment and Devices.

30.5.1. Manholes, Aerial Cables and Pole Lines. Motor vehicle traffic is a hazard to personnel working in and around manholes on streets and highways. Warning devices, barriers and guarding shall be used to protect personnel working at these locations. Workers 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. **Figures 30.1** through **30.5** contain additional information regarding the placement of warning devices. Ventilating equipment shall be positioned so the air intake is located away from vehicular exhaust. Refer to TO 31W3-10-12, paragraph 10.2., for additional guidance on guarding requirements and warning devices.

30.5.2. Safety Straps, Harnesses, and Lanyards. Nylon straps, not leather safety straps, shall be used on steel structures. Safety harnesses, straps and lanyards shall be provided and supervisors shall ensure their use when work is performed at positions more than four (4) feet above the ground, on poles and on towers. Safety harnesses, straps and lanyards are not required for portable ladders. Refer to **Chapter 13** and 29 CFR 1910.268(g) *Telecommunications, Personal Climbing Equipment*, for additional guidance. **Note:** If personnel can sustain a fall of more than two (2) feet while wearing climbing equipment, fall arrest procedures and equipment guidance in **Chapter 13**, UFC 3-560-01, 29 CFR 1910.66, Appendix C, *Personnel Fall Arrest System*, and ANSI Z359, Fall Protection series standards, shall be followed. 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 qualified individual to determine if it is in safe working condition. Each person using safety harnesses, straps and lanyards shall inspect the equipment prior to each use.

30.5.3. Climbing Safety Devices. Climbing safety devices shall be installed on all ladders that are an integral part of the antenna support. Where climbing safety devices are not installed, installation or maintenance shall 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. **Note:** All Cyber Support field technicians required to climb un-stepped communication poles will use the squeeze pole fall protector (pole choker) arrest system. Users of the pole chokers will comply with TO 00-25-245, *Operations Instructions Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, and manufacturer's instructions regarding inspection, maintenance, cleaning and storage of PFAS equipment.

#### 30.5.4. Signs or Visual Aids.

30.5.4.1. Signs. Portable emergency signs shall be constructed of nonconductive materials. Refer to **Chapter 29**, *Mishap Prevention Signs and Tags*, for additional information and guidance. **Note:** Consideration shall be given to providing bilingual signs when located in areas where people speak or read a primary language other than English.

30.5.4.1.1. AFVA 91-303, *DANGER — DO NOT ENERGIZE — PERSON WORKING ON ANTENNA*. This sign shall be placed on the radio frequency (RF) power control switch or transmitter before any work is started and when the alternating current (AC) power to the transmitter has been disabled. If lockout capability exists, the RF control switch shall also be locked out IAW local lockout procedures. Refer to **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)* for additional guidance on lockout/tagout requirements and procedures and **Chapter 29** for additional guidance on signs.

30.5.4.1.2. AFVA 91-304, *DANGER — DO NOT ENERGIZE — WORK IN PROGRESS ON EQUIPMENT*. This sign may be used in applications where power has been de-energized. In all cases where lockout capability exists, the signs shall be used in conjunction with lockout procedures.

30.5.4.1.3. *HARD HAT AREA*. This sign shall be placed around any job site when work is being performed aloft, i.e., where falling object hazards are present.

30.5.4.1.4. AFVA 91-305, *DANGER — INTERLOCKS DISABLED*. This sign shall be placed on equipment that has had interlocks temporarily disabled during maintenance as required by TOs.

30.5.4.1.5. AFVA 91-306, *DANGER — HIGH VOLTAGE*. This sign shall 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), nominal or more, or current flow of 50 milliamperes.

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

30.5.4.1.7. *RADIO FREQUENCY RADIATION*. These signs shall be posted at access points to all areas where RFR levels exceed permissible exposure limits (PEL). Specific requirements are provided in AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*.

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

30.5.6. Proximity Warning Devices. These devices may be used on cranes or aerial lifts. Refer to **Chapter 16**, *Mobile Elevating Work Platforms*, **Chapter 35**, *Materials Handling Equipment*, 29 CFR 1910.67, *Vehicle-Mounted Elevating and Rotating Work Platforms*, and 29 CFR 1910.180, *Crawler Locomotive and Truck Cranes*, for additional guidance.

30.5.7. Electrical Safety Boards. Refer to paragraph **8.12** for required items in an emergency equipment kit or board.

30.5.8. Hard Hats.

30.5.8.1. Commanders, supervisors and team members shall 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 shall be worn while working on or around

poles, overhead structures, vaults, manholes, excavations, demolition areas and tower and antenna construction jobs. The chinstrap shall be worn during work aloft.

30.5.8.2. Hard hats shall be the electrical worker's safety helmet, Class G, IAW **Chapter 14**, *Personal Protective Equipment (PPE)*, and ANSI Standard Z89.1, *Protective Headwear for Industrial Workers*. The preferred color for hard hats is yellow due to its high visibility during inclement weather and darkness. Hard hats shall not be painted. Markings on hard hats shall be of the stick-on type and shall 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 shall be conservative and will not degrade the effectiveness or non-conductivity of the hard hat.

30.5.9. Reflective Clothing. When mission requirements dictate, light-reflective clothing or accessories shall be worn IAW **Chapter 14** or other applicable guidance.

30.5.10. 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 **Chapter 14**.

30.5.11. Fire Extinguishers. Supervisors/functional managers shall ensure appropriate fire extinguishers shall be provided. The installation FES Flight shall be consulted to determine types, quantities and locations of this equipment.

### **30.6. Tools and Equipment.**

30.6.1. The supervisor shall ensure all tools and equipment are maintained in a safe condition. All workers are responsible for the condition and correct use of the tools and equipment they use.

30.6.2. Nonconductive tools shall be used while performing work on energized communications systems equipment. Taping or plastic coating is not an acceptable means of insulation. Wooden handle tools shall not be used on energized communications systems equipment.

30.6.3. All tools shall be kept clean and free of grease, oil, paint or other foreign material IAW TO 32-1-101, *Use and Care of Hand Tools and Measuring Tools*. **Exception:** This does not prevent the use of a light film of oil on tools for rust protection.

30.6.4. Wood or reinforced fiberglass ladders shall be used for work performed on or near electrical equipment. Wood ladders shall not be used on electrical equipment if ladder is wet.

30.6.5. Metal ladders or ladders with metal reinforced side rails shall not be used when work is being performed in, on or near electrical equipment, and shall not be stored in any area where electronic equipment may be in operation. If ladders are not marked by manufacturer with a safety statement that reads, "Do not use around electrical equipment," then stencil ladder with *DANGER — DO NOT USE AROUND ELECTRICAL EQUIPMENT*, in two-inch high red letters or contrasting letters on both ladder side rails. Refer to **Chapter 7** for additional guidance.

30.6.6. Equipment and/or component cleaning. Vacuuming is the preferred method of cleaning electronic equipment. If compressed air is used, workers will limit the air pressure



to less than 30 psi, use effective chip guarding and wear required PPE. Refer to **Chapter 18, Machinery**, for additional guidance and information.

30.6.7. Test Equipment Set Up. Test operators and technicians shall follow the exact methods of adjustment, operation and repair of test equipment given in TOs, manufacturer's instructions and manuals or applicable diagrams. Workers shall be knowledgeable of the characteristics and safe operation of the various instruments before being permitted to use them. This shall be accomplished by briefings and warning signs at affected locations. Before voltage is applied, cable conductors shall be isolated to the maximum extent practicable.

30.6.8. Test equipment shall be designed, constructed and installed to provide safe work procedures and to minimize personnel exposure to hazardous work situations. When tests involve live circuits, the area shall be enclosed. Only authorized personnel who have been briefed about the potential hazards involved shall be in this area when tests are performed. At least one safety observer shall be present when high voltage is involved.

30.6.9. Approved and effective warning signs and/or signals shall be used to indicate when power is on. A means of emergency power shutdown shall be provided outside the test area in addition to the main power switch within the test area.

30.6.10. Connections to test tables, bus bars, plug racks, terminal cabinets and distribution boards shall be secure.

30.6.11. Other Tools and PPE. All workers involved in test operations shall be provided with approved PPE. Refer to **Chapter 14**, 29 CFR 1910.268(e) and 29 CFR 1910.268(i) for additional mandatory requirements for head and eye protection, portable lights, protective devices on tools and appliances, soldering devices and lead work.

**30.7. High Voltage.** High voltage is defined as 600 volts (root-mean-square [RMS]) or greater. However, much lower voltage can be lethal. The design and development of all military electronic equipment shall provide fail-safe features for safety of workers during the installation, operation, maintenance or interchanging of a complete equipment assembly or component part. Operators and technicians shall not attempt to adjust any electronic equipment when there is a possibility of injury from unprotected high voltage. Adjustments on operating high voltage equipment, other than those specified by TO or manufacturer's manuals, shall only be authorized by the unit commander. The unit commander shall consider all operational requirements, TOs, manufacturer's guidance, safety precautions and emergency procedures before authorizing work to proceed. Workers using high voltage to troubleshoot and/or test cables shall be instructed in the precautions necessary for their safety and the safety of others. Workers shall be warned to stay clear while voltage is applied.

30.7.1. Only qualified personnel shall perform work near energized overhead power lines. Approach distances for qualified workers shall be IAW UFC 3-560-01, Table 3-1. Before starting any communications work near overhead power lines, coordinate the work with CE's electrical shop. IAW 29 CFR 1910.268, *Telecommunication*, and 1910.333, *Selection and Use of Work Practices*, the following safety precautions shall be considered when working near overhead power lines:

30.7.1.1. Any vehicle or mechanical equipment which may have parts of its structure elevated near energized overhead power lines shall be operated so a clearance of at least 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 .

30.7.1.2. 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.

30.7.1.3. 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.

30.7.1.4. 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 UFC 3-560-01, Table 3-1.

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

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

30.7.4. Line workers' electrical safety boots shall be worn to provide additional protection against electrical hazards. Rubber footwear or line workers' overshoes shall not be worn.

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

### **30.8. Rubber Insulating Floor Matting.**

30.8.1. Insulating matting shall be used near electrical apparatus or circuits in high voltage maintenance areas as an additional safety measure to protect workers. Insulating matting is for protection against accidental shock only and shall not be depended upon for protection when handling energized wires and circuits. Refer to TO 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*, TO 00-25-234, *General Shop Practice Requirements For The Repair, Maintenance and Test of Electrical Equipment*, and MIL-DTL-15562G, *Matting or Sheet, Floor Covering, Insulating for High Voltage Application*, for information and instructions for the control, use and marking of insulating matting. Approved electrical insulating matting is permanently marked IAW MIL-DTL-15562G.

30.8.2. Upon request, the supervisor, with the assistance of the installation Ground Safety office, shall inspect areas where electrical facilities are located and determine whether insulating matting is required for worker protection. Typical examples of high voltage areas requiring insulating matting are where potential shock hazards exist and additional resistance is required; floor resistance is lowered due to dampness; high voltages (above 600 volts) may be encountered, such as high voltage consoles; and areas with electrical repair or test benches (shops), motors or equipment and control panels.

30.8.3. Cleaning shall 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.

30.8.4. Insulating matting shall be replaced when worn to one-half its original thickness or the manufacturer's suggested replacement requirements. **Note:** Shoes with nails shall not be worn on insulating matting.

30.8.5. Insulating matting on floors in front of and around electronic workbenches, high voltage cabinets, switch panels, etc., shall be of one continuous length or strip. Where possible, the matting shall 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 shall determine the amount needed.

30.8.6. Insulating matting shall be seamless and markings shall be non-conducting and not impair the insulating qualities of the equipment.

30.8.7. Matting shall be capable of withstanding the AC proof test voltage specified in [Table 14.1](#) or the DC proof test voltage specified in [Table 14.3](#)

30.8.8. The voltage test shall be applied continuously for three (3) minutes for equipment other than matting and applied continuously for one minute on matting.

30.8.9. Insulating matting shall not be used for nonskid applications such as walkways or hallway runners, in front of workbenches (non-electronic) 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.

### **30.9. Aerial Work.**

30.9.1. The only personnel authorized to climb poles and towers are those who have been properly trained and who are certified or in a training status under the observation of a qualified instructor. Appropriate safety equipment shall be worn while performing aerial work. Refer to TO 31-10-3, *Air Force Communications Command (E-I Standard) – Standard Instl Practices – Outside Plant Instl*, for proper climbing techniques.

30.9.2. Commander responsibilities.

30.9.2.1. Unit commanders shall designate, in writing, all personnel required to maintain climbing proficiency.

30.9.2.2. Commanders shall restrict climbing authorizations to structures that must be climbed to accomplish mission requirements.

30.9.3. Initial Certification Procedures.

30.9.3.1. Upon assignment to a unit, each individual whose future duties will require climbing poles and towers where they may be subject to a fall of four (4) feet or more in height shall be trained and certified, as applicable. The requirements ensure workers who must climb use proper PPE, are fully qualified and physically capable of climbing and working aloft.

30.9.3.2. For Air Force Specialty Codes (AFSEC) other than 3D1X7, commanders shall restrict climbing authorizations to those structures that must be climbed to accomplish mission requirements.

30.9.4. Supervisors/trainers responsibilities.

30.9.4.1. Climbing recertification is an annual requirement.

30.9.4.2. Annual recertification may be satisfied by demonstrating climbing proficiency any time climbing is performed while completing actual job requirements or training events under supervision of qualified certifier.

30.9.4.3. Decertify personnel not qualified to perform climbing tasks and restrict from climbing until recertified. The certifier will determine the training requirements.

30.9.4.4. Supervisors must have a rescue plan in place in the event a climber cannot descend the tower on their own.

30.9.4.5. Supervisors shall ensure personnel on the ground or in the air do not remove or tamper with guy wires, guying hardware or supporting ropes when workers are aloft.

30.9.4.6. Supervisors and each team member have the responsibility to prohibit persons from climbing if it would be potentially unsafe due to mental or physical condition, such as a fear of heights or dizziness, fainting or lack of experience.

30.9.5. Climbing Certifier Requirements. Climbing certifier must:

30.9.5.1. Complete a climbing certification training course or commercial equivalent. Tower certifier training, **J3AZR3D157 0C1A**, can be found at website: <https://etca.randolph.af.mil/>. ANG offers climbing course Cable/Antenna SIPT, and information can be found at website: [http://www.milvet.state.pa.us/air\\_national/lightningforce/index.htm](http://www.milvet.state.pa.us/air_national/lightningforce/index.htm).

30.9.5.2. Be designated, in writing, by the commander to conduct climbing certification.

30.9.5.3. Be current in cardiopulmonary resuscitation (CPR) and first aid training.

30.9.5.4. Demonstrate ability to perform and teach complex tasks aloft.

30.9.5.5. Be certified to train individuals in pole top and tower rescue.

30.9.5.6. Use a training plan to conduct pole top and tower rescue training and climbing certification.

30.9.5.7. Maintain climbing proficiency and knowledge of current OSHA requirements.

30.9.5.8. Determine and arrange for the specific safety equipment to use during performance evaluations.

30.9.5.9. Evaluate a written and/or oral knowledge test.

30.9.6. Climbers responsibilities.

30.9.6.1. Each team member has the responsibility to ensure all personnel are prepared for the climbing task.

30.9.6.2. Personnel handling or using the equipment will inspect to determine if the climbing equipment is in safe working condition. Refer to TO 00-25-245, *Operations Instructions Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, for additional guidance.

30.9.6.3. Climbers must maintain three points of contact while climbing at all times. Either one hand and two feet or two hands and one foot must be in contact with the tower or pole at all times while ascending or descending.

30.9.7. Safety Observers. When performing aerial work on communication cable and antenna systems, safety observers must be qualified to operate the equipment in use and shall have a current climbing certification, be proficient in CPR and administering emergency first aid treatment that involves control of bleeding, shock, open wounds and burns, and procedures for obtaining medical assistance.

30.9.8. Documentation.

30.9.8.1. Military: Document certification in the IMDS training subsystem. A record of climbing certification shall be maintained on AF Form 1098, *Special Task Certification and Recurring Training*, and AF Form, 623 *Individual Training Record Folder*.

30.9.8.2. Civilian: AF Form 971, *Supervisor's Employee Brief*, or an approved computer automated system.

30.9.9. The potential of falling is the most obvious hazard encountered while climbing. It is extremely important that your safety gear is used and worn properly. The personal fall arrest system (PFAS), i.e., climbing harness, lanyard and other safety equipment must be inspected prior to each use. Workers shall inspect the equipment prior to use. Refer to paragraph **30.9.15** for additional guidance on PFAS.

30.9.10. Steps and ladders shall be installed on all antenna towers and structures when the design permits. These steps and ladders shall 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 shall be retrofitted as required in coordination with the installation CE. New towers, poles and masts shall have protective devices included in the original design. When installed, use of protective devices shall be strictly enforced.

30.9.11. Certification is not required, for example, to walk up and down stairways. Refer to **Chapter 7**, TO 31-10-3, *Outside Plant Installation*, 29 CFR 1910.24., *Fixed Industrial Stairs*, and 29 CFR 1910.27., *Fixed Ladders*, for additional precautions and guidance.

30.9.12. Workers engaged in climbing communication poles, antenna supports, etc., shall be issued suitable PPE, i.e., line worker boots, hard hat with chinstrap, safety harnesses and safety straps, which shall be worn at all times while climbing and working aloft. When PPE is not used during climbing, it shall be attached to the harness or elsewhere as prescribed. It shall not be carried in the hand, over the shoulder or by other unauthorized methods. Hard

hats shall be worn and secured with chinstraps while climbing and working aloft. Climbing equipment shall be inspected IAW **Chapter 13**, *Fall Protection*.

30.9.13. 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, shall be provided with safety railings IAW **Chapter 7**.

30.9.14. Environmental Factors.

30.9.14.1. Check Weather Forecast Prior to Climbing.

30.9.14.2. Personnel shall not climb if lightning is within five miles.

30.9.14.3. Personnel shall not climb if winds are in excess of 25 MPH.

30.9.15. Personal Fall Arrest System (PFAS).

30.9.15.1. OSHA requires that employers provide fall protection for any worker whose work requires them to be four (4) feet or more above a lower level or off the ground. The use of full body harness is required. This harness shall be part of a PFAS. There are three parts to a PFAS: an anchor, a body harness and a connecting device. Refer to **Chapter 13** for additional guidance.

30.9.15.2. Users of PFAS shall comply with TO 00-25-245, *Operations Instructions Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, - regarding inspection, maintenance, cleaning and storage of PFAS equipment. Refer to **Chapter 13** for additional guidance.

30.9.15.3. Kernmantle rope is rope that is constructed with the interior core (the kern) surrounded by and protected by a woven sheath (the mantle) designed to maximize strength, durability and flexibility. Kernmantle ropes come in a variety of different sizes and ratings; for example, the 5/8" diameter kernmantle rope is rated at 12,000 lbs. and the 1/2" diameter is rated at 10,000 lbs.

30.9.15.4. There are mainly two (2) different types of kernmantle rope: static and dynamic. Static rope is used in situations where little stretching is required, mainly for hauling items, rappelling and other applications. Dynamic rope is used to secure climbers and is designed to stretch under heavy loads to absorb the shock of a fallen climber. Dynamic ropes are only rated to handle a certain number of falls and shall be discarded once signs of stress appear. These signs show up as a tapered appearance in the rope.

30.9.15.5. Kernmantle rope shall never be stepped on. Getting fine rock and dust particles in the sheath (mantle) will happen with everyday work. However, stepping on the rope will grind these particles into the inner core (kern) and cause damage to the rope internally.

30.9.15.6. Test the rope grab for proper operation. Ensure the rope grab is installed with the arrow pointed in the up position and properly locked down onto the rope. Slide the rope grab up and down the rope to ensure it slides freely. When a sharp downward pull is applied, the braking mechanism shall activate, preventing the rope grab from moving

downward. The rope grab must be the proper size for the rope used, for example, use a 5/8" rope grab on a 5/8" rope.

30.9.15.7. Some towers are equipped with a safety rail and sliding sleeves. Sliding sleeves are similar to rope grabs in that they have an arrow on them which shows the proper installation direction. The arrow must be installed pointing up or the brake won't activate during a fall. Inspect the sliding sleeve for cracks, corrosion and pitting before use. If any of these conditions exist, the sliding sleeve must be replaced before use.

30.9.15.8. Carabineers are simply a clip or hook. When used for climbing, they must have a spring loaded gate (keeper) and the gate must self-lock. Carabineers must be rated to handle 5,000 lbs.

30.9.16. Equipment For Un-stepped Communications Poles. All Communications-Electronic (C-E) field technicians required to climb un-stepped communications poles will use the squeeze pole fall protector (pole choker) arrest system. Users of the pole chokers will comply with TO 00-25-245 and manufacturer's instructions regarding inspection, maintenance, cleaning and storage of PFAS equipment.

30.9.17. Tower Rescue.

30.9.17.1. All tower workers shall be qualified in first aid, buddy care and CPR.

30.9.17.2. Use the following steps for descending/suspension method of rescue.

30.9.17.2.1. Climb the tower using the "Y" lanyard and attach a snatch block to the tower.

30.9.17.2.2. Install a rope through the snatch block. This shall be used to raise the other equipment that shall be used for rescue.

30.9.17.2.3. Attach the canvas bucket to the rope and raise it to the anchor position.

30.9.17.2.4. Attach the anchors; one for the victim's rope grab, and another for the rescuer's rope grab. The third anchor for the Fisk Descender, which shall be attached in the middle, with the victim to the right and the rescuer to the left.

30.9.17.2.5. Rig the three termination plates and attach them to the anchor straps.

30.9.17.2.6. The rescuer shall attach to the rope grab and rig the descender and prepare to rescue the victim.

30.9.17.2.7. The rescuer shall not disconnect from the rope grab until on the ground.

30.9.17.2.8. Once in position, the rescuer shall descend to the victim and permanently lock-off the Fisk Descender.

30.9.17.2.9. After permanent lock-off has been accomplished, the rescuer shall attach to the victim using a carabiner.

30.9.17.2.10. After connecting to the victim, the rescuer shall cut the mule tape which will cause the victim to fall about two (2) inches. The Fisk Descender shall take on the weight of the victim, and the rescuer will not feel the affect of the victim's weight.

30.9.17.2.11. Once attached to the victim, the rescuer shall position the victim on his/her right hip.

30.9.17.2.12. After getting the victim positioned properly, the rescuer shall place the descender in the descend position and lower him or herself and the victim to the ground.

30.9.17.2.13. The rescuer shall apply first aid, buddy care or CPR, if needed, while awaiting the arrival of emergency services.

### 30.9.18. General Tower Climbing Precautions.

30.9.18.1. Check tower antenna supports and mounts for corrosion. **Note:** Check bolts on towers, because they corrode before tower sections. Refer to TOs 31-10-19, *Antenna Systems —Anchors and Supports*, and 31R-10-5, *Air Force Comm Commands (E-I Standards) – Antenna Systems, Maintenance, Repair and Testing*, for additional guidance.

30.9.18.2. Before starting work, ensure power to antennas is turned off and locked out, the capacitors are discharged and appropriate signs or tags are posted.

30.9.18.3. 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 for the diameter of the rope.

30.9.18.4. Do not carry bulky and heavy tools, parts or other materials on safety harnesses while climbing.

### 30.9.19. Pole Top Rescue.

30.9.19.1. Pole top rescue shall only be attempted by personnel who have been properly training and who are certified or in a training status under the observation of a qualified instructor.

30.9.19.1.1. All pole workers shall be qualified in first aid, buddy care and CPR.

30.9.19.1.2. If no aerial lift devices are available for rescue, get help and call or assign someone to call the local emergency medical service (EMS) or FES Flight. Artificial respiration can be applied to an unconscious victim on a pole, and the best position shall be slightly above the victim. If CPR is required, the victim must be lowered as quickly as possible, and then CPR administered.

30.9.19.1.3. Climb to rescue. Climb the pole and free the victim from the energized line if necessary. Take great care to ensure the rescuer is not also electrocuted. If CPR is not required, mouth-to-mouth resuscitation can be attempted before lowering the injured worker to the ground. If resuscitation necessary, the best position for the rescuer is slightly above the victim. When the victim begins breathing naturally, keep the victim in position and under control until additional help is available for lowering the victim to the ground, using rope rigging if possible.

30.9.19.1.4. Take a position below the victim on the pole and place your safety strap around the pole. Then climb up the pole with the victim's legs straddling your safety



strap, and with the victim's body between you and the pole. When the safety strap is sufficiently high, the victim's weight can then be taken on your safety strap. Do not unfasten the victim's safety strap. 30.9.19.1.5. Use a handline to lower the victim for either one or two rescuers.

#### 30.9.19.2. Pole Top Rescue Training Requirements.

30.9.19.2.1. Graduates of the communications cable and antenna systems apprentice course or other accredited climbing courses are recognized by the Cyber Systems Air Force Career Field Manager (AFCFM) as qualified climbers for a period of 90 days from the graduation date. At those units with existing climbing capabilities, the gaining unit must evaluate the graduates within 90 days from the graduation date to verify and document qualifications. The individual shall be tested, orally and/or in writing 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. Decertify the individual if the initial evaluation exceeds the 90-day period.

#### 30.9.19.3. General Pole Climbing Precautions.

30.9.19.3.1. Inspect the pole for unsafe conditions both before and during the climb.

30.9.19.3.2. Check poles for deterioration. Prior to placing body weight on step, check steps on poles for proper depth and tightness.

30.9.19.3.3. Unsafe conditions include such things as rake (leaning of the pole), shell rot, cracks, breaks, knots, woodpecker holes and foreign attachments to the pole.

30.9.20. Radome Installation, Maintenance and/or Removal. Workers engaged in radome work shall be experienced riggers and work under the direction of a qualified supervisor. Those who work on or in the immediate vicinity of the radome shall wear hard hats and safety-toed shoes. Workers shall make frequent checks with the nearest weather forecasting agency to allow time to lash down equipment for impending inclement weather. Also, workers shall never try to replace panels when the wind is blowing more than 30 miles per hour and shall never remove more than one panel at a time under normal conditions. When mixing resin, workers shall follow the manufacturer's instructions. Workers shall use the maintenance rope to lift the maintenance ladder to the top of the radome. Prior to each use, the rope shall be inspected for frayed or worn spots and replaced, if required.

### **30.10. Antenna Supports (Towers and Poles).**

30.10.1. Before starting work, ensure power to antennas is turned off and locked out, the capacitors are discharged and appropriate signs or tags are posted IAW **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*. Check poles for deterioration. Prior to placing body weight on step, check steps on poles for proper depth and tightness. Do not carry bulky and heavy tools, parts or other materials on safety harnesses while climbing. Refer to TO 31-10-3, *Outside Plant Installation*, TO 31R-10-5, *Antennas Systems: Maintenance Repair and Testing*, and **Chapter 21** for additional guidance.

30.10.2. 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. Additionally, check tower antenna supports and mounts for corrosion. **Note:** Check bolts on towers because they corrode before tower sections. Refer to TOs 31-10-19, *Antenna Systems —Anchors and Supports*, and 31R-10-5, for additional guidance and information.

30.10.3. 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 for the diameter of the rope. Refer to TOs 31-10-3, 31-10-28, *Erection of Steel Towers*, and 31R-10-5 for further guidance.

30.10.4. Ensure only special purpose vehicles designed for heavy antenna erection and removal, which are 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.

### **30.11. Single Phase Portable and Vehicle-Mounted Generators.**

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

30.11.1.1. The generator supplies only equipment mounted on the generator and/or cord- and plug-connected equipment through receptacles mounted on the generator.

30.11.1.2. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

30.11.2. 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:

30.11.2.1. The frame of the generator is bonded to the vehicle frame.

30.11.2.2. 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.

30.11.2.3. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

30.11.3. 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.

30.11.4. Metallic Encased Tools. The tools and equipment being powered by generators shall contain three-wire cords with grounded plugs.

30.11.5. Fixed Wiring Systems. Portable and vehicle-mounted generators that supply fixed wiring systems shall be grounded IAW NFPA 70, *National Electrical Code*, Article 250, *Grounding*.

### **30.12. Repairs and Adjustments.**

30.12.1. Repairs and adjustments shall be made to energized circuits only when a power-on condition is essential. Refer to applicable TO for additional guidance.

30.12.2. Repairs and adjustments of components, when the equipment slides are extended from their cabinets and voltages are applied, shall be permitted only when specified by applicable TOs, manufacturer's manuals or approved isolation and troubleshooting methods. Personnel not essential to the operation shall be removed from the area before power is applied. When high voltages are present or transmitters of 1-kilowatt (kW) power rating or higher are involved, unit commander will approve procedures and adjustments not specified by TO or manufacturer's manuals. Additionally, insulated gloves shall be used when directed by TOs or the manufacturer's manuals. Ensure insulated matting is used and a qualified safety observer is present.

### **30.13. Power Distribution Panels.**

30.13.1. Power Distribution Panels and Interlocks. Power distribution panels and interlocks shall be secured to prevent personnel contacting energized circuits. When equipment must be removed from service for inspection or repair, the appropriate circuit breaker or interlock shall 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. Tape shall not be used to "lock" open circuit breakers. Refer to [Chapter 29](#) and paragraph [30.5.4](#) for additional guidance and information on signs and visual aids.

30.13.2. Fuses and Circuit Breakers. The inside cover of fuse(s) and circuit breaker panels (or area adjacent if not equipped with a cover) shall indicate in writing the equipment controlled by which fuse or circuit breaker. Whenever possible, over-current devices shall 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. Blown fuses shall be replaced by the type required by the manufacturer. When possible, clip type or flat-mount cartridge fuses shall only be removed and replaced by using insulated fuse pullers. Wire, foil, solder and similar materials shall not be used as substitutes for fuses.

30.13.3. Carbon Blocks and Heat Coils. Prior to removal of operating carbon blocks or heat coils, a measurement of line potential shall 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. Carbon blocks and/or heat coils shall not be removed or replaced if the FEMF is still present.

**30.14. Cathode Ray Tubes (CRT).** Precautions shall 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 shall be retained in their original containers until removed for actual installation or for inspection and test. A tube shall 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 shall be exposed or changed only in areas where a minimum number of personnel are present. All personnel working in the vicinity shall wear eye protection whenever a CRT is removed from its container. Handling of large diameter tubes shall be done by two (2) workers. Workers who handle tubes will:

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

30.14.2. 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. Do not place a tube on its side on a flat surface. Instead, place the tube face down on a nonabrasive pad or suitable material. Avoid scratching the glass of a tube since such scratches weaken the tube and can cause failure.

30.14.3. 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.

30.14.4. 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, the older type tubes may still be in use and the safety precautions cited herein shall be observed.

30.14.5. 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. Contact the installation Environmental Management office and BE for potential radiation issues prior to destroying the tube and for disposal guidance.

30.14.6. Immediately wash the cut(s) to remove dirt, phosphorus or other particles, and obtain immediate medical attention if broken glass from a tube cuts the skin.

30.14.7. In the event of equipment fires, use only approved extinguishers on CRTs. Refer to paragraph [30.5.11](#) and the installation (FES) Flight for additional guidance.

30.14.8. Contact BE for an evaluation of the X-ray hazard of all color video display tubes (VDT) manufactured before 1970 and operating at voltages greater than 16 kV, or for VDTs manufactured after 1970 when maintenance procedures have the potential for violating manufacturer-applied warning labels.

### **30.15. Radar and Microwave Equipment.**

30.15.1. Radar and microwave equipment are sources of non-ionizing radiation. Personnel shall be instructed in the hazards of non-ionizing radiation and shall not be exposed to non-ionizing radiation levels above the permissible exposure limits outlined in AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*. .

30.15.2. Exercise caution when working on or adjacent to transmitter antennas. Special precautions shall be taken to ensure a transmitter, connected to an antenna that is being inspected or worked on, is locked out IAW [Chapter 21](#), *Hazardous Energy Control (Lockout and Tagout)*, requirements and cannot be energized. Ensure adjacent antennas, which create

hazardous levels of RF radiation at the work location, are also secured. Ensure workers remove all jewelry prior to performing any task on equipment. Review the site standard operating procedures (SOP) for radiation hazard control and site RF hazards reports and drawings. This will 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. A danger tag, warning sign, AFVA or other suitable identification advising others of the nature of work in progress shall be posted on the console of the transmitter and in all other critical locations.

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

30.15.4. A non-ionizing radiation warning sign shall be posted in areas where a hazard may exist. Refer to AFOSH Standard 48-9 for additional guidance.

### **30.16. Entering Manholes and Unvented Vaults.**

30.16.1. **Chapter 23**, *Confined Spaces*, requirements shall be met during all entry operations. Manholes and vaults shall be evaluated and tested to determine the classification of the confined spaces and whether entry permits shall be required. Additionally, manholes, vaults and handholes shall be positively identified as to utility type (communication, electrical power distribution, sewer, etc.) prior to entry. In the absence of positive identification, personnel shall coordinate with the installation Ground Safety office and contact the appropriate installation organizations to establish positive identification. These shall normally include the installation CE electrical shop, communication unit and FES Flight.

30.16.2. Unidentified cables shall be positively identified as to the utility type. Cables shall 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 shall be used and the communication cable shall be positively identified. When requested, the installation civil engineering electrical shop shall provide an electrician to assist in determining guarding and safe procedures.

### **30.17. Cables.**

30.17.1. Aerial Cables. Maintain minimum distances (42 inches up to 87,000 volts and 48 inches over 87,000 volts) between power and communications cables on joint-use poles. If minimum distances cannot be maintained, de-energize the power line before performing installation or maintenance work. Workers shall comply with the requirements in UFC 3-560-01, Table 3-1.

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

30.17.3. When crossing over roadways, railroads, walkway, etc., ensure proper overhead clearances are maintained. Refer to TO 31W3-10-19, *AF Communication SVC (E-I Standard) — Standard Installation Practices, Telephone, Outside Plant Installation, Pole Line*, for additional guidance.

30.17.4. 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 (2) workers suspend their weight on it.

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

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

30.17.7. Use safety straps and safety harnesses while working on elevated work platforms such as aerial splicing platforms, pole platforms, ladder platforms and terminal balconies. Wear insulating rubber gloves when handling suspension strand that is being installed on joint-use poles. TO 31W3-10-19 contains additional guidance and information for these requirements.

30.17.8. Underground and Buried Cables. Refer to TO 31W3-10-12, *AF Comm Command (E-I) Standard Installation Practices – Outside Plant Cable Placement*, for guidance and requirements.

30.17.9. Pressurized Cables. Refer to TO 31W3-10-16, *Outside Plant Cable Pressurization*, for information and guidance.

30.17.10. Trenching and Excavations. Refer to TO 31W3-10-12, *Outside Plant Cable Placement*, US Army Corps of Engineers Manual (EM) 385-1-1, *Safety and Health Requirements Manual*, and 29 CFR 1926.652, *Excavations — Requirement for Protective Systems*, for information and guidance.

**30.18. Special Purpose Vehicles.** See AFI 23-302, *Vehicle Management*, for guidance.

30.18.1. Inspection. Prior to operation, visually inspect the vehicle and check vehicle documentation, i.e., AF Form 1800, *Operator's Inspection Guide and Trouble Report*, and AF Form 1807, *Operator's Inspection Guide and Trouble Report (Fuel Servicing Vehicles/Equipment)* to determine if it is safe, serviceable and in good condition. Inspect for correct assembly, storage of equipment and worn equipment. After operation, document and correct any operating deficiencies, report defects that require repair to the unit vehicle control officer and/or organizational maintenance section, and replace unserviceable equipment.

30.18.2. Truck-Mounted Winches. 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 used. Winches are extremely powerful tools and extreme caution shall be exercised when used. The winch operator shall be thoroughly trained and familiar with both the operation of a winch gear train and power takeoff lever movement.

30.18.2.1. Winch operators shall wear leather gloves when handling a winch line and never hand feed the line onto the drum. 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. Never rig a winch line so it will pull against the flange of the winch drum. **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.

30.18.3. 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. Caution shall be used when handling cable reels and cable reel trailer. 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. Never permit the reel to tilt. On uneven or soft ground, provide a substantial runway of heavy planks. Level the reel by blocking it in a manner that prevents tilting. After positioning in the desired storage location, block the reel to prevent rolling.

**30.19. Ground Controlled Approach (GCA) Radars.** Before ascending to the roof of the GCA trailer or other rotating antenna location, the supervisor shall inform all nearby personnel that work is being performed on the roof and shall ensure the following is accomplished:

30.19.1. 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. The roof-mounted antenna safety switch shall be turned off. Refer to [Chapter 21](#) for additional information on lockout and tagout requirements and paragraph [30.5.4](#) for signs and visual aids.

30.19.2. TO 35-1-3, *Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE)*, 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.

**Figure 30.1. Location of Warning Devices – Manhole Off Highway.**

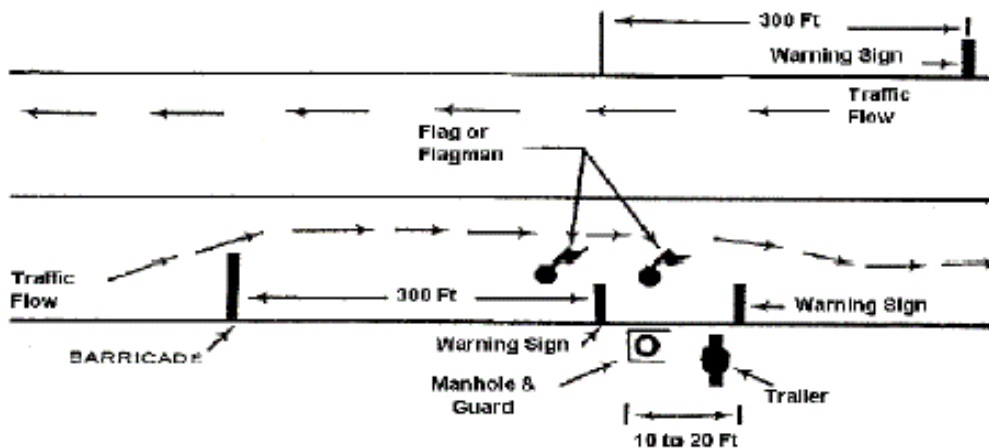


Figure 30.2. Location of Warning Devices – Manhole in Two-Lane Highway.

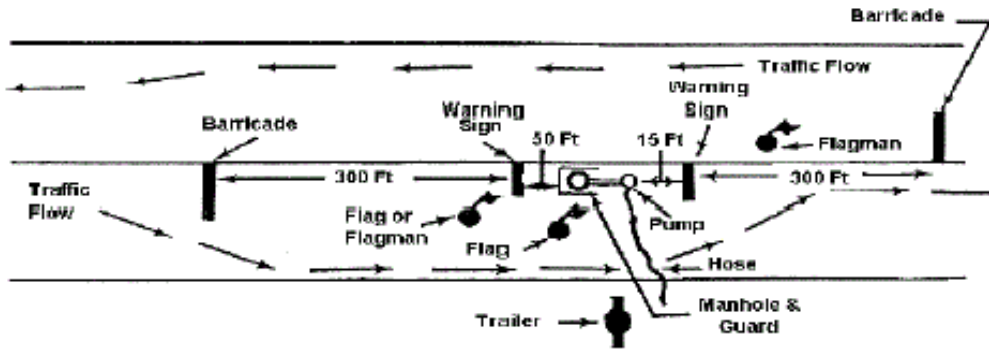


Figure 30.3. Location of Trailer.

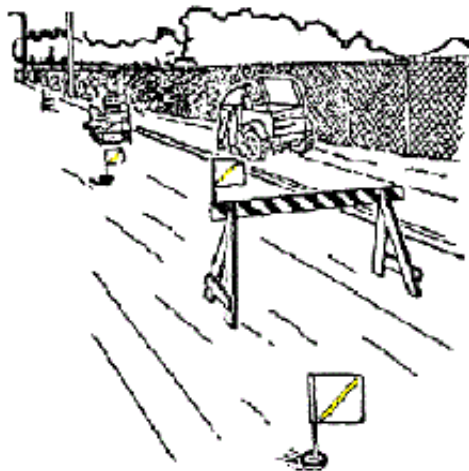
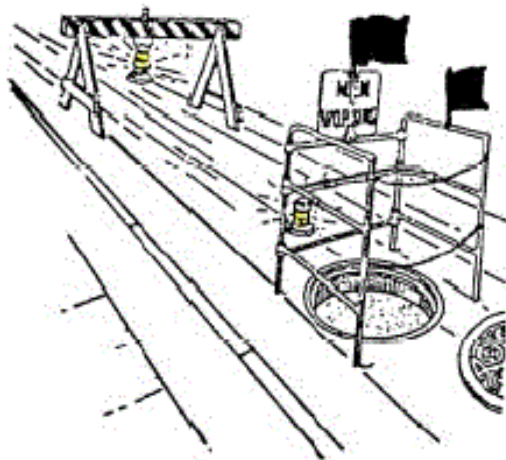
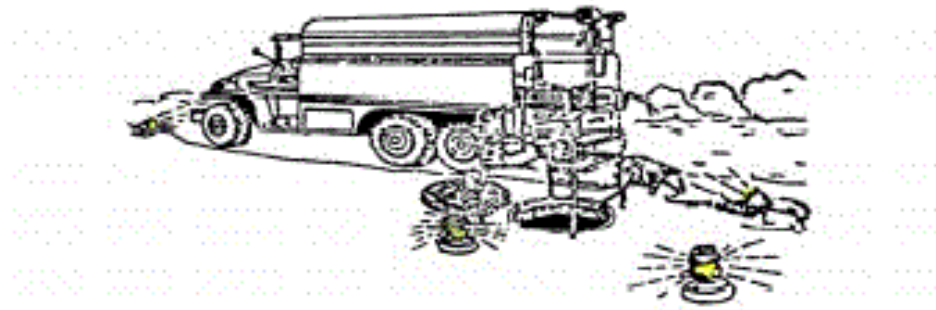


Figure 30.4. Night Warning – Arrangements of Warning Signs.





**Figure 30.5. Night Warning – Use of Floodlights.**



**30.20. Communications Cable, Antenna and Communications Systems Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

30.20.1. Are flammable wastes disposed of at the end of each shift in clearly marked metal containers? Reference [30.1.1](#)

30.20.2. Are workers aware of the risk of electromagnetic interference for persons who have electrically active medical implants? Reference [30.1.3](#)

30.20.3. Are procedures established to protect personnel and notify the installation Radiation Safety Officer if an electron tube containing radioactive materials is broken? Reference [30.2.3.3](#)

30.20.4. Are regulators removed, safety caps installed and compressed gas cylinders properly secured during transport or when not in use? Reference [30.2.5](#)

30.20.5. Are compressed gas cylinders secured, stored away from excessive heat and protected from the direct rays of the sun? Reference [30.2.5.1](#)

30.20.6. Do workers adhere to established safety practices when working near exposed electrical circuits or maintenance and installation activities, such as not wearing rings, watches or other conductive objects; not using or carrying in pockets, metallic measuring rules, tools or metal-cased objects; and avoiding working in wet clothes? Reference [30.3.1](#)

30.20.7. Are electrical circuits de-energized, and locked and tagged out before attempting any work, unless the work requires the circuits to remain energized? Reference [30.3.5](#)

30.20.8. Do workers wear arc-fault protective clothing when work tasks expose them to a potential for arc flash? Reference [30.3.5](#)

30.20.9. Are workers trained on the proper procedures to be accomplished if leakage of suspected PCBs is detected during work on transformers? Reference [30.3.9](#)

30.20.10. Have the installation (FES) Flight and the emergency response personnel been provided maps with routes to locations of remote work sites? Reference [30.3.11](#)

- 30.20.11. Are metal workbenches and those that are metal framed or metal legged, which are used for repairing and testing electronic equipment, grounded? Reference [30.3.14.1](#)
- 30.20.12. Is the soldering work area free of combustible materials and equipped with fire extinguishers? References [30.3.15](#)
- 30.20.13. Is proper face protection used by personnel performing soldering tasks? Reference [30.3.15.1](#)
- 30.20.14. Is the soldering work area properly ventilated? Reference [30.3.15.2](#)
- 30.20.15. Do workers 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? Reference [30.3.16](#)
- 30.20.16. Have all workers required to perform duties on communications systems or act as safety observers received first aid and CPR training? Reference [30.4.1](#)
- 30.20.17. Are personnel who are required to enter confined spaces trained in self-rescue? Reference [30.4.2.2](#)
- 30.20.18. Is a pre-task safety briefing performed prior to any task requiring the use of or exposure to hazardous materials? Reference [30.4.2.3](#)
- 30.20.19. Is the training for all workers required to perform duties on communications systems or act as safety observers documented properly? Reference [30.4.3](#)
- 30.20.20. Are warning devices and barriers used when motor vehicle traffic is a potential hazard to personnel working in manholes or on aerial lifts? Reference [30.5.1](#)
- 30.20.21. Are appropriate warning signs or AFVAs available and used when working in and around communications systems work sites? Reference [30.5.4](#)
- 30.20.22. Is emergency equipment available to personnel exposed to high voltage when performing communications maintenance tasks? Reference [30.5.7](#)
- 30.20.23. Are hard hats issued to personnel who work on and around poles, overhead structures, tower and antenna construction jobs? Reference [30.5.8.1](#)
- 30.20.24. Are all tools and equipment maintained in safe condition? Reference [30.6.1](#)
- 30.20.25. Are nonconductive tools used when performing work on energized C-E equipment? Reference [30.6.2](#)
- 30.20.26. Are all ladders used to support electrical work of proper design (wood or fiberglass)? Reference [30.6.4](#)
- 30.20.27. 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*”? Reference [30.6.5](#)
- 30.20.28. When working close to energized overhead power lines, are procedures in place to prevent equipment or aerial lifts from violating minimum distances? Reference [30.7.1](#)
- 30.20.29. Are workers assigned duties that require climbing poles or structures trained? Reference [30.9.3.1](#)

- 30.20.30. When performing work on aerial communication cable and antenna systems, are safety observers current in climbing certification? Reference [30.9.7](#)
- 30.20.31. Prior to climbing communication poles or antenna supports, are workers equipped and wearing suitable PPE? Reference [30.9.12](#)
- 30.20.32. Are natural fiber, nylon, or wire ropes inspected for deterioration, fraying or broken strands prior to use and discarded if found to be unsafe? References [30.9.18.3](#)
- 30.20.33. During work on or near radomes, are personnel required to wear hard hats and safety-toed shoes? Reference [30.9.20](#)
- 30.20.34. Are workers instructed in the hazards of non-ionizing radiation associated with radar and microwave equipment? Reference [30.15.1](#)
- 30.20.35. Are workers instructed on the hazards of working with RF transmitters and antennas? Reference [30.15.2](#)
- 30.20.36. Do workers check handlines for serviceability prior to use? **Reference [30.17.6](#)**
- 30.20.37. Do workers wear safety straps and harnesses when working on elevated work platforms? Reference [30.17.7](#)
- 30.20.38. Do workers wear insulating rubber gloves when handling suspension strand that is being installed on joint-use poles? Reference [30.17.7](#)
- 30.20.39. Prior to operating a special purpose vehicle, is the vehicle visually inspected for serviceability, condition, correct assembly for the operation, proper storage of equipment and worn equipment? Reference [30.18.1](#)
- 30.20.40. Prior to the operation of a winch, is a safety observer positioned in the front and well clear of the winch being used? Reference [30.18.2](#)
- 30.20.41. When operating a truck-mounted winch, is the vehicle operator trained and familiar with the operation of a winch gear train and power takeoff lever movement? Reference [30.18.2](#)
- 30.20.42. Do winch operators wear leather palm gloves when handling a winch line? Reference [30.18.2.1](#)
- 30.20.43. Prior to use, do winch operators inspect the winch line for defects such as broken or worn strands, kinks, flat spots and worn eye loops? Reference [30.18.2.1](#)

## Chapter 31

### BATTERIES – MAINTENANCE, HANDLING AND STORAGE REQUIREMENTS

**31.1. General Information.** This standard provides basic background information for safe battery operations and is not intended to be all-inclusive. Much of the following information is derived from TO 8D2-62-1, *Operation and Maintenance Instructions with IPB – Naval Aircraft and Naval Aircraft Support Equipment Storage Batteries*, and other documents which provide additional guidance for aircraft and support equipment battery operations.

31.1.1. Air Force battery shops, rooms and areas contain space and equipment for shipping, receiving, cleaning, charging, discharging, storing and repairing storage batteries for aircraft, vehicles and ground support equipment. Personnel engaged in these activities shall use approved Air Force TOs. Commercial manufacturer's manuals are not authorized for Air Force use on aircraft batteries and must be converted to TO guidance by the appropriate AF Engineering Support Specialist or Systems Program Office (SPO).

31.1.2. The battery shop, room or area shall be designed to eliminate certain hazards associated with battery maintenance and shall conform to the specific requirements in this document and 29 CFR 1910.178, *Powered Industrial Trucks*, 29 CFR 1926.403, *General Requirements (Electrical)*, 29 CFR 1926.441, *Batteries and Battery Charging*, NFPA 70, *National Electrical Code*, including Articles 480, *Storage Batteries*, and Chapter 5, *Special Occupancies*, which includes Article 500, *Hazardous (Classified) Locations*, Article 501, *Class I Locations*, and Article 503.14, *Storage – Battery Charging Equipment*. The installation Ground Safety office, BE, Fire Emergency Services (FES) Flight and Environmental Management office shall evaluate and certify battery rooms, shops or areas to ensure they conform to safe design and operating practices. Refer to the provisions of AFH 32-1084, *Facilities Requirements*, paragraphs 7.6.1. through 7.6.5., for additional guidance.

31.1.3. Whenever a facility deficiency is identified, appropriate controls and corrective actions are required. If the deficiency involves a local requirement and cannot be corrected, a waiver letter shall be obtained from the applicable base agency. For deficiencies involving AF or AFOSH requirements, identify the deficiency to the parent Numbered Air Force or MAJCOM for additional guidance on resolving the deficiency.

### 31.2. Safety.

31.2.1. Appropriate PPE, approved and certified in BE's OEH risk assessment, shall be worn whenever charging, maintaining, removing and/or replacing batteries. PPE required when working with batteries shall be documented IAW AFI 91-202, *The US Air Force Mishap Prevention Program*. PPE is required when:

31.2.1.1. Cleaning batteries, battery connection points and/or cables, servicing fluid level, connecting or disconnecting a battery charger at the battery, jump-starting a battery installed in a vehicle or piece of equipment, or any other type of service activity, requires ANSI Z87.1 approved eye protection with side shields. When handling electrolyte, a face shield, splash resistant chemical goggles and chemical resistant gloves and apron shall be worn. Refer to [Chapter 14](#), *Personal Protective Equipment (PPE)*, for additional guidance and information.

31.2.1.2. Handling vented lead acid vehicle or support equipment batteries (removing or installing in vehicles or equipment or transporting them) or when working in the battery room or maintenance area, requires personnel to wear acid resistant gloves, arm gauntlets, aprons, face protection and ANSI Z87.1 approved eye protection with side shields. Acid resistant safety shoes or acid resistant rubber knee length safety toed boots shall also be worn. Refer to **Chapter 14** for additional guidance and information.

31.2.2. Electrical components and systems shall be de-energized and isolated from other energized circuits and/or power sources before working on, servicing, removing or replacing a battery, unless specifically directed by a TO or specific requirement.

31.2.3. In areas where battery maintenance is performed on a regular basis, a permanent eyewash station shall be installed. If battery electrolyte comes in contact with the skin, the worker shall immediately flush the skin with tepid water. If electrolyte is splashed into the eyes, they shall be flushed with tepid water for at least 15 minutes. The worker shall seek immediate medical attention. **Note:** Portable eyewash stations shall be located in areas not affected by extreme temperatures (under 60°F or over 95°F), unless protected from such temperature extremes.

31.2.4. Battery Safety Practices. Nickel cadmium and silver-zinc batteries shall be serviced in an area isolated from lead-acid batteries. When both acid and potassium hydroxide electrolyte batteries are handled in the same shop, specific equipment for the two kinds of batteries shall be kept separate and carefully labeled. Tools and implements used to service nickel-cadmium, silver-zinc, nickel-iron or other alkaline batteries shall be used on those types only. **Note:** Basic safety practices for all lead-acid batteries are similar and only vary with specialized construction or conditions of use. Therefore, guidance given for one type of battery usage can and shall be followed with other uses, when applicable.

31.2.5. Battery Equipment and Charging Operations. Only trained and qualified personnel shall be permitted to change, maintain or charge batteries. Personnel assigned to the battery shop shall be qualified on all equipment and TO procedures. Qualification shall be documented in their individual training records. Only qualified personnel or those accompanied by qualified personnel shall be allowed access to battery shops, rooms or areas. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance* and NFPA 410, *Standard on Aircraft Maintenance*, for additional guidance and information.

31.2.5.1. Battery charging operations shall be conducted in adequately ventilated areas designated for that purpose.

31.2.5.2. "No Smoking" signs shall be posted in plain view of incoming personnel, to prohibit smoking in the charging area.

31.2.5.3. Tools and other metallic objects shall be kept away from the top of uncovered batteries.

31.2.5.4. When charging batteries, the vent caps shall be kept in place to avoid electrolyte spray.

31.2.5.5. The battery compartment or covers shall be open to dissipate heat.

31.2.6. Servicing Batteries. Servicing of batteries, i.e., changing and charging, shall only be performed by trained and qualified equipment operators. If services other than removal and replacement of batteries are performed, operators shall wear appropriate protective equipment, i.e., rubber apron, face shield and gloves. Additionally, when working with corrosives, an emergency shower or eyewash unit shall be provided for emergency use. Rings, watches and similar jewelry shall not be worn. Refer to **Chapter 19, *Emergency Shower and Eyewash Units***, for additional information on emergency showers and eyewash units.

**31.3. General Facility and Equipment Requirements for Battery Rooms and Areas.** A battery shop, room or area is where batteries are charged, maintained or stored. The shop, room or area shall be sized to accommodate the operation and workload. Storage batteries shall be located within a protective enclosure or area accessible only to qualified personnel. There are three common lead-acid battery technologies: flooded, gel and absorbed glass mat. A valve-regulated lead-acid (VRLA) battery, i.e., the absorbed glass mat (AGM) and the gel battery (gel cell), is a type of low-maintenance lead-acid rechargeable battery. Because of their construction, VRLA batteries do not require regular addition of water to the cells. The charging, maintaining or storage of the VRLA batteries shall follow the manufacturer's recommendations and guidance. The requirements apply to flooded (wet) lead-acid batteries.

31.3.1. Emergency Eyewash. Procedures shall be developed for flushing and neutralizing spilled electrolyte in work areas where batteries are charged, maintained or stored. Emergency eyewash and/or water facilities for rinsing eyes and skin shall be provided in the battery charging rooms and areas IAW **Chapter 19, *Emergency Shower and Eyewash Units***.

31.3.2. The FES Flight shall prescribe the quantity and placement of extinguishers for battery shops, rooms or areas based on the size of the operation. Battery shops shall have ready sources of running tap water, with a hose provided for washing the work area and emergency eyewash/showers.

31.3.3. Exit Doors. Battery shop, room or area doors shall swing outwards.

31.3.4. Floors shall be of acid-alkali-resistant construction or be protected from acid-alkali accumulations. Floors, walls, ceilings, doors and other painted surfaces in battery rooms and areas shall be painted with an acid-alkali-resistant epoxy-poly-urethane paint. **Note:** The battery shop can be painted any color. It is highly suggested to paint the floors gray and the walls white. An acid-alkali-resistant epoxy-poly-urethane paint with primer (i.e., Grainger Company, or equivalent, as listed below) shall be used. These paints provide the most protection against corrosion. Always follow the manufacturer's Technical Data Sheets, the applicable Material Safety Data Sheet (MSDS) and the Electro-Environmental Maintenance Standardization Evaluation Program (MSEP) checklist for these paints. Also, refer to TO 8D2-1-31, *Operation, Service Instruction (Shop Manual) – Aircraft Storage Batteries (Lead-Acid Batteries)*, for additional guidance and information.

<u>Paint Color</u>	<u>Part Number</u>
WHITE (primer)	4CJ36
GRAY (primer)	4CT32
Activator (1 can activator to 1 can of paint)	4CH84

31.3.5. All mechanical equipment and fixtures shall be designed and specified to withstand the corrosive acid-alkali atmosphere from battery operations.

31.3.6. Racks and Tools. Racks used to support batteries during charging shall be made of or coated with non-sparking materials and designed to permit free access for servicing batteries. Metal racks shall be protected with an acid-alkali resistive coating and the actual supports on which a battery rests shall be made of non-conductive materials or be suitably insulated. To facilitate battery handling and proper maintenance, low racks (close to the floor) shall be used when feasible. Tools used during battery charging or servicing shall be non-conductive or coated with non-conductive materials.

31.3.7. Work Surfaces. Work surfaces shall be non-conductive, and resistant to both acid and alkali. Whenever possible, battery servicing and maintenance shall be performed on elevated, non-conductive racks. These racks shall allow air to flow under the battery to provide additional cooling to dissipate heat generated during charging and discharging.

31.3.8. Charging Bench Floor Matting. Provide three-foot wide non-slip matting in front of all charging benches. The matting protects personnel from electric shock and slipping hazards. Matting shall conform to TO 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*.

31.3.9. Warning signs shall be posted inside and outside the battery shop, room or area, prohibiting smoking, sparks or flame-producing items. Signs shall also be posted warning of electric shock and slipping hazards. For guidance on construction and use of warning signs, refer to **Chapter 29**, *Mishap Prevention Signs and Tags*.

31.3.10. Battery Chargers.

31.3.10.1. Chargers shall be turned off before a battery is connected or disconnected. Failure to follow this practice can cause sparks, arcing and pitting of contact surfaces of mating plugs or connectors. Connections between a battery and charger shall be through a mating plug or connector assembly.

31.3.10.2. Some multiple battery and charger installations are equipped with polarized connectors of identical form on the battery and charger cables. Workers shall trace each plug or connector assembly back to its original source to ensure the correct interconnection between the battery and charger. This practice shall also be used to prevent inadvertent connection of two batteries or two chargers.

31.3.10.3. If charger or battery connectors are the same, additional steps shall be taken. Some connectors are available in various colors to identify a series of integral, mechanical interlocks, while others can be field-equipped with interlocking voltage keys to avoid improper voltage connections. If interlocking devices are not available, consideration shall be given to another means of identification, such as number coding.

31.3.10.4. To prevent ignition of accumulated gases, work shall not be conducted on batteries while they are being charged or discharged unless otherwise specified by the applicable TO.

31.3.10.5. Before performing work on charger plug contacts, workers shall ensure chargers are turned off and disconnected from the input power source. Refer to **Chapter**

**21**, *Hazardous Energy Control (Lockout and Tagout)*, for additional lockout/tagout guidance.

31.3.10.6. Provide chargers in the battery charging area ample ventilation and protection from damage by nearby vehicles, hand trucks or batteries. Charger leads shall be kept off the floor and out of aisles to avoid damage and potential tripping hazards. Overhead leads shall be plainly marked and be high enough to keep personnel from walking into them.

31.3.10.7. A carboy tilter or siphon shall be provided for handling electrolyte.

31.3.10.8. When charging batteries, acid shall be poured into water; water shall NOT be poured into acid. **Warning:** A severe reaction occurs when water is poured into acid and splattering of the acid can cause acid burns on exposed personnel. When pouring acid, the required PPE shall be worn. Refer to paragraph **31.2.1** for further guidance.

#### **31.4. Fire Protection and Prevention.**

31.4.1. Explosive Hazards. Always assume explosive gases exist in and around batteries, unless positive steps have been taken to eliminate them. For this reason, smoking, open flames, sparks, arcs and other sources of ignition shall be prohibited in the immediate vicinity of batteries that are being charged or discharged. The following ignition sources shall not be permitted in the vicinity of batteries:

31.4.1.1. Sparks, from any source, which could ignite explosive gases in or around batteries. Avoid shorting out a battery with metal tools or objects. Extreme care must be taken not to short out a battery with tools or metal objects.

31.4.1.2. Sparks from connecting or disconnecting batteries while they are in use, i.e., jump-starting a vehicle. Also, connecting or disconnecting a battery from a charger before turning the charger off, or while removing or installing a battery in a vehicle when current is flowing in the battery circuit.

31.4.1.3. Sparks occurring during vent cap removal. Combustible gases shall be flushed out of each cell with a gentle stream of air, i.e., by fanning each vent opening with a stiff piece of cardboard or other suitable non-conductor.

31.4.1.4. Sparks or short circuits in the presence of flammable or combustible liquids. If installing or replacing electrical components in the presence of flammable or combustible liquids, the worker shall keep battery ground cable disconnected until liquids are no longer present.

31.4.1.5. Sparks occurring when cleaning batteries or terminals. Never clean batteries with metal brushes or other metal devices which may generate sparks or contact both terminals and short circuit the cells.

#### **31.5. Ventilation Systems.**

31.5.1. Battery shops, rooms and areas shall be ventilated, either by a natural or powered ventilation system, for dispersal of airborne contaminants from batteries. The ventilation system shall ensure the maximum gas-air mixture generated during charging is maintained below 25 percent of the lower explosive limit (LEL). The ventilation system shall provide for



automatic cutoff of charging equipment if the ventilation blower or fan fails. BE's OEH risk assessment will identify ventilation needs for battery shops, rooms and areas IAW ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. **Note:** NEC Article 480.9(A), *Ventilation*, requires adequate ventilation to prevent classification of a battery location as a hazardous (classified) location. Without adequate ventilation, NEC Article 500, *Hazardous (Classified) Locations*, requires installation of explosion proof lighting fixtures and receptacles.

31.5.2. Ventilation in battery charging rooms shall be sufficient to keep batteries and chargers from overheating and shall conform to applicable local codes and ordinances. Ventilation in battery charging rooms shall be sufficient to keep rooms or areas maintained between 68° F and 85° F, unless permitted by a TO or other appropriate guidance. Consult the installation Ground Safety office, BE, CE and Environmental Management office for guidance on ventilation requirements.

31.5.3. Vented lead-acid and vented nickel-cadmium (NICAD) battery rooms, shops or areas shall have their own ventilation systems. They cannot share a ventilation system. This ventilation system shall be either a natural or powered ventilation system, which must be able to disperse airborne contaminants from gassing batteries.

31.5.4. Floor fans with explosion-proof motors can help keep battery temperatures from rising above 120° F. Batteries shall never be operated, charged or discharged at temperatures above 120° F, if normal service life is expected.

### **31.6. Storage and Handling.**

#### 31.6.1. Chemical Spills and Environmental Issues.

31.6.1.1. Precautions shall be taken to prevent the electrolyte from spilling. Batteries shall not be laid on their side unless permitted by TO. Batteries shall not be transported without being properly secured with straps or other restraint devices.

31.6.1.2. BE shall provide instructions on how to flush and neutralize electrolyte spilled on workers. Spill control procedures shall be developed and coordinated with the installation Ground Safety office, BE, CE and Environmental Management office.

31.6.1.3. Dispose of waste batteries and fluids in a manner consistent with approved hazardous waste disposal procedures and applicable environmental regulations. Contact the installation Environmental Management office for waste disposal guidance.

31.6.2. Vented lead-acid and vented NICAD batteries shall be maintained and stored in separate rooms or areas. The battery shop supervisor shall ensure all visitors entering the battery shop receive a safety briefing on the hazards located in the battery room or area before entry is authorized. If maintenance is performed while visitors are in the battery shop, the visitors shall also wear required PPE as prescribed in paragraph [31.2.1](#).

31.6.3. Sealed lead-acid batteries and sealed NICAD batteries do not require a dedicated battery room or area, and can be charged in the same battery room or area as long as a five-foot minimum clearance is maintained between the different batteries. A sealed lead-acid battery can be charged in a dedicated NICAD battery shop as long as a minimum distance of five feet is maintained between the different battery chemistries.

31.6.4. The electrolyte in lead-acid batteries contains water. These batteries are subject to damage in freezing temperatures and shall be stored in temperature-controlled areas. Lower battery charges shall allow for freezing at higher temperatures.

31.6.5. Batteries of different chemistries shall be stored as directed by the installation Ground Safety office, BE, CE and Environmental Management office. Ensure NICAD and silver-zinc batteries are serviced in areas isolated from lead-acid batteries. Batteries of different chemistries must be kept at least five feet apart when charging, discharging or being serviced.

31.6.6. Batteries received during cold weather or which cannot be disposed of during warm weather, shall be stored in heated or protected storage areas (temperature-controlled) to avoid broken cases and/or contamination of storage areas from electrolyte spill caused by freezing or overheating.

31.6.7. Industrial motive power batteries vary widely in the number of cells, size, weight and configuration. Handling these batteries is different from handling automobile batteries and shall not be attempted without proper equipment. The battery weight is usually stamped on the steel tray near one of the lifting ears. The battery manufacturer shall be consulted if the weight of a battery is not known and it cannot be weighed.

### **31.7. Electrical.**

31.7.1. Electrical test equipment shall be de-energized prior to being disconnected from energized circuits or power sources unless specifically directed by the appropriate TO.

31.7.2. Receptacles and lighting switches shall be located outside the battery maintenance or storage area. Lighting fixtures shall be protected from physical damage by guards or isolation.

31.7.3. Flexible cords used for charging shall be suitable for the type of service used and approved for extra-hard usage. Connectors shall have a rating not less than the current-carrying capacity of the cord.

31.7.4. Refer to [Chapter 9, Jewelry](#), on the wear of jewelry and eyeglasses/safety goggles.

### **31.8. Installation and Care of Vehicle and Support Equipment Batteries.**

31.8.1. Proper installation and care of batteries shall help ensure maximum life and performance. Batteries shall always be installed in a level position to prevent leakage of electrolyte. Excessive tightening of hold-down brackets can distort or crack the battery case. Cable clamps shall not be pounded on battery terminals, but shall be spread until they can be seated properly. Battery housings shall be free of dirt, moisture, corrosion and electrolyte to prevent self-discharge of the battery. When handling batteries, take precautions not to short the battery terminals together.

31.8.2. When removing a battery from a vehicle, the battery ground cable shall be disconnected **FIRST** to prevent the possibility of a spark. Upon reinstallation, the battery ground cable shall be installed and tightened **LAST** to prevent a short or spark and possible explosion. **Caution:** Some vehicles have two or more batteries, hooked in parallel, with one or more of the batteries remotely located. When the positive and negative cables are removed from one battery, the spark potential can still exist until the ground cable has been

removed from the other batteries. Personnel shall consult the appropriate TO to determine the number of batteries within the vehicle or equipment before maintenance is performed.

31.8.3. Use straps for lifting and carrying batteries. If straps cannot be used, exercise extreme caution when lifting to prevent worker strain, particularly when removing batteries installed in vehicles. When possible, use two people to handle batteries located in places that put a person in an awkward position or if the battery weighs more than 25 pounds.

31.8.4. Use mechanical lifting devices when handling batteries that cannot be safely handled by two people. Chain hoists that are used to handle batteries shall have a chain container or bucket to prevent the dangling chain from shorting out a battery.

31.8.5. When removing or replacing a battery, if there is a possibility of shorting out the battery, the battery terminals shall be covered with a non-conductive material, such as rubber or a piece of plywood.

31.8.6. Ensure tools and other metallic objects are kept away from the top of uncovered batteries and stored such that there is no possibility the tool will fall on the batteries.

31.8.7. Vent Cap Maintenance. Vent caps are designed to help keep the electrolyte or chemical paste within the battery and to keep dirt and other contaminants out. Vent caps shall be kept clean and firmly in place to avoid electrolyte spray, unless authorized by the applicable TO. 31.8.8. Vehicle Battery Jump-Starting. Battery jump-starting procedures shall only be accomplished by trained and qualified personnel. Follow TO guidance for proper jump-start procedures. If not available, follow manufacturer's guidance. If manufacturer's guidance is not available, follow steps in [Figure 31.1, Jump-Start Diagram](#). Workers shall identify the positive and negative terminals on both batteries. Improper connections may cause a large flaming spark and cause both batteries to explode. **Note:** Workers shall NOT connect positive (+) to negative (-) or negative (-) to positive (+) when jump-starting a vehicle. Jumper cables shall be grasped by the insulated handles and not by the bare metal ends. Additionally, workers shall not place their heads close to the battery when connecting jumper cables.

31.8.8. Exercise care when handling and storing batteries to prevent damage to the cases and to avoid electrolyte spills. **Caution:** Use care when handling broken battery cases to avoid acid-alkali burns from spilled electrolyte. When handling damaged batteries, follow specific equipment TO maintenance procedures for damaged batteries.

31.8.9. The battery in most industrial trucks also serves as a counterweight for the carried load. A replacement battery shall never be installed when its service weight is not within the range of battery weights marked on the truck nameplate. A lighter weight battery could change the truck's center of gravity and upset a loaded truck.

31.8.10. Batteries encased in steel trays have lifting holes for moving the battery. Lifting devices shall be designed so vertical lifting stresses are confined to the battery tray. Lifting batteries with two chains attached to a hoist at a single central point (to form a triangle with the battery) is unsafe. Not only does the safe load capacity of a double sling decrease as the angle increases, but the angular stress on the lifting ears of the battery may cause the chain hook to tear out of the steel battery case. A properly insulated spreader bar, or other device as permitted by the applicable TO or manufacturer's instructions, of ample size shall be used with any overhead hoist.

31.8.11. Before a battery is removed from a truck or is recharged in a truck, the electrical circuit of the truck shall be open, the battery unplugged from the truck and the brakes set or the wheels chocked. When moving a battery to a recharging location by overhead crane, the battery shall not be pulled or led by the battery cables. Personnel shall not stand under suspended loads.

31.8.12. When an enclosed/covered battery is charged, the cover of the steel tray of the battery shall always be kept open throughout the entire recharging period. If a battery remains in the truck for recharging, all battery compartment covers of the truck shall be kept open to help promote cooling of the battery and release of the gases freed during the recharging process. Excessive charging of batteries shall not be permitted, as hydrogen gas is generated. Batteries shall not be disassembled when taken directly from the charger or worked on immediately after being discharged under a heavy load. In either case, the battery may be off-gassing rapidly and may explode if an ignition source is present.

31.8.13. The contact surface of mating plugs or connectors on vehicles/equipment, batteries and chargers shall be maintained free of pitting or oxidation to prevent a high-resistance contact condition. Such a condition can result in a decrease of voltage delivered to the truck, with possible premature or sudden stopping of the vehicle. This could be a hazard if rapid withdrawal from a hazardous situation is required. Any work on battery plug contacts shall include precautions to avoid shorting out the battery.

31.8.14. Visual inspections are usually sufficient to determine the condition of contacts, which shall be cleaned or replaced if they show evidence of oxidation or pitting. Excessive heating of current-carrying parts indicates a poor electrical contact which shall be investigated.

### **31.9. Aircraft Battery and Electrical System Specific Requirements.**

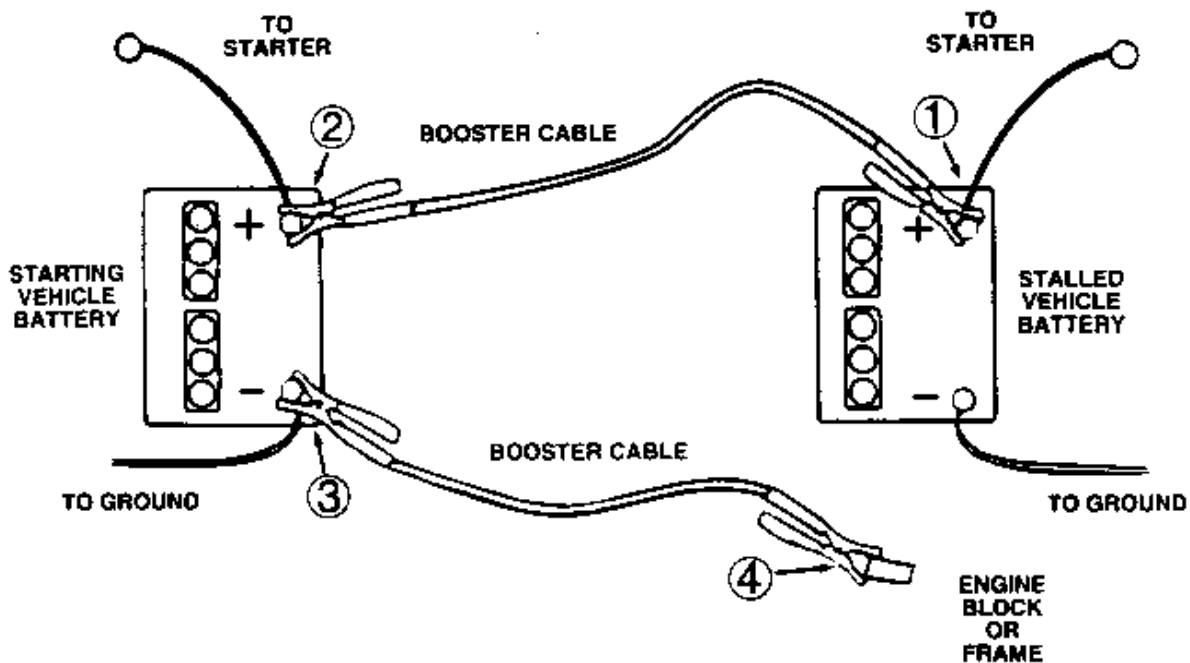
31.9.1. Aircraft Electrical System Maintenance. Only personnel qualified on aircraft battery and electrical systems shall perform maintenance on aircraft battery and electrical systems. Potential hazards involving aircraft electrical system maintenance include: overloading, poor electrical contacts and wiring short circuits. Specialists shall follow TO guidance whenever troubleshooting aircraft electrical systems. When the TO does not cover a specific troubleshooting procedure, reference the aircraft wiring schematics. The specialists shall exercise extreme caution and ensure each step of the TO is followed before proceeding to the next step.

31.9.2. Electrical systems shall be de-energized whenever possible. If the approved procedure requires work on an energized circuit, the sequence of steps shall be followed and other maintenance personnel must be informed of this action. If the system has been de-energized, procedures shall include a provision to effectively lockout or tagout the power source while work is in progress. An **AF Form 1492, Warning Tag**, authorized by AFI 21-101, *Aircraft and Equipment Maintenance Management*, shall be used IAW local procedures. Refer to **Chapter 29** for additional guidance.

31.9.3. Aircraft Battery Shop Requirements. Batteries shall never be charged while in the aircraft, unless permitted by the aircraft TO. Batteries being charged, battery chargers and their control equipment shall not be positioned in Class I locations as classified in NFPA 70,

*National Electrical Code, 511-3, Class 1 Locations, or defined in NEC 513-3, Wiring and Equipment in Class 1 Locations.* These locations include pits or depressions below floor level, areas from floor level up to 18 inches above the floor and within 5 feet of aircraft fuel vents, tanks or engines. Chargers shall be located in a separate building or in an area (as described in NEC 513-3) which is adequately ventilated and effectively separated from the hangar, shelter or nose dock by walls or partitions. Battery chargers shall carry at least one permanently affixed warning sign which reads: *Warning—Keep 25 Feet Clear of Aircraft Engines and Fuel Tank Areas.*

**Figure 31.1. Jump-Start Diagram.**



**31.10. Batteries – Maintenance, Handling and Storage Requirements Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

31.10.1. Is appropriate PPE used when charging, maintaining, removing or replacing batteries? Reference [31.2.1](#)

31.10.2. Is ANSI Z87.1 approved eye protection with side shields worn when servicing, jump-starting batteries or connecting or disconnecting a battery charger at the battery? Reference [31.2.1.1](#)

31.10.3. Do workers wear a face shield, splash resistant chemical goggles and chemical resistant gloves and apron when handling electrolyte? Reference [31.2.1.1](#)

31.10.4. Do workers wear acid resistant gloves, arm gauntlets, aprons, face protection and ANSI Z87.1 approved eye protection with side shields when handling vehicle or support

equipment batteries, or working in the battery room or maintenance areas? Reference [31.2.1.2](#)

31.10.5. Are battery and charging system electrical components and systems de-energized and isolated from other energized circuits or power sources, unless specifically directed by a TO, before being worked on? Reference [31.2.2](#)

31.10.6. Do exit doors of battery shops/rooms swing outwards? Reference [31.3.3](#)

31.10.7. Are warning signs posted inside and outside the battery room prohibiting smoking, sparks, flames and warning of electric shock and slipping hazards? Reference [31.3.9](#)

31.10.8. Are battery chargers turned off before connecting or disconnecting batteries? Reference [31.3.10.1](#)

31.10.9. Do workers ensure battery chargers are turned off and disconnected from the input power source before performing work on charger plug contacts? Reference [31.3.10.5](#)

31.10.10. Does management ensure vented lead-acid and vented NICAD battery rooms have their own separate ventilation systems? Reference [31.5.3](#)

31.10.11. When removing a battery from a vehicle, is the battery ground cable(s) disconnected first to prevent the possibility of a spark? Reference [31.8.2](#)

31.10.12. Are mechanical lifting devices used on batteries that cannot be safely handled by two people? Reference [31.8.4](#)

31.10.13. Is jump-starting of vehicles only accomplished by qualified personnel? Reference [31.8.8](#)

31.10.14. Do workers adhere to the **Note** against connecting positive (+) terminal to negative (-) terminal and vice versa when jump-starting a vehicle? Reference [31.8.8](#)

31.10.15. Do workers exercise care when handling broken battery cases to avoid the possibility of acid-alkali burns from spilled electrolyte? Reference [31.8.9](#)

31.10.16. Do workers ensure the electrical circuit of the vehicle/equipment is open, the battery is unplugged from the vehicle/equipment and the brakes set or wheels chocked, before a battery is removed or recharged in the vehicle/equipment? Reference [31.8.12](#)

31.10.17. Do workers ensure the cover of the steel battery tray is kept open throughout the recharging period when an enclosed/covered battery is charged? Reference [31.8.13](#)

31.10.18. Is the contact surface of mating plugs or connectors on vehicles/equipment, batteries and chargers maintained free of pitting or oxidation to prevent high-resistance contact? Reference [31.8.14](#)

31.10.19. Do specialists follow TO guidance when troubleshooting aircraft electrical systems? Reference [31.9.1](#)

31.10.20. Are batteries not charged while in the aircraft, except as permitted by the aircraft TO? Reference [31.9.3](#)

## Chapter 32

### MOTOR VEHICLE—OPERATIONS AND MAINTENANCE

#### 32.1. Specific Hazards.

32.1.1. Vehicle maintenance hazards include hazardous noise, compressed gases, pressurized air, toxic materials, flammable or explosive mists, particulates and vapors. During servicing of single piece rim wheels, pressurized air in the tire may release suddenly either by bead break-in or by the bead slipping over the rim flange. Brake and clutch assemblies on military vehicles may contain asbestos, which poses an inhalation hazard. Inhalation of mists and vapors from nearly all fuels, paints, solvents, thinners, cleaning chemicals, strippers and epoxies can be hazardous depending upon the material's toxic characteristics and amount and method of exposure. Further, many chemicals/solvents can cause skin irritations, burns and/or defatting of the skin. These chemicals/solvents can also be absorbed through the skin and cause internal damage. In addition, paints containing epoxy or polyurethanes can cause worker sensitization, which causes an allergic reaction to a given substance. Sensitivity usually occurs after exposure of a few days to a few months. After sensitivity is established, exposure to even a small amount of the sensitizing material will likely produce a severe reaction. Refer to AFI 90-821, *Hazard Communication*, and **Chapter 3**, *Physical Hazards*, for additional guidance and information on chemical exposures.

32.1.2. Compressed Gas Hazards. Compressed gases can be hazardous. Depending on the particular gas, there is a potential for simultaneous exposure to both chemical and mechanical hazards. Gases may be combustible, explosive, corrosive, poisonous, inert or a combination of hazards. If the gas is flammable, flash points lower than room temperature compounded by high rates of diffusion (which allow for fast permeation throughout the laboratory) present a danger of fire or explosion. High concentrations of seemingly "harmless" gases such as nitrogen can pose an asphyxiation hazard. Since compressed gases are contained in heavy, highly pressurized metal containers, the large amount of potential energy makes the cylinder a potential rocket or fragmentation bomb. Gas cylinders shall be properly identified, handled and secured. Vehicle maintenance personnel shall be aware of proper procedures for handling the various compressed gases, the cylinders containing the compressed gases, regulators or valves used to control gas flow, and associated piping systems. TO 42B5-1-2, *Gas Cylinders (Storage Type) Use, Handling and Maintenance*, provides gas cylinder precaution guidance.

32.1.3. Tool misuse or abuse and failure to properly use protective equipment can cause eye injuries, lacerations, punctures, burns, pinching and bruises. These mishaps result from:

32.1.3.1. Catching fingers, hair, necktie and other loose clothing or jewelry in moving pulleys and belts in the fan area.

32.1.3.2. Removing radiator cap on an overheated engine. **Caution:** Removing the radiator cap from a vehicle that has been operating (hot engine) is equally dangerous, i.e., fluids are hot and under pressure.

32.1.3.3. Working under vehicles without safety glasses or goggles, thus allowing rust or other debris to fall into the eyes.

32.1.3.4. Elevating a vehicle using jacks or ramps that are not resting on a firm, level surface.

32.1.3.5. Crawling under a vehicle supported only by a jack and not using jack stands for additional support.

32.1.3.6. Placing hands or feet directly under the wheel while changing a flat tire.

32.1.3.7. Peering directly into the throat of a carburetor when engine is running, resulting in face and hair burns or eye damage (or both) if engine backfires through the carburetor.

32.1.3.8. Leaving creepers on the floor.

32.1.3.9. Failing to properly deflate tires on split rim wheels before dismantling for repairs.

## **32.2. General Safety.**

32.2.1. Vehicle maintenance personnel shall not wear neckties, loose flowing clothing, loose sleeves or gloves which can become entangled when working on or around shop equipment or vehicles. Open footwear and canvas or cloth shoes without safety toes shall not be worn in maintenance shops. Long hair (including facial hair) or pony tails shall be secured to prevent becoming tangled when working around shop equipment or vehicles.

32.2.2. Compressed air shall not be used to clean dirt and dust from clothing or the body. Compressed air shall be regulated to less than 30 psi when used for cleaning and only when effective chip guarding is used. Appropriate eye protection shall be worn at all times while using compressed air.

32.2.3. Mechanics shall never place any part of their body directly under the wheels or tires of a vehicle on jacks without jack stands being in place .

32.2.4. Housekeeping. Good housekeeping is essential to safe operations. Vehicle maintenance operations are prone to oil spillage, debris on work surfaces and cleaning materials and tools lying around. Housekeeping requirements include:

32.2.4.1. Clean up spills promptly.

32.2.4.2. Perform motor vehicle maintenance activities, such as painting, welding, battery work and wheel and tire maintenance in separate parts of the shop, where one type of operation will not become hazardous to another.

32.2.4.3. Paint rooms, booths, etc., shall be kept clean with equipment stored in a proper and orderly manner.

32.2.4.4. Keep street clothing and protective clothing in separate lockers. Work clothing shall be stored in metal lockers, vented at top and bottom.

32.2.4.5. Approved self-closing metal waste containers shall be provided wherever rags or waste are impregnated with flammable or combustible materials and all such rags or waste deposited therein immediately after use. IAW AFPAM 32-7043, *Hazardous Waste Management Guide*, and 29 CFR 1910.107(g)(3), the contents of waste containers shall be disposed of at least once daily or at the end of each shift. Contact the installation Environmental Management office for waste disposal guidance.



32.2.4.6. All flammable and combustible materials stored in vehicle maintenance shops shall be kept in tightly covered metal containers IAW **Chapter 22**, *Flammables and Combustibles*. Refer to **Chapter 5**, *Housekeeping*, for additional guidance on housekeeping.

32.2.4.7. Floor surfaces shall be cleaned as often as necessary to maintain a safe walking surface. Personal protective equipment (PPE) shall be worn whenever toxic or hazardous cleaning materials are used. As a minimum, eye protection, nonslip rubber boots and rubber gloves shall be worn.

32.2.5. Where snow and ice conditions are present, personnel shall keep walkways, emergency exits and personnel and vehicle door openings free of snow and ice. If these areas become slippery, they shall be treated with sand, ashes, calcium chloride or other similar materials. Overhangs above personnel walkways or doorways and vehicle entrances and exits shall be kept free of ice or snow that could fall and injure personnel or damage equipment. Install icefall protection in hard to access areas. Snow removal equipment and other vehicles with large amounts of snow and ice accumulation on the vehicle shall be brought into the shop and snow or ice allowed to melt before repairs are started. If this is not practical, the vehicles shall be washed with water to remove snow and ice. Melted snow and ice deposits from each vehicle shall be washed down the floor drains before work is started or another vehicle is moved into the area. In areas where maintenance on vehicles during winter months causes constantly wet floors, the floor surface shall be covered with nonskid materials, if possible.

32.2.6. PPE shall be kept clean and, if not individually issued, shall be prominently displayed and/or stored in the immediate vicinity where its use is required.

32.2.7. The vehicle maintenance supervisor shall ensure all personnel are trained in the care and use of PPE and shall enforce its use.

32.2.8. **Table 32.1** lists frequently occurring operations where the use of PPE shall be locally evaluated. The list is not all inclusive and local supervisors may need to identify additional work situations. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

32.2.9. Respiratory protection is required if prolonged breathing of chemical vapors, mists or fumes is expected or if working in confined spaces when the atmosphere is oxygen deficient or hazardous. A supplied breathing air system with quick access emergency egress air supply may be needed. BE's OEH risk assessment identifies recommended controls.. Refer to paragraph **2.3**, ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, for additional guidance.

### **32.3. Occupational Health.**

32.3.1. Refer to paragraph **2.3** for additional guidance on hazardous noise or noise level surveys.

32.3.2. Stationary internal combustion engine-driven equipment shall not be operated inside buildings unless an exhaust system, approved by BE, is installed and used. When equipment is operated adjacent to buildings, the exhaust shall be directed away from the building.

Ventilation shall be adequate to provide fresh air and prevent accumulation of JP-4, gasoline, carbon monoxide and other hydrocarbon vapors. Refer to paragraph 32.6 for additional guidance on ventilation.

32.3.3. JP-4, JP-5, JP-8 and other jet engine fuels containing toxic aromatics shall be handled with the same precaution(s) as gasoline.

32.3.4. Personal Hygiene. IAW 29 CFR 1910.134(g)(1)(i)(A), personnel required to wear tight-fitting respiratory protection must be clean shaven so facial hair does not interfere with the face-piece seal of the respirator. Personnel shall keep hands and faces clean, change clothes when contaminated and keep hands and soiled objects out of mouth. Do not bring or consume food or drink in paint and dope shops. Personnel shall wash their hands prior to smoking or consuming food.

32.3.5. Manual Handling. Refer to **Chapter 4**, *Manual Material Handling and Lifting Techniques*, for additional information.

32.3.6. First Aid.

32.3.6.1. First aid kits shall be approved by base medical services. This item is required if work is over 3-4 minutes from the nearest medical facility. **Note:** OSHA's letter of interpretation for paragraph 1910.151(b) explains that a first aid kit is required if medical services are more than three to four minutes away.

32.3.6.2. If hydrocarbon fuels, such as gasoline, E85, B20, JP-4, JP-5 and JP-8, are splashed or spilled onto personnel, the following steps shall be taken:

32.3.6.2.1. Remove contaminated clothing as soon as possible and wash affected skin areas with soap and water. Launder contaminated clothing before wearing again. Do not place contaminated clothing in lockers or other confined spaces. Hang in a safe area away from fire and heat and allow to air dry.

32.3.6.2.2. If fuel is splashed into the eyes, immediately flush eyes with water continuously for at least 15 minutes, then seek immediate medical attention.

32.3.6.2.3. If fuels are swallowed, do not induce vomiting. Seek immediate medical attention.

32.3.7. Exposure to high concentrations of tetraethyl lead (TEL) shall be avoided. While use of leaded gasoline is no longer permitted in over the road vehicles, it may still be used in off-road vehicles, support equipment and in aircraft. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph 2.3 for additional guidance.

#### **32.4. Facility and Equipment Requirements for Vehicle Maintenance Operations.**

32.4.1. Proper layout, spacing and arrangement of equipment and machinery are essential. The installation Ground Safety office, Fire Emergency Services (FES) Flight, BE and CE shall coordinate on all layout plans. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, for additional guidance.

32.4.2. Only authorized shop personnel shall be allowed on shop floor. All other persons shall remain in designated areas so they do not interfere with shop operations. Vehicle

operators shall not approach mechanics on the floor to report discrepancies. When necessary, shop supervision shall authorize the operator's presence on the floor. Normal operator debriefings shall be a function of the Customer Service Center.

32.4.3. Vehicle operators and mechanics shall sound vehicle horns before backing and intermittently during the entire backing operation unless vehicles are equipped with backup alarms. Vehicle operators shall stop and sound horn prior to entering and leaving the maintenance shop. A spotter shall be posted when moving large equipment and vehicles backwards or in close quarters. The spotter shall be visible to the operator and shall not stand directly behind the vehicle. Roll-down or side sliding doors shall be completely opened whenever a vehicle enters or exits the vehicle maintenance shop .

32.4.4. Shop entrances and exits shall be clearly marked and lighted to prevent mishaps. Appropriate traffic signs shall be posted at entrances and exits. To minimize mishaps, a maximum speed limit of five (5) miles per hour shall be enforced in and around shops. The operator shall sound the vehicle horn prior to entering or exiting facilities to alert nearby personnel.

32.4.5. Door frames and edges of doorways used for vehicle entry and exit, and any obstruction (building support columns, etc.) within the vehicle maintenance area that could pose a hazard to vehicular traffic shall be highlighted. Highlighted or reflective areas shall be painted or marked, when possible, in contrasting colors with three (3) inch stripes, 3 inches apart and at least four (4) feet up from the ground. Reflectivity may be enhanced using paint with reflective beads or reflective tape.

32.4.6. Floor slopes, drains and oil/water separators in shops shall be constructed and maintained using guidance from the installation Environmental Management office. Oil separators shall be cleaned at a frequency determined by the installation Environmental Management office. The shop supervisor shall maintain the letter identifying the cleaning frequency and document compliance with the cleaning frequency. Drains shall not be connected to sanitary sewers, except the effluent from oil separators shall be connected to sanitary sewers.

32.4.7. Emergency Eyewash. Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes or body shall be provided within the work area for immediate emergency use. A water hose may not be used to meet the requirements in this reference. Eyes and skin shall be flushed/washed with water for 15 minutes prior to transport to medical care. Medical attention shall be obtained immediately after adequate flushing and drenching of the eyes or body has been accomplished. Supervisors may contact the installation Ground Safety office for assistance in determining how to meet the requirements of this reference. Refer to **Chapter 19, *Emergency Shower and Eyewash Units***, for additional guidance.

32.4.8. Catching, snagging and pulling of rings and jewelry may occur in and around vehicle maintenance operations. Because of this, controls shall be exercised over the wear of these and other items of jewelry with all such items removed before working on or around shop equipment or vehicles. Refer to **Chapter 9, *Jewelry***, for additional guidance.

32.4.9. Only one wheel per axle or one dual wheel assembly shall be jacked at one time.

32.4.10. No person outside the range of prompt and easy communication with other employees shall perform work with a risk of serious injury unless a second person is available to assist in an emergency.

32.4.11. No employee shall enter a confined space until the atmosphere has been evaluated and found safe to enter, or proper precautions, IAW **Chapter 23**, *Confined Spaces*, are taken.

32.4.12. Workers shall never use ramps on soft earth. They shall ensure the ramps rest on a firm, level surface.

32.4.13. Illumination. At least 50 foot-candles of illumination shall be maintained at a worker's position. Where necessary, additional lighting shall be supplied. The installation CE shall be consulted for further guidance on illumination levels. Additionally, the installation CE will conduct lighting surveys, if requested.

32.4.14. Machinery, Machine Guarding, Power Transmission Guarding and Shop Equipment. **Chapter 18**, *Machinery*, 29 CFR 1910 Subpart O, *Machinery and Machine Guarding*, and OSHA 3067, *Concepts and Techniques of Machine Safeguarding*, shall be followed when designing and maintaining machine and equipment guards.

32.4.14.1. Supervisors shall maintain technical data, to include applicable 48--series AFOSH standards, for all machinery and shop equipment in their area of responsibility.

32.4.14.2. Machinery and shop equipment shall be maintained and operated by qualified personnel.

32.4.14.3. Machine guarding and power transmission guarding not covered in AFOSH Standards shall be IAW 29 CFR 1910 Subpart O. All machinery guard and danger zones shall be conspicuously identified. Refer to OSHA 3067, *Concepts and Techniques of Machine Guarding*, for additional information and guidance.

32.4.14.4. No attempt shall be made to clean any part of a machine until all moving parts have come to a complete stop. Chips or other particles shall be removed by brushes or compressed air. If compressed air is used, the pressure at the discharge end of the air nozzle shall be less than 30 psi and effective chip guarding shall be used. Eye and/or face protection shall be worn while using compressed air to clean machines. Effective methods of preventing flying chips and particles are screens, barriers and protective cones attached to air nozzles. Compressed air shall not be used to blow chips or other debris from a worker's body or clothing. Some dusts such as lead, beryllium, cadmium, asbestos, etc., are extremely hazardous if inhaled, and cleaning these dust with compressed air shall not be done under any circumstances. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph **2.3** for additional guidance.

32.4.14.5. Air compressors shall be installed with easy access to all drains, valves and drives. A drain cock shall be provided at the lowest point of the tank to allow removal of water and metal particle accumulations. Air compressors shall be located outside the work area whenever possible to minimize noise exposure.

32.4.15. Hand Tools: Portable Powered and Nonpowered.

32.4.15.1. The first factor of hand tool safety is that the tools are of good quality and designed for the job at hand. All tools shall be kept in good repair and maintained by qualified personnel or removed from service.

32.4.15.2. Specific criteria unique to a certain tool shall be contained in the technical data requiring use of the tool. To determine required tools and equipment, consult TO 32-1-2, *Use of Hand Tools*. Allowance Standards (AS) 403, *General Purpose Tools*, and AS 457, *Vehicle Maintenance, Locomotive Maintenance, and Vehicle Operations*, and General Services Administration (GSA) catalogs shall be used to determine additional requirements necessary for a particular maintenance mission.

32.4.15.3. Portable powered tools shall conform to military specifications (Mil Specs), if available. If Mil Specs applicable to a portable powered tool have not been published, the procuring document shall include a requirement for the tool to meet or exceed requirements of 29 CFR 1910.243, *Guarding of Portable Powered Tools*, and 29 CFR 1910.304, *Electrical, Wiring Design and Protection*. Whenever possible, low noise power tools or tools with noise reduction attachments shall be utilized. Vibration dampening material/PPE shall be used to minimize fatigue when applicable. Consult AFOSH Standard 48-20 and if process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph 2.3 for additional guidance..

32.4.15.4. Tools, when not in use, shall be kept in suitable containers and not in clothing pockets. Power tools shall not be left running unattended on a stand, the floor or a vehicle.

**32.5. Fire Prevention.** The installation FES Flight shall be consulted for specific shop requirements.

32.5.1. Open Flames.

32.5.1.1. Flame-producing equipment shall not be used in refueler maintenance shops. Other vehicle maintenance shops may use flame-producing equipment if all safety procedures are followed and requirements in **Chapter 27, Welding, Cutting, and Brazing**, are complied with.

32.5.1.2. The welding shop shall be properly identified as such and approved by the installation FES Flight and Ground Safety office for open flame activities.

32.5.2. Low Flashpoint Solvents. Supervisors in charge of operations where solvents, lubricants or other flammable liquids are used shall avoid the use of low flashpoint solvents and try to use non-flammable solvents when practical. Other items to avoid in the presence of flammable or combustible liquids are open flames, open-element heaters, equipment not properly grounded and use of nonexplosion-proof electrical equipment.

32.5.3. Fuel ethanol fires, like all fires, shall be taken seriously. An E85 fuel fire shall be handled like a gasoline fire. Use a CO2 or dry chemical extinguisher that is marked B, C, BC or ABC. An alcohol-type or alcohol-resistant foam (ARF) may also be used to combat fuel ethanol fires. Never use water to control a fire involving high-concentration fuel ethanol such as E85.

**32.6. Ventilation.**

32.6.1. Control of Vehicle Exhaust.

### 32.6.1.1. Local Engine Exhaust Ventilation.

32.6.1.1.1. The vehicle maintenance work area shall have a suitable exhaust ventilation system either under the floor with readily available adapter hoses or an overhead system arranged so connecting hoses can be raised when not in use. In shop areas with under floor systems, adapters shall be used on equipment having vertical exhaust stacks to conduce the exhaust to the floor connections. Carbon monoxide (CO) concentration shall be monitored by BE and levels kept under occupational and environmental exposure limits (OEELs) listed in AFMAN 48-155. The facility owner/operator shall ensure a proper calibration schedule for the airborne gas analyzer.

32.6.1.1.2. Exhaust ducts shall be protected against mechanical damage. In-floor ducts shall be flush with the floor, level when closed and capable of withstanding vehicle and equipment traffic or the maintenance operation being performed. In-floor ducts shall be equipped with a fluid collection system that prevents drainage into the installation sanitary sewage system. This can be accomplished by sump pumps, a fuel and/or oil separator, a combination thereof, or by routing collected fluids to the shop's main drainage system. Overhead ducting shall be properly supported and located to avoid damage from moving vehicles and equipment.

32.6.1.1.3. When not in use, ducting shall be stowed in a way that prevents damage to the equipment and does not cause a hazard to personnel.

32.6.1.2. General Engine Exhaust Ventilation. Minimum general ventilation rates are specified in ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. This ventilation, either natural or mechanical, is in addition to local exhaust ventilation and is required to remove vehicle exhaust gases and fuel vapors.

32.6.2. The following operations or processes may produce airborne contaminants that exceed OEEL. The vehicle maintenance supervisor shall have these and similar operations evaluated by BE and shall document the results, along with any corrective actions taken.

32.6.2.1. Spray painting, spray cleaning, solvent cleaning or stripping operations.

32.6.2.2. Open surface tanks (dip tanks, etc.).

32.6.2.3. Welding, soldering, torch cutting and metalizing.

32.6.2.4. Abrasive blasting operations.

32.6.2.5. Metal cutting, grinding, buffing and polishing operations.

32.6.2.6. Machine shop operations (lathes, etc.).

32.6.2.7. Battery shops. Refer to **Chapter 31**, *Batteries – Maintenance, Handling and Storage Requirements*, for additional guidance.

32.6.2.8. Open tanks on refueler vehicle.

32.6.2.9. Brake lining discs.

32.6.2.10. Clutch linings.

32.6.3. IAW AFMAN 48-155, BE's OEH risk assessment identifies controls.

32.6.4. If ventilation system deficiencies exist, the vehicle maintenance supervisor shall use current BE OEH risk assessment to determine interim control measures needed.

32.6.5. Periodic Testing. IAW AFMAN 48-155, BE shall perform periodic evaluations. BE shall provide evaluation results to the vehicle maintenance supervisor. If a shop has a manometer or similar piece of equipment that measures the ventilation system's air flow, then only the monitoring data needs to be reviewed annually by BE and the shop supervisor.

### **32.7. Hazardous Materials Storage and Handling.**

#### 32.7.1. Spills.

32.7.1.1. Fuel Spills. All maintenance operations shall immediately cease if a fuel spill or severe petroleum product leak occurs in the vehicle maintenance area with drainage into a fuel separator. All affected personnel shall immediately evacuate the area and the installation FES Flight shall be notified. Report and handle all fuel spills IAW local contingency spill plans. No one except emergency and cleanup personnel shall be permitted to return to the area until the spill is cleaned up, diluted, evaporated or absorbed. Workers shall avoid any action that could provide an ignition source for fuel vapors. Fuel-saturated clothing shall be removed away from the spill area. Skin shall be thoroughly washed with soap and water if fuel is splashed or spilled onto it. Clothing shall be flushed with water in a well-ventilated area where the fuel and vapors will not pose a hazard. Clothing contaminated with fuel shall not be placed in lockers or other confined areas, since fuel vapors can be trapped in clothing. If vapors in clothing are ignited, the resulting fire is difficult to extinguish and could cause severe burns to the person involved.

32.7.1.2. Oil and Hydraulic Fluid Spills. The organization responsible for the spill shall contain/clean the spill using the applicable approved method, such as compound, oil and water absorbent (NSN 7920-00-269-1272 or equivalent). Contact the installation Environmental Management office for additional guidance.

32.7.1.3. Sanitary Sewers. Every effort shall be taken to preclude spilling petroleum products into sanitary sewers because this can adversely affect sewage treatment facilities. The installation FES Flight, Environmental Management office and BE shall be notified if spillage enters a sewer. If fuel spills are washed down floor drains, sufficient water shall be used to ensure all fuel has been flushed from the drainage system. Before using large amounts of water to flush the fuel, supervisors shall ensure proper containment measures are available to prevent an environmental pollution incident in a receiving stream.

32.7.1.4. Hazardous materials shall be removed and disposed of in compliance with published environmental regulations. Installation Environmental Management personnel shall be contacted for assistance. Refer to AFI 32-7080, *Pollution Prevention Program*, for additional guidance.

#### 32.7.2. Flammable Liquid Storage.

32.7.2.1. The storage, use and handling of flammable and combustible liquids shall be IAW [Chapter 22](#), *Flammables and Combustibles*, and installation FES Flight guidance.

Refer to ETL 03-4, *Alternate Fuels E85 and B20*, and US DOE, *Handbook for Handling, Storing, and Dispensing E85*, for additional guidance on alternative fuels. The facility manager shall retain a copy of the FES Flight guidance.

32.7.2.2. The type of cabinet, location, type of materials and quantities stored shall be coordinated with the installation FES Flight.

32.7.2.3. Cabinets storing flammables shall be conspicuously labeled “*FLAMMABLE - KEEP FIRE AWAY.*” For additional guidance, refer to paragraph [22.5.3](#) and 29 CFR 1910.106, *Flammable and Combustible Liquids*.

32.7.2.4. Fuels shall not be used to clean floors, clothing hands, or parts. Refer to paragraph [32.9.1.4](#) for additional guidance on cleaning parts with JP-8. Fuels or solvents shall not be used as cigarette lighter fluid.

**32.8. Electrical.** All electrical work, installation and wire capacities in vehicle maintenance facilities shall be IAW NFPA 70, *National Electrical Code*.

32.8.1. Only trained and qualified electricians shall install and maintain electrical equipment.

32.8.2. All personnel shall know the location and on-off operation of power control switches and stations in their work area. In addition, emphasis shall be placed on the need to maintain clear, unrestricted access to these controls at all times. This knowledge is essential to disengage electrical power to equipment if a fire or accidental electrical contact occurs. All panels and control switches shall identify what they control, as required by the NEC. Refer to paragraph [8.10.2](#) for additional information.

**32.9. Cleaning With Solvents.**

32.9.1. General Requirements.

32.9.1.1. A metal tank or container approved for flammable or combustible liquid shall be used to immerse articles or materials for cleaning, finishing, treating or similar processes whenever flammable or combustible cleaning materials are used. The metal tank or container shall be labeled with the contents. Care shall be taken to avoid solvent spillage.

32.9.1.2. Due to the exceptionally low flashpoint of some solvents used in cleaning operations, care shall be exercised in the correct selection of solvents. The lower the flashpoint, the higher the risk of ignition at low temperatures. The flashpoints of various solvents differ widely due to their chemical properties; these properties determine the flammability, thus the need to understand the difference between solvents. For example: There are four types of MIL-PRF 680B solvents. Although each group is closely related and somewhat similar, they are not identical and shall not be confused.

32.9.1.2.1. MIL-PRF 680B, Type I, has a flashpoint between 100°F and 140°F.

32.9.1.2.2. MIL-PRF 680B, Types II and IV, has a flashpoint between 141°F and 198°F, due to the higher flashpoint, is the recommended solvent for cleaning operations.

32.9.1.2.3. MIL-PRF 680B, Type III, is a recommended interim substitute for MIL-PRF 680 Types II and IV. There shall be no change in cleaning solvent from MIL-



PRF 680B Type II/Type III/Type IV or compound emulsion cleaning solvent (Mil Spec C-25179) without prior approval of the installation FES Flight, Ground Safety office and BE.

32.9.1.3. The following items shall not be used as cleaning solvents: acetone, benzene, carbon tetrachloride, gasoline, isopropyl alcohol, methanol, methyl ethyl ketone, naphtha (solvent), perchlorethylene, toluene, trichloroethylene or turpentine. Commercial cleaning solvents, such as "Safety Klean" or other non-flammable emulsion type cleaning liquids shall be considered for use whenever possible.

32.9.1.4. Flammable cleaning solvents, jet fuel or aviation gas (AVGAS) shall not be used to clean floors or clothing. JP-8 may be used for parts cleaning provided the requirements of paragraph [32.9.1.1](#) and any TO or manufacturer's restrictions are met.

32.9.1.5. Cleaning rooms shall be equipped with an adequate mechanical ventilation system and blowers and exhaust systems shall conform to NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and AFMAN 48-155 for additional guidance.

32.9.1.6. There shall be no open flames, spark-producing devices or heated surfaces having a temperature sufficient to ignite vapors in any vapor area.

32.9.1.7. There shall be no electrical equipment in the immediate vicinity of cleaning tanks subject to splashing or dripping of cleaning tank liquids, unless approved for use in that environment.

32.9.1.8. There shall be no open flames or spark-producing devices in any floor space outside a vapor area or within 20 feet thereof (not separated by tight partitions), except as specifically permitted in NFPA 86, *Standard for Ovens and Furnaces*. Areas in the vicinity of dip tanks shall be kept as clear of combustible stock as practical and shall be kept entirely free of combustible debris.

32.9.1.9. When waste or rags are used in connection with dipping operations, approved metal waste cans with self-closing lids, or as required by the installation Environmental Management (EM) office, shall be provided and all impregnated rags or waste shall be placed there immediately after use. The contents of waste cans shall be properly disposed of at least once daily and at the end of each shift in a manner consistent with local hazardous waste disposal procedures and applicable environmental regulations. Contact the installation EM office for disposal guidance.

32.9.1.10. Periodic inspection or tests of all dip tank facilities shall be made, including associated ventilation and fire protection equipment. Any defects shall be promptly corrected.

32.9.1.11. **DANGER - NO SMOKING** signs shall be conspicuously posted in the vicinity of dip tanks.

32.9.1.12. Areas in the vicinity of dip tanks shall have manual fire extinguishers suitable for combustible liquids. Protection systems shall be provided for tanks of 150 gallon capacity or more, or 10 square feet or more of liquid surface area. Refer to NFPA 34,

*Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*, for additional guidance.

### 32.9.2. Specific Requirements.

#### 32.9.2.1. Personal Protective Equipment (PPE).

32.9.2.1.1. When handling parts cleaned in PD 680 solvent, all personnel shall wear rubber gloves and keep the inside of gloves clean and dry. Rubber gloves and an apron shall be worn when acids are poured or dumped. ANSI Z87.1-compliant eye protection with side shields shall also be worn. Consult BE regarding the OEH risk assessment. Refer to paragraph 2.3 and Chapter 14, *Personal Protective Equipment (PPE)*, and ANSI Z87.1., *Occupational and Educational Personal Eye and Face Protective Devices*, for additional guidance.

32.9.2.1.2. Contact lens wearers shall wear appropriate eye and face protection. Contact lenses may trap toxic or dangerous substances that are harmful to the eye. Contact lenses decrease the effectiveness of emergency eyewash fountains and sometimes compound the severity of an injury. Soft contact lenses may absorb and be contaminated by chemicals, their vapors and/or fumes. **Note:** Workers shall advise supervisors if they wear contact lenses.

32.9.2.2. Vehicle Engine Cleaning. Starters, generators, alternators, distributors or magnetos shall be protected (covered with waterproof paper or plastic), so internal mechanisms are not exposed to water spray or cleaning agents. Remove the air cleaner and cover the carburetor throat or air intake with waterproof paper or plastic. Follow TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenance*, when cleaning installed engines.

32.9.2.2.1. Workers shall wear PPE listed in paragraph 32.9.2.1 when cleaning engines.

32.9.2.2.2. When cleaning tanks are located in an isolated room or facility, users shall obtain permission from the appropriate supervisor to use the tank. A buddy system shall be used, when required by management or safety, to ensure assistance is available if a mishap or emergency occurs.

32.9.2.3. Solvent Storage and Handling. Bulk solvents shall be stored in well-ventilated rooms, physically separated from other storage and operations. Caution and warning labels shall not be removed. Leaking drums shall be removed outdoors immediately so vapors or liquid will not collect and become a hazard. Contact the installation Environmental Management office for proper disposal guidelines for leaking drums. Drip pans shall not be used to catch spilled liquids unless these pans drain into a closed container. Approved containers with the solvent name clearly marked on the container shall be used. The BE shall help determine the adequacy of ventilation in areas where solvents will be used, prior to their use. Through BE's OEH risk assessment, appropriate ventilation, if any, is recommended. Refer to paragraph 2.3 for additional guidance.

## 32.10. Paint Shop.

32.10.1. General Requirements. To ensure safe and efficient operation, all painting activities shall be performed IAW accepted safety standards and **Chapter 28**, *Interior Spray Finishing*.

32.10.2. Specific Requirements.

32.10.2.1. Personal Protective Equipment. BE's OEH risk assessment outlines PPE, if required. Refer to paragraph **2.3** and **Chapter 14** for additional guidance.

32.10.2.2. Housekeeping. Good housekeeping is essential to safe paint shop operations. Paint rooms shall be kept clean and their equipment stored in an orderly manner.

32.10.2.3. Spray Booths. All high volume low pressure (HVLP) spraying shall be accomplished in a paint booth to minimize health, fire and explosion hazards. The walls of these booths shall be made of fire-resistant material that can be easily and frequently cleaned. Refer to **Chapter 28** and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for construction and installation of ventilating systems for paint-spraying operations.

32.10.2.3.1. Walls. Walls and floors of spray booths may be covered with thin paper bags or a cellophane bag having a thickness of .003 inches or less to protect them from paint deposits. Coverings shall be replaced frequently to prevent the accumulation of deposits. This paper shall be removed and disposed of IAW state and federal hazardous waste regulations. Contact the installation Environmental Management office for disposal guidelines. Soap-like, water-soluble materials or coatings which can be stripped, or other similar materials that can be easily washed down, may be used to protect the walls and floors of spray booths from paint accumulation, provided they do not pose an environmental pollution problem. Protective paper wall coatings shall not be used for dry or dusty paint substances that can be removed from the booths by adequate ventilation. Refer to NFPA 33, *Spray Application Using Flammable and Combustible Materials*, for additional guidance. **Note:** Paint facilities with overhead sprinklers shall have sprinkler heads covered with a paper bag to prevent paint overspray from clogging the heads.

32.10.2.3.2. Direction of Spray. Personnel shall always spray paint toward the exhaust portal to minimize accumulation of harmful mists and vapors in the booth and to minimize any potential health hazards from airborne contaminants. Spray guns shall never be pointed toward other personnel.

32.10.2.3.3. Hand Work. Adequate exhaust ventilation shall be provided in booths when hand spray painting. BE's OEH risk assessment identifies controls. Refer to paragraph **2.3** and **Chapter 14** for additional guidance. Care shall be taken to ensure hoses do not present a tripping hazard for personnel or are cut by passing vehicles. **Caution:** Some paints and additives contain toxic isocyanates. Ensure all recommendations and warnings listed on the container label are followed. Adequate NIOSH approved respiratory protection shall be worn during the entire paint process. Refer to 29 CFR 1910.134(d)(1)(ii). NIOSH recommends the employer provide the worker with the supplied-air respiratory protection whenever there is potential for exposure to isocyanate-containing compounds, including concentrations below the NIOSH recommended exposure level.

32.10.2.4. Ventilation. Mechanical ventilation shall be provided in all paint spray booths to prevent accumulation of flammable and injurious vapors. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and 29 CFR 1910.107, *Spray Finishing Using Flammable and Combustible Materials*, for additional guidance.

32.10.2.5. Interlocks. Electrical equipment for electrostatic hand spraying shall be interlocked with spray booth ventilation controls so spraying cannot be done unless the ventilation fans are operating. Refer to 29 CFR 1910.107 for additional guidance.

### **32.11. Air Compressors.**

#### 32.11.1. General Requirements.

32.11.1.1. Only qualified personnel shall repair or adjust pressure-regulating equipment.

32.11.1.2. All personnel operating air compressors shall be familiar with air compressor operating instructions.

#### 32.11.2. Specific Requirements.

32.11.2.1. All new air tanks and safety valves shall be constructed, installed and maintained IAW American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code, Section VIII*. The ASME code seal is permanently stamped on tanks meeting this criteria.

32.11.2.2. Air receivers shall be installed so all drains are easily accessible. Air receivers shall be installed with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces.

32.11.2.3. A drain pipe and valve shall be installed at the lowest point of the air receiver to remove accumulated oil and water. The drain valve shall be opened and the receiver completely drained daily to prevent accumulation of excessive amounts of liquid in the receiver. Air receivers shall be stenciled to reflect this requirement (exclude air receivers with automatic drains).

32.11.2.4. Every air receiver shall be equipped with a readily visible pressure indicating gauge and with one or more spring-loaded safety valves. The total relieving capacity of such valves shall prevent receiver pressure exceeding the maximum allowable working pressure by more than 10 percent.

32.11.2.5. No valve of any type shall be placed between the air receiver and its safety valve or valves.

32.11.2.6. All safety valves shall be tested at regular intervals by installation CE or designated representative to ensure the valves are operational, and will repair and replace the safety valves, if faulty/non-operational.

32.11.2.7. Installed compressed air line outlets shall have the delivered air pressure tagged or marked showing maximum working pressure.

32.11.2.8. Air hoses shall not be placed where they may create tripping hazards. All hoses shall be inspected to ensure they are properly connected to pipe outlets before use.

Hoses shall not be kinked to stop air flow. The control valve shall be used to turn off the air. Water hose type clamps or wire connections shall not be used to replace or repair broken fittings.

32.11.2.9. When used for approved cleaning, compressed air shall be regulated to less than 30 psi and only when effective chip guarding and eye protection is used. Compressed air shall not be routinely used to blow dry parts since this process can increase the inhalation hazards to workers.

32.11.2.10. Vehicles shall not be parked or left running near air intakes of compressors used to supply breathing air to painters.

32.11.3. Compressed Air. Compressed air is used in many shop operations: spray painting, tire inflation, fuel line cleaning and others. Compressed air can be used safely when handled with care and according to accepted safety standards. Eye protection shall be used at all times when cleaning with compressed air.

32.11.3.1. Personnel with cuts/lacerations on their hands or fingers shall not hold parts that have been washed in cleaning solvent if using compressed air to blow dry the parts. Personnel shall wear neoprene or rubber gloves to avoid problems from contact with solvents. Refer to paragraph [32.11.2.9](#) for additional guidance.

32.11.3.2. A vacuum system or water hose shall be used to remove dust, etc., from large surfaces.

32.11.3.3. Compressed air shall not be used to clean clothing or body parts.

32.11.3.4. Compressed air shall not be used to “spin-dry” or “air-dry” bearings, unless permitted by the applicable TO.

32.11.3.5. Never point compressed air toward other personnel.

32.11.3.6. Assume all brakes contain asbestos, unless proven otherwise. Personnel shall utilize the OSHA Wet Method, IAW 29 CFR 1910.1001, Appendix F, *Work Practices and Engineering Controls for Automotive Brake and Clutch Inspection, Disassembly, Repair and Assembly*. Cleaning materials shall be disposed of IAW local guidance. Consult the installation Environmental Management office for further disposal guidelines. Never use compressed air to clean clutch and brake assemblies.

## **32.12. Compressed Gas Cylinders.**

32.12.1. General Requirements. Vehicle maintenance shops use acetylene and oxygen in welding, R-12 and Freon as refrigerants, and liquid petroleum gas (butane-propane) as a motor vehicle fuel. These cylinders may contain pressures up to 3,600 psi. Cylinders are designed and constructed IAW Department of Transportation (DOT) regulations and bear the DOT identification. This stamping is generally found near the neck of the cylinder. Subsequent re-inspections shall be stamped in the same area. The cylinder contents shall be legibly marked on each cylinder in large letters. Refer to Military Standard (Mil Std) 101B, *DoD Color Code for Pipelines and Compressed Gas Cylinders*, 29 CFR 1910.101, *Compressed Gases*, 1910.102, *Acetylene*, 1910.103, *Hydrogen*, 1910.104, *Oxygen*, 1910.105, *Nitrous Oxide*, and applicable TOs for additional guidance. Non-government owned cylinders shall be tagged or otherwise marked to indicate cylinder contents. Guidance in

AFMAN 23-227(IP), *Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders*, shall be followed.

#### 32.12.2. Specific Requirements.

32.12.2.1. Inspection. Cylinders shall be inspected upon receipt at the installation or organization by a qualified supply inspector IAW AFMAN 23-227(IP) and Air Force 23-series (Supply) instructions. The user shall perform a similar inspection when receiving the cylinder from supply.

#### 32.12.2.2. Manual Handling:

32.12.2.2.1. Due to their shape and weight, most cylinders are difficult to handle manually. However, if such handling is necessary, they shall be tipped slightly and rolled on the bottom edge, not dragged or slid across the floor, whenever feasible. Mechanical handling generally requires carts in which cylinders are secured on specially constructed skids. The use of electromagnets or slings is not acceptable for mechanical handling. The insertion of bars through the protective caps may damage the valve assembly; for this reason, bars shall not be used. Cylinders shall not be handled without protective caps in place.

32.12.2.2.2. Cylinders shall not be dropped or permitted to strike each other. Cylinders shall not be used as rollers or for any purpose other than gas containers. Cuts or abrasions and corrosion on cylinders may seriously reduce their design strength and shall be identified to the supply inspector.

32.12.2.2.3. Acetylene cylinders shall never be placed on their sides or laid down for any reason.

#### 32.12.2.3. Use:

32.12.2.3.1. Before connecting compressed gas cylinders to a regulator or system outlet, cylinders shall be cleared of dust and particles (except cylinders containing hydrogen or toxic gases). The valve shall be pointed away from the body and other personnel, then opened slightly to blow out foreign material.

32.12.2.3.2. A compressed gas cylinder shall not be used without a pressure reducing regulator attached to the valve. If cylinders are in a manifold, the regulator shall be attached to the manifold header. Only regulators and pressure gauges designed for the specific gases shall be used. Workers shall not attempt to force connections that do not fit easily. If a leak develops between the cylinder and regulator, shut off the cylinder gas valve before attempting to tighten the regulator connection.

32.12.2.3.3. All compressed gas valves shall be opened slowly to prevent sudden pressure surges that may damage regulators. Oxygen valves shall be opened fully to gain the benefit of the sealing qualities of the double-seated valve. Valves on acetylene cylinders shall never be opened more than one-quarter turn. Regulator output pressure shall not exceed 10 psi gauge. The special tool recommended by the supplier shall be the only tool used for these valves. The tool shall be left on the valve. Compressed gas cylinder valves shall be closed when not in use.

32.12.2.3.4. When high and low pressure gases are used on the same cylinder cart, the hoses shall be different colors and the fittings on the ends of these hoses different types and sizes.

32.12.2.3.5. Oil or grease shall not be used to lubricate oxygen cylinder outlets or attachments. Oxygen cylinders and attachments shall be handled with oil-free hands, gloves and clothing.

32.12.2.4. Manifolds for Compressed Gas Cylinders. They shall be a type approved by the gas supplier or other reputable manufacturer for the gas being used. Connections shall be tested for tightness using an approved leak testing product or soap and water. **Caution:** Never use an open flame to test for leaks.

32.12.2.5. Storage.

32.12.2.5.1. Inside cylinder storage areas shall be free from excessive heat and kept clean. Flammable gases shall be stored separately from other gases and oxygen. Storage areas shall have good natural ventilation or mechanical ventilation shall be provided. Inside storage areas shall be identified with product identification.

32.12.2.5.2. Cylinders of one type shall not be mixed with cylinders of other types. Where a safe distance between flammable gases and oxygen is unattainable, partitions of fire resistant material shall be provided. Floors shall be level and of noncombustible construction.

32.12.2.5.3. Outside storage requires all the protection afforded by inside storage, plus a noncombustible canopy to protect cylinders from adverse weather and the sun.

32.12.2.5.4. All cylinders shall be stored upright, with the valve up. Empty cylinders shall be stored apart from full cylinders and the word *EMPTY* or *MT* chalked in large letters on them. The valves shall be closed and protective caps put in place. Storage areas shall be free of sources of ignition and smoking prohibited.

32.12.2.5.5. The storage area shall be provided with chains (or similar devices) to keep the cylinders from being knocked over. Cylinders shall not be secured around valves or caps. Areas near elevators, stairs or ramps shall be avoided for storage, because cylinders could easily be knocked down or damaged. Cylinders shall be stored so they are used in the order in which they are received.

32.12.2.5.6. In main areas of type *C* (combustible) constructed buildings other than storage buildings and in main areas of noncombustible constructed buildings, the amount of flammable gas stored shall be IAW Air Force 23-series (Supply) instructions. In cutoff rooms and enclosures within buildings of combustible construction or occupancy, the amount of gas shall be limited to that allowed by the installation FES Flight. Refer to [Table 32.2](#) for additional guidance.

### 32.13. Lifting Devices.

32.13.1. Inspection. Many lifting device problems can be detected prior to use if properly inspected. Periodic inspections shall be performed by qualified inspection or maintenance personnel. Test and certification of cranes and hoists shall be performed by experienced, qualified inspectors. Certification, inspection and test reports shall be available on the premises where the crane or hoist is located, in the supervisor's office or in a central

maintenance shop. Refer to **Chapter 35**, *Material Handling Equipment*, for additional inspection guidance.

32.13.2. Responsibilities. Responsibilities for periodic inspection, records, maintenance and test of lifting devices and separate lifting aids shall be as follows:

32.13.2.1. Permanently Installed Equipment (Real Property Installed Equipment [RPIE]). The installation CE shall be responsible for RPIE inspection requirements. RPIE includes installed equipment attached to and made part of buildings and structures, i.e., air conditioning/heating systems, but not movable equipment such as plant equipment.

32.13.2.2. Mobile Equipment. The vehicle maintenance officer and/or superintendent shall be responsible for mobile equipment inspection requirements.

32.13.2.3. Fixed Shop and Portable Equipment (Equipment Authorized Inventory Data [EAID]). The responsible activity, as described in AFMAN 23-110, *USAF Supply Manual (FOUO)*, shall be responsible for fixed shop and portable equipment inspection requirements.

32.13.2.4. Hoists and Cranes. Refer to specific technical data. If none is available, consult the installation CE or safety representatives. Refer to **Chapter 35**, *Material Handling Equipment*, for additional guidance.

32.13.3. Specific Requirements.

32.13.3.1. Hydraulic Vehicle Lifts.

32.13.3.1.1. Workers shall stand to one side of the vehicle as it is driven on or off the lift. The load shall rest squarely on the lift. The operator shall close the vehicle doors, hood and trunk and make sure there is no one inside the vehicle prior to raising it, except to facilitate repairs. This applies to vehicle lifts equipped with automatic locking devices that shall not allow the vehicle to descend with loss of power. The operator shall know the load limits of the lift and adapter and ensure it is not overloaded. The operator shall not lock the hoist controls in the open or shut position, but operate them manually. All vehicle lifts shall be equipped with a safety device to prevent accidental lowering. The device can be a simple mechanism such as a safety leg, which locks in a vertical position as the lift is raised, or a restricted orifice device, which permits controlled lowering during hydraulic failure. As an added safety feature, air-oil operated hydraulic lifts shall be equipped with a lock which prevents raising by air if the oil supply is low, i.e., a "low oil lock." This is a removable device which prevents compressed air entering the lift cylinder assembly. The arrangement prevents the plungers being raised above the oil supply in the air-oil reservoir.

32.13.3.1.2. Roll-on lifts shall be equipped with stop chocks to prevent the vehicle moving while the lift is hoisting, lowering or in the elevated position. Stop chocks shall be automatic (springing into position when the vehicle is on the lift).

32.13.3.1.3. All vehicle lifts shall be marked with the manufacturer name, lift capacity and date of installation. These markings shall be stamped or etched on a metal plate permanently attached to the lift in a position where it can be inspected.



32.13.3.1.4. All vehicle lifts shall be equipped with “dead man” controls, which automatically return to *NEUTRAL* or *OFF* when released by an operator. Controls shall be conveniently located near a lift, if feasible.

32.13.3.1.5. A lift shall not be used and an appropriate hazard warning tag shall be attached if it:

32.13.3.1.5.1. Jerks or jumps when raised.

32.13.3.1.5.2. Slowly settles downward after being raised.

32.13.3.1.5.3. Slowly rises, either when in use or when not in use.

32.13.3.1.5.4. Comes down very slowly.

32.13.3.1.5.5. Blows oil out of the exhaust line.

32.13.3.1.5.6. Leaks oil at the packing gland.

#### 32.13.3.2. Electric Vehicle Lifts.

32.13.3.2.1. Inspect the lift daily. Never operate it if it has damaged parts which render it unsafe. Make repairs with original equipment parts, if possible.

32.13.3.2.2. Operating controls are designed to close when released. Do not block open or override them.

32.13.3.2.3. Never overload the lift. The manufacturer’s rated capacity is shown on the lift nameplate.

32.13.3.2.4. Do not operate the lift if any safety devices are inoperative.

32.13.3.2.5. Allow only trained and authorized personnel to position the vehicle and operate the lift.

32.13.3.2.6. Never raise the vehicle with anyone inside, except to facilitate repairs. (This applies to vehicle lifts with automatic locking devices that do not allow the vehicle to descend with loss of power.) Do not allow anyone under the vehicle when raising or lowering the lift. When operating the lift, stand outside of it and keep hands clear of moving parts.

32.13.3.2.7. Always keep the lift area free of obstructions, grease, oil, trash and other debris.

32.13.3.2.8. Before driving the vehicle over the lift, position arms and supports to provide unobstructed clearance. Do not hit or run over lift arms, adapters or axle supports. This could damage the lift or vehicle.

32.13.3.2.9. Position the vehicle on the lift carefully. Position lift supports to contact at the vehicle manufacturer’s recommended lifting points. Raise lift until supports contact the vehicle. Check supports for secure contact with vehicle. Raise the lift to desired working height. **Caution:** Raise the lift high enough for the locking device to engage whenever someone is working under the vehicle.

32.13.3.2.10. Do not attempt to move the vehicle when the lift is off the ground.

- 32.13.3.2.11. With some vehicles, removal or installation of components may cause a critical shift in the center of gravity and result in raised vehicle instability. Refer to the vehicle manufacturer's service manual for recommended procedures when vehicle components are removed.
- 32.13.3.2.12. When performing maintenance on electrical lifts, ensure electrical power is disconnected unless required for checking unit operation.
- 32.13.3.2.13. Before lowering lift, ensure tool trays, stands, etc., are removed from under the vehicle and vicinity of the lift. Release locking devices before attempting to lower the lift.
- 32.13.3.2.14. Lower lift slowly.
- 32.13.3.2.15. Before removing vehicle from the lift area, position lift arms and supports to provide an unobstructed exit.
- 32.13.3.3. Jacks. Vehicle maintenance personnel shall not use hydraulic floor jacks, post jacks or mechanical jacks to support vehicles while repair is accomplished. The vehicle shall be blocked and placed on approved axle or frame stands before a repair operation is started.
- 32.13.3.3.1. The rated load of the jack shall be legibly and permanently marked in a prominent location by casting, stamping or other suitable means.
- 32.13.3.3.2. Shop personnel shall not use a leaking or faulty jack. Defective jacks shall be taken out of service immediately, tagged and not used until repaired.
- 32.13.3.3.3. Shop personnel shall exercise care in positioning jacks under vehicles, making sure the cap is properly located to preclude the jack slipping after the load is applied. A flat piece of wood, thick enough to withstand the load, may be placed between the jack cap and vehicle lift point to help prevent the jack cap from slipping.
- 32.13.3.3.4. All jacks shall be properly lubricated at regular intervals and only lubricants recommended by the manufacturer shall be used.
- 32.13.3.3.5. Improper jacking can cause serious injury or property damage. The following jacking procedures shall be used:
- 32.13.3.3.5.1. Equipment shall be properly chocked prior to jacking.
- 32.13.3.3.5.2. Jack stands shall be used any time equipment is jacked for maintenance.
- 32.13.3.3.5.3. Equipment shall be removed from jacks as soon as possible.
- 32.13.3.3.5.4. Equipment shall be jacked to the minimum height required for the particular task.
- 32.13.3.3.5.5. Personnel shall only remain under a jacked unit for the time required to place axle or frame stands for support.
- 32.13.3.3.5.6. Personnel shall not position any portion of themselves under the tire or wheel of jacked equipment.

32.13.3.3.5.7. Supervisors are responsible for ensuring jacks and jack stands of sufficient capacity are available and utilized.

32.13.3.3.5.8. Workers shall ensure placement of jack does not cause damage to the equipment.

32.13.3.3.5.9. Jacks and jack stands shall be inspected and maintained IAW equipment TOs. If no technical data exists, manufacturer's manuals may be used as long as it meets criteria in 29 CFR 1910, Subpart P, *Hand and Portable Powered Tools and Other Hand-Held Equipment*.

32.13.3.3.5.10. Defective jack stands shall be taken out of service immediately and tagged for disposition.

### **32.14. Wheel and Tire Maintenance.**

#### 32.14.1. Employee Training.

32.14.1.1. Extensive damage to equipment and serious injury to personnel may result from careless or improper demounting, mounting and inflation of tires on both single piece and multi-piece rim wheels. To ensure safety of equipment and personnel, all personnel involved in wheel dismantling or buildup operations shall be thoroughly familiar with applicable TOs, rim manuals, OSHA 3086 entitled "*Servicing Single-Piece and Multi-Piece Rim Wheels*," and this standard for the particular wheel involved. Precautions outlined in these publications shall be strictly adhered to when working on wheels and rims. As an added safety measure, procedures shall be reviewed prior to starting tire maintenance operations.

32.14.1.2. The supervisor shall ensure all workers who service multi-piece or single piece rim wheels are trained in the proper servicing techniques and practices applicable to the type of wheels being serviced. A mechanic's level of proficiency shall be established by demonstrating his or her familiarity with and ability to use the information contained in the charts, rim manuals, TOs and this standard. Refer to **Figure 32.1** for procedures for tubeless passenger car tires.

32.14.1.3. The supervisor shall ensure each worker demonstrates and maintains the ability to service rim wheels safely, including the following tasks:

32.14.1.3.1. Inspection of rim wheel components.

32.14.1.3.2. Mounting of tires, including inflation within a restraining device or other safeguard required by this chapter. Refer to **Figure 32.2** and **Figure 32.3** for additional guidance.

32.14.1.3.3. Use of the restraining device, barrier and other equipment required by this chapter.

32.14.1.3.4. Handling of rim wheels.

32.14.1.3.5. Inflation of tire when a rim wheel is mounted on the vehicle.

32.14.1.3.6. An understanding of the need to stand outside the trajectory shown in **Figure 32.2** and **Figure 32.4** during inflation of the tire and inspection of the tire following inflation, and installation and removal of rim wheels.

32.14.1.4. The supervisor shall evaluate each worker's ability to perform these tasks and to service rim wheels safely and shall provide additional training as necessary to ensure each worker maintains proficiency.

#### 32.14.2. Tire Servicing Equipment.

32.14.2.1. The supervisor shall ensure a restraining device for servicing multi-piece rim wheels is available and used.

32.14.2.2. When servicing single piece rim wheels, the worker shall use a restraining device or barrier, except where the rim wheel is bolted to the vehicle during inflation.

32.14.2.3. Supervisors shall ensure restraining devices and barriers meet the following requirements:

32.14.2.3.1. Each restraining device or barrier shall withstand the maximum force transferred to it during an explosive rim wheel separation occurring at 150 percent of maximum tire specification pressure for the type wheel being serviced.

32.14.2.3.2. Restraining devices and barriers shall prevent rim wheel components being thrown outside or beyond the device or barrier for any rim wheel positioned within the device.

32.14.2.3.3. A restraining device or barrier shall not contain a solid flat surface against which the rim wheel can lie or lean during inflation, such as the bed or table of a tire changing machine.

32.14.2.3.4. Restraining devices and barriers shall be visually inspected prior to each day's use and after any explosion or explosive separation of the rim wheel components. Any restraining device or barrier exhibiting damage such as the following defects shall be immediately removed from service:

32.14.2.3.4.1. Cracks at welds.

32.14.2.3.4.2. Cracked or broken components.

32.14.2.3.4.3. Bent or sprung components caused by mishandling, abuse, tire explosion or rim wheel separation.

32.14.2.3.4.4. Pitting of components due to excessive corrosion.

32.14.2.3.4.5. Rust or other structural damage.

32.14.2.3.4.6. Inoperative air pressure warning light or gauge.

32.14.2.3.4.7. Leaking, cracked or deteriorating hoses.

32.14.2.3.5. NDI techniques may be used to verify existence of cracks or other damage to welds whenever a tire/wheel failure occurs inside a restraining device, a weld is found to be severely rusted or whenever a weld's integrity is in doubt. **Note:** Accomplish a one-time NDI of all welds on locally manufactured restraining devices or commercially procured devices when weld integrity has not been documented.

32.14.2.3.6. Restraining devices or barriers removed from service and requiring structural repair, such as component replacement or re-welding, shall not be returned

to service until certified, by the manufacturer or a Registered Professional Engineer. This certification shall ensure the restraining device or barrier will withstand the maximum force transferred during a rim wheel separation at 150 percent of the maximum tire specification pressure for the rim wheel being serviced or as required by the applicable TO, whichever is greater.

32.14.2.4. The supervisor shall ensure a hose assembly consisting of the following components is used for inflating rim wheels:

32.14.2.4.1. A clip-on chuck.

32.14.2.4.2. A sufficient length of hose to allow the employee to stand outside the trajectory.

32.14.2.4.3. An in-line valve with a pressure gauge or an adjustable regulator.

32.14.2.5. An approved tire inflator cage appropriately sized for tires being serviced shall be used for inflating multi-piece wheels. A regulator gauge, shutoff valve, service hose and lock-on type chuck shall be used with the cage to control the air when inflating. In addition, a bleed valve shall be used to relieve pressure in the hose when the tire is filled. Refer to TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenance*, and [Figure 32.3](#) for additional guidance.

32.14.2.6. A current OSHA 3086, *Servicing Single-Piece and Multi-Piece Rim Wheels*, along with OSHA charts entitled “*Demounting and Mounting Procedures for Truck/Bus Tires*,” and “*Multi-piece Rim Matching Chart*,” shall be available and posted in the service area. To order OSHA instructions: OSHA Publications Office, U.S. Department of Labor Room N-3101, Washington, DC 20210.

32.14.2.7. A current rim manual and TO 36-1-191, containing instructions for the types of wheels being serviced, shall be available in the service area. Refer to [Figure 32.1](#) for further information on the referenced rim manual.

32.14.2.8. The supervisor shall ensure only tools recommended in the rim manual for the type of wheel being serviced are used to service rim wheels. **Warning:** Failure to observe precautions outlined in this standard may result in faulty positioning of the tire and/or rim parts, causing the assembly to burst with explosive force sufficient to cause serious physical injury or death.

32.14.3. Wheel Component Acceptability.

32.14.3.1. Multi-piece wheel components shall not be interchanged except as provided in the charts or applicable rim manual.

32.14.3.2. Multi-piece wheel components and single piece wheels shall be inspected prior to assembly. Any wheel part bent out of shape, pitted from corrosion, broken or cracked shall not be used and shall be rendered unserviceable and discarded. Damaged or leaky valves shall be replaced.

32.14.3.3. Rim flanges, rim gutters, rings, bead seating surfaces and bead areas of tires shall be free of any dirt, surface rust, scale or loose or flaked rubber build-up prior to mounting and inflation.

32.14.3.4. The size and type of the tire and wheel shall be checked for compatibility prior to assembly of the rim wheel.

32.14.4. Safe Operating Procedure – Multi-piece Rim Wheels. The supervisor shall establish a safe operating procedure for servicing multi-piece rim wheels and shall ensure workers are instructed in and follow that procedure. The procedure shall include, as a minimum, the following elements:

32.14.4.1. Tires shall be completely deflated by removing the valve core before a rim wheel is removed from the axle. If the axle and rim are secured by wedges and lug nuts, loosen the lug nuts out to the end of the stud, but DO NOT remove. Lightly tap on wedges to break them free. When all wedges are broken free, lug nuts can be removed. Wedges can become dangerous projectiles if these procedures are not followed. Workers shall use mechanical devices, such as dollies, to help them remove or mount large, heavy tires.

32.14.4.2. A nonflammable rubber lubricant shall be applied to bead and rim mating surfaces during assembly of the rim wheel and inflation of the tire, unless the wheel or tire manufacturer advises against its use. The rubber lubricants used shall not be flammable.

32.14.4.3. Tires mounted on multi-piece rims shall only be inflated when constrained by a restraining device or placed in a tire cage referenced in [Figure 32.3](#) Tires on multi-piece rims mounted on vehicles that are more than 20 percent under-inflated shall not be re-inflated until inspected by a qualified person and the tire certified safe to re-inflate. Safeguards, such as chains or remote control inflation systems, shall be used to encase the wheel and tire during the re-inflation process. Supervisors shall ensure no personnel are in the trajectory area during tire re-inflation. Heat shall not be applied to a multi-piece rim with a tire mounted on it. **Exception:** After the tire is completely deflated, the lug nuts may be heated briefly to facilitate their removal.

32.14.5. Safe Operating Procedure — Single Piece Rim Wheels. The supervisor shall establish a safe operating procedure for servicing single piece rim wheels and shall ensure workers are instructed in and follow that procedure. The procedure shall include as a minimum the following elements:

32.14.5.1. Tires shall be completely deflated by removing the valve core before demounting. Mechanical devices, such as dollies, shall be used to mount or remove large, heavy tires.

32.14.5.2. Mounting and demounting of tire shall be performed only from the narrow ledge side of wheel. Care shall be taken to avoid damage to tire beads while mounting tires on wheels. Tires shall be mounted only on compatible wheels of matching bead diameter.

32.14.5.3. A nonflammable rubber lubricant shall be applied to bead and wheel mating surfaces before assembly of the rim wheel and inflation of tire.

32.14.5.4. If a bead expander is used to seat the beads, it shall be removed before the valve core is installed and before the tire is inflated to more than 10 psi.

32.14.5.5. Tires may be inflated above 10 psi only when contained within a restraining device, positioned behind a barrier or bolted on the vehicle with lug nuts fully tightened. Tires shall never be serviced above the pressure stamped on the tire sidewall, unless the manufacturer recommends a higher pressure.

32.14.5.6. When inflating a tire, workers shall not place a rim wheel where it will rest against or within one foot of any flat solid surface, as measured from the sidewall. **Exception:** Hold-down components of a restraining device may be placed within one foot of the sidewall.

32.14.5.7. Tires shall not be inflated to more than their recommended operating pressure. The proper tire inflation pressure, tire size and load range can be found on the vehicle information/data plates or stenciled on the door jamb/glove box or as specified in the Dash-1 TO or owner's manual. If this information is not available, TO 36-1-191, *Technical and Managerial Reference For Motor Vehicle Maintenance* or the *Tire and Rim Association Handbook*, shall be used to obtain the recommended tire pressure. Refer to paragraph [32.14.5.5](#) for additional guidance.

32.14.5.8. Workers shall stay out of the trajectory when inflating a tire. Refer to [Figure 32.2](#) and [Figure 32.4](#) for trajectory examples.

32.14.5.9. If the tire beads are not fully seated by the time the tire is inflated to its recommended pressure, the tire shall be deflated and rim wheel disassembled. The wheel and tire shall be rechecked for compatibility, re-lubricated, repositioned and then re-inflated IAW paragraphs [32.14.5.2](#) thru [32.14.5.7](#).

32.14.5.10. No heat shall be applied to a single piece wheel when a tire is mounted on it. **Exception:** After the tire is completely deflated, the lug nuts may be briefly heated to facilitate their removal.

32.14.5.11. Cracked, broken, bent or otherwise damaged wheels shall not be reworked, welded, brazed or otherwise heated, except as provided in paragraph [32.14.5.10](#)

32.14.5.12. High pressure air shall not be used to inflate tires.

32.14.5.13. Rims shall be inspected and maintained IAW the individual equipment manufacturer's rim manuals or TO 36-1-191. See [Figure 32.1](#) for additional information.

#### 32.14.6. Demounting, Mounting and Inflating All Types of Tires.

32.14.6.1. Personnel shall:

32.14.6.1.1. Respect the potential power and explosive force of air under pressure. Serious mishaps have resulted from lack of awareness of the explosive potential of compressed air. Respect it as you would an explosive!

32.14.6.1.2. Make sure all tools are in good condition – not damaged, dented or deformed.

32.14.6.1.3. Remove valve core and exhaust all air from the tire (or tires, in the case of a dual assembly), before demounting. Probe the valve stem with a wire as a final check to ensure the valve is not obstructed by a foreign material. **Caution:** Do not stand in front of valve opening, as dirt particles may be blown into eyes.

- 32.14.6.1.4. Block vehicle so it cannot roll forward or backward after it is lifted.
  - 32.14.6.1.5. Place large hardwood blocks under the jack, regardless of how hard or firm the ground appears.
  - 32.14.6.1.6. Place safety jack stands – or crib up with blocks – at an appropriate spot under the vehicle, in case the jack slips.
  - 32.14.6.1.7. Check rim diameter to ensure it exactly matches rim diameter molded on tire.
  - 32.14.6.1.8. Clean and inspect used rim parts thoroughly.
  - 32.14.6.1.9. Use new tubes and new flaps in new tires.
  - 32.14.6.1.10. Inspect inside of tire for loose cords, cuts, penetrating objects or other carcass damage. Tires that are damaged beyond simple repair shall be removed from service. Remove dirt, debris and liquids from inside of tire before tube is installed.
  - 32.14.6.1.11. Lubricate with approved rubber lubricant, such as thin vegetable oil or soap solution.
  - 32.14.6.1.12. Use a clip-on chuck and extension hose with remote control valve and pressure gauge, long enough to allow you to stand to one side – not in front of the assembly – during inflation.
  - 32.14.6.1.13. Center tire properly on rim before inflating.
  - 32.14.6.1.14. Securely lock wheel down or place assembly in safety cage or portable safety device before attempting to inflate tire to seat beads.
  - 32.14.6.1.15. Position the vehicle crane boom in the center of the hub prior to inflation of off-the-road tires in field service work.
  - 32.14.6.1.16. Check for proper flange and lock ring seating.
  - 32.14.6.1.17. Adjust air pressure to manufacturer's recommended cold operating pressure after beads have been seated.
  - 32.14.6.1.18. Inspect valve cores for proper air retention. Replace damaged or leaky cores.
- 32.14.6.2. Personnel shall not:
- 32.14.6.2.1. Work on tire and rim assemblies until they review applicable safety practices and procedures.
  - 32.14.6.2.2. Loosen lug nuts on dual equipment with split or multi-piece rims until all air is exhausted from both tires. A broken or cracked rim part under pressure may blow apart and seriously injure or kill if lugs are removed before air is exhausted.
  - 32.14.6.2.3. Apply heat or do repair work on an inflated tire, rim or wheel assembly. Heat can increase tire air pressure sufficient to burst the tire or rim.
  - 32.14.6.2.4. Re-inflate a tire that has been run flat or seriously under-inflated without demounting that tire and checking tire and tube for damage.



32.14.6.2.5. Mix rim parts of different manufacturers unless approved by those manufacturers.

32.14.6.2.6. Rework, weld, heat or braze rim parts. Always replace damaged parts with same size, type and make.

32.14.6.2.7. Reuse tubes or flaps that have buckled or creased.

32.14.6.2.8. Use a tube in a tire larger or smaller than that for which the tube was designed.

32.14.6.2.9. Inflate beyond recommended bead seating pressure.

32.14.6.2.10. Stand over tire when inflating.

### **32.15. Maintenance Operations.**

#### **32.15.1. Body Shops.**

32.15.1.1. Jagged edges of mangled fenders, decks and quarter panels can be razor sharp. Protective gloves shall be worn when handling them.

32.15.1.2. A full protective plastic face shield plus safety glasses or goggles shall be worn while cutting or grinding glass. If handling large sheets of glass, gloves shall be used for a better grip and to keep hands from being cut.

#### **32.15.2. Welding in Vehicle Maintenance Shops.**

##### **32.15.2.1. General Precautions.**

32.15.2.1.1. Inspect all equipment regularly. Equipment with worn, leaky or burned hoses or damaged cables and connections shall not be used.

32.15.2.1.2. Never weld or cut gas tanks, oil barrels or drums without first purging and inerting them.

32.15.2.1.3. Weld behind flame resistant screens or in booths to protect other workers from flying sparks and flash burns. Refer to [Chapter 27](#) for additional guidance.

32.15.2.1.4. Always provide adequate ventilation. Arrange work so air movement pulls fumes away from the breathing zone.

32.15.2.1.5. Wear clean, oil free, flame resistant clothing while welding. Wear protective gloves and apron (hearing protection may be required for some welding operations).

32.15.2.1.6. Wear special welder's goggles as specified in [Chapter 27](#) (a welding helmet may also be required).

32.15.2.1.7. Provide a suitable fire extinguisher and pails of sand in the vicinity of the welding area. Mount fire extinguishers (if space permits) on portable welding carts used in locations where adequate fire extinguishers are not available.

32.15.2.1.8. Always mark hot work either with a sign or with chalk on the work itself.

32.15.2.1.9. Store welding equipment securely when not in use.

32.15.2.1.10. Have welding tasks evaluated by BE to determine the need for (and type of) respiratory protection.

32.15.2.2. Gas Welding.

32.15.2.2.1. Store cylinders in areas that are isolated, protected, ventilated, dry and removed from any heat source.

32.15.2.2.2. Store oxygen cylinders and welding gas cylinders at least 20 feet apart or separate them with a flame resistant barrier at least 5 feet high when not connected for use.

32.15.2.2.3. Keep oxygen cylinders at least 35 feet away from oil, oil pits and grease.

32.15.2.2.4. Keep cylinder valve caps in place when cylinders are not connected for use.

32.15.2.2.5. Shut cylinder valves off tightly when not in use.

32.15.2.2.6. Do not use acetylene with the tank pressure less than 15 psi.

32.15.2.2.7. Always leave the shutoff wrench on the valve stem.

32.15.2.2.8. Secure all tanks with a chain or fire resistant strap.

32.15.2.2.9. Ensure cylinder contents are identified before use.

32.15.2.3. Electric Arc Welding.

32.15.2.3.1. Carefully spread out cables while performing work. Avoid placing cables in walkway areas to prevent tripping hazards.

32.15.2.3.2. Join ground and electrode cables with connectors designed for that purpose.

32.15.2.3.3. Do not allow splices in the cable within 10 feet of the electrode holder.

32.15.2.3.4. To avoid electrical shock, check all connections, ground the work piece, do not weld in wet locations and do not use wet machines until they are dry and tested.

32.15.2.3.5. Store electrode holders in a safe location away from objects which conduct electricity.

32.15.3. Mobile Maintenance. Vehicles used routinely for mobile maintenance shall include as part of their equipment: baking soda for neutralizing acid spills, adequate fire extinguishers, container of water and eye and/or face protection for use by individual performing vehicle jump start procedures. **Note:** In cold climate regions, effort shall be made to prevent container of water from freezing.

32.15.4. Air Conditioning Maintenance. Gas and liquid coolants used in automotive air conditioners shall be handled with care, especially those stored under pressure. Eye and face protection and gloves shall be worn while servicing or purging these systems.

32.15.5. Radiator Maintenance.

32.15.5.1. Never open a pressurized radiator while the engine is hot. Use eye protection and caution when boiling out radiators. The cleaning solutions contain caustic chemicals that will burn if splashed on the skin or face. Flush the skin with water if splashed.

32.15.5.2. Wear protective gloves when handling a damaged radiator because it may have jagged metal edges.

#### 32.15.6. Fuel Tank Repairs.

32.15.6.1. Vehicles with leaking fuel tanks shall be removed from the shop immediately. Ground the siphon tank and pump out remaining fuel into a safety can.

32.15.6.2. If the tank requires welding, cutting or soldering, clean out all fuel and fuel vapors. The best way to do this is by steam cleaning. Steam the tank, both inside and outside, for at least 10 minutes. Flush out the tank with hot water for five (5) minutes. Then dry the inside and outside thoroughly, using warm air. After cleaning, check for fuel odor and, if needed, repeat the cleaning process. Test the tank for vapors prior to any welding.

#### 32.15.7. Refueler Vehicle Maintenance Areas.

32.15.7.1. Open flames and spark-producing devices are prohibited within 50 feet of the refueling maintenance shop when a refueling vehicle is undergoing maintenance and fuel vapors are likely to be present. There shall be no smoking within 50 feet of a refueler maintenance building. Danger signs shall be posted in the immediate area and worded as follows: *NO OPEN FLAME OR IGNITION SOURCE BEYOND THIS POINT* or the nearest commercially available equivalent. Refer to [Chapter 36, Hydrocarbon Fuels](#), for additional guidance.

32.15.7.2. Static Grounding. Aircraft refuelers shall have a static ground system in serviceable condition. Refueling equipment in a refueler maintenance facility or undergoing maintenance shall be connected to a serviceable ground at all times, except when the vehicle is in motion. Refueling maintenance support equipment shall be grounded. Storage bins shall be grounded if located inside the maintenance bay. Ramp ground rods shall have resistance values of 10,000 ohms or less. These static grounds do not require retesting unless damaged or if the system has a deficiency. Any static ground which measures greater than 10,000 ohms shall be removed or replaced. Static ground test data shall be maintained by the installation CE. Fuel nozzle static grounding shall be IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. Only approved 75 amp ground clips, for example, National Stock Number (NSN) 5999-00-134-5844, shall be used IAW TO 00-25-172. Alligator clips shall not be used to ground or bond aircraft and support equipment. Only specified ground wire shall be used in the shop or on refueling equipment. Ground cables shall be inspected weekly for broken strands. Repaired or newly constructed grounding cable assemblies shall be checked for continuity. Refueling maintenance personnel shall check bonding devices on all aircraft refueling units and associated equipment to ensure proper bonding prior to use.

32.15.7.3. The supporting Air Force weather organization, IAW the weather support document, shall advise the Fuels Management Flight of adverse or mission-limiting weather, such as thunderstorms, lightning, strong winds, heavy rain, snow or freezing precipitation. All maintenance on fuel systems of fuel servicing vehicles shall cease work

conducted outside. The supporting Air Force weather organization shall advise the Fuels Service Center (FSC) when the adverse weather advisory is terminated. Refer to **Chapter 11, *Weather Safety***, for additional information on weather.

32.15.7.4. As an extra precaution, personnel shall ground themselves prior to entering a refueler maintenance shop. Several methods can be used to discharge static electricity from the body. If the facility or building is metal, it shall be grounded and bonded. Personnel can ground themselves by touching their hand to the bare metal. By touching their bare hand to the door knob they are grounded (if the door is metal and sufficiently bonded to the metal structure).

32.15.7.5. The NEC and NFPA codes provide guidance and/or requirements for electrical equipment and wiring in locations where fire or explosion hazards may exist due to flammable gases or vapors and flammable liquids. The classification used for flammable gases, vapors and liquids is Class I, Division 1 or 2, Group D and is used to design facilities and buildings. The Division 1 location is in areas below floor level (a pit or depression) and the Division 2 location is in areas up to 18 inches above the floor as defined in NEC Articles 511 and 513. This classification does not mean the building is a hazardous location or the working environment is a hazardous area at all times. Certain areas in the building may become hazardous when working on fuel systems, fuel leaks occur or excessive vapors exist due to venting. If the working environment has flammable vapors greater than 20 percent of the lower explosive limit (LEL), the operation shall be shut down until the vapors are removed to maintain a safe working environment.

32.15.7.6. Whenever major maintenance is required to the main tank, all fuel and fuel vapors shall be cleaned out from the tank pumping system and filter separator and the tank purged prior to any maintenance. Cleaning procedures shall comply with TO 36Y31-1-1, *Removal of Rust and Sediment from Fuel and Oil Servicing Truck and Trailer Tanks and Application of Coating, Interior, Fuel and Water Resistant*. Precautions outlined in the applicable TO of the equipment being serviced shall be followed.

32.15.7.7. When fuel filter elements are changed, old filters shall be disposed of IAW installation Environmental Management office regulations.

32.15.7.8. A minimum of two (2) persons, one qualified in the task to be performed and the other a safety observer to provide assistance, shall be available in the refueling maintenance site whenever repairs are done on a vehicle fuel system. For minor maintenance after duty hours, the Vehicle Flight Commander may waive, in writing, the two-person policy if all safety precautions are taken and a qualified 5-skill level mechanic does the work. **Note:** A vehicle operator for the type of equipment being repaired may be the second person. Refer to AFI 23-302, *Vehicle Management*, for additional guidance.

32.15.7.9. Personnel performing maintenance on fuel trucks shall not wear shoes with exposed nails or metal plates.

32.15.7.10. Clothing containing more than 65 percent nylon, rayon, wool or polyester shall not be worn as outer garments when working with/around low flash point fuels. Flak vests shall not be worn during aircraft fuel servicing operations or during fuel operations where low flashpoint vapors may be present. In all cases (i.e., servicing with any fuel), a worker wearing a flak vest will always ground or bond him or herself when approaching an aircraft and prior to beginning work. If no spark occurs during bonding or grounding, normal work may begin. However, if a spark does occur during bonding or grounding, the worker will ground or bond him or herself frequently during all work phases. **Note:** Commanders may authorize wear of body armor/flak vests and Gortex-type clothing in combat areas. Outer garments shall not be removed or put on in the work area. Matches or lighters shall not be handled or removed from pockets.

32.15.7.11. All tools used in the refueling maintenance shop shall be approved for such use.

32.15.7.12. Axle stands, rated at least 10 tons, shall be used for axle support on refuelers.

32.15.7.13. Hydraulic jacks, rated at least 10 tons, shall be used when lifting refueling vehicles.

#### 32.15.8. Refueler Maintenance Buildings.

32.15.8.1. An empty refueling vehicle containing fuel vapors is a potential bomb and shall be treated as such. Except under conditions listed below, no other vehicular equipment will be serviced or repaired in refueler maintenance shops when fuel servicing vehicles are present.

32.15.8.1.1. Vehicle(s) containing only JP-5, JP-8, JP-10 or other high flashpoint fuels may be serviced or repaired in refueler maintenance shops with fuel servicing vehicles present.

32.15.8.1.2. Vehicle(s) containing only JP-4, AV-gas, Mo-gas or other low flashpoint fuels may be serviced or repaired in refueler maintenance shops only if no other fuel servicing vehicles are present. **Note 1:** For remote/austere locations or where vehicle maintenance services are distant to the location where refueling vehicles are assigned, commanders may authorize minor maintenance (i.e., lubrication, oil and filter changes, headlight and tire changes, etc.) in facilities not designed for refueler maintenance if the refueler vehicle is used to transport and operates on only high flashpoint fuels (i.e., the refueler transports and operates only on JP-8). **Note 2:** While the exceptions provide commanders additional flexibility, organizations shall still perform and document an appropriate risk assessment prior to introducing other vehicles into a refueler maintenance facility or performing maintenance on refuelers in other than a refueler maintenance facility. Risk assessments shall be coordinated with the installation FES Flight and Ground Safety office.

32.15.8.1.3. Because of the large number of fueling vehicles and carts normally assigned, an AF installation shall have a separately sited maintenance and repair facility. It shall be physically separated from other inhabited structures and any other source of ignition by at least 50 feet. Due to space restrictions and the low number of fueling vehicles and carts normally assigned to an Air National Guard unit, a separately sited maintenance and repair facility, separated from other inhabited

- structures and any other source of ignition by at least 50 feet, is recommended. Refer to AFI 23-302, *Vehicle Management*, and AFI 32-1024, *Standard Facility Requirements*, for additional guidance.
- 32.15.8.2. The refueling maintenance shop should be located near the refueling vehicle parking area to minimize travel distance and help keep refuelers off installation streets.
- 32.15.8.3. The shop should be located so the installation FES Flight will have immediate and direct access on paved roads. One or two minutes saved in response time may mean the difference between saving or losing the facility.
- 32.15.8.4. Both external and internal earth grounds shall be provided for the refuelers and a lightning protection system provided for the structure.
- 32.15.8.5. Separate locker areas, washing areas and eating areas shall be provided for workers. Adequate PPE for exposure to liquid fuels and vapors shall be provided. Refer to AFI 23-302 and AFI 32-1024 for additional information.
- 32.15.8.6. The amount of space required for refueler maintenance areas is determined by the number of refueling vehicles assigned. Refer to AFI 32-1024 for specific requirements.
- 32.15.8.7. Contamination from floor drains is a potential fire, safety and health hazard. Floor drains shall be kept clean at all times. Solvent or fuel shall not be used to clean floor drains. Protective clothing such as goggles, rubber boots and gloves shall be worn during drain cleaning.
- 32.15.9. Vehicle Maintenance Repair Pits.
- 32.15.9.1. Vehicle repair pits shall be guarded. The type of guard used is dependent on the location, reason for the opening and frequency of use. Where railings are used, they shall be permanently attached leaving only one exposed side. The exposed side shall have a removable railing kept in place when not in use. It shall be painted yellow to designate caution.
- 32.15.9.2. A vertical barrier shall be placed at the floor level, along open edges of the pit, to prevent materials, tools, etc., from dropping and striking workers.
- 32.15.9.3. All pits equipped with steps shall have handrails and approved (NEC/NFPA) lighting. Steps shall be painted, coated or made with an approved nonskid material to prevent slippage.
- 32.15.9.4. Adequate explosion-proof lighting shall be installed in pits or portable explosion-proof extension lights furnished.
- 32.15.9.5. Pits shall be built with drains equipped with oil or grease traps, shall not be connected to sanitary sewers. In addition, local exhaust should be provided to remove vapors. Refer to BE's OEH risk assessment for additional guidance. Exhaust fans used in pit ventilation systems shall be suitable for use with fuel vapors, i.e., have explosion-proof motors and non-sparking blades IAW NEC/NFPA. Refer to paragraph 2.3 for additional guidance.

32.15.9.6. Pit contamination is a potential fire, safety and health hazard. Pits shall be cleaned regularly with soap and water or an approved caustic solution, but not flammable or combustible solvents. PPE, including goggles, rubber boots and gloves, shall be worn during pit cleaning.

32.15.9.7. To prevent accumulation of hazardous gases, the vehicle engine shall not be operated while a vehicle is positioned over a repair pit, unless required by manufacturer's instructions or TO.

**Table 32.1. PPE Requirements For Frequently Performed Vehicle Maintenance Operations Where PPE Is Required.**

<b>PPE Requirements For Frequently Performed Vehicle Maintenance Operations Where PPE Is Required</b>	
<b>Operation</b>	<b>PPE Type</b>
Battery Handling	Side and frontal eye protection
	Acid resistant gloves
	Arm gauntlets or extended length gloves
	Acid resistant apron
	Acid resistant shoes or boots (only when performing battery maintenance)
Body Shop	Gloves
	Eye protection and face shield. (See <b>Note</b> below.)
	Respiratory protection may be required during sanding operations - consult BE's OEH risk assessment
	Hearing protection
Brake Shop	Respiratory protection - consult BE's OEH risk assessment
Cleaning Tank (when processing parts in cleaning tank)	Eye protection
	Respiratory protection may be required - consult BE's OEH risk assessment
	Apron
	Gloves
	Boots
Compressed Air Cleaning	Eye protection and face shield. (See <b>Note</b> below.)
Machinery and Grinders	Eye protection and face shield. (See <b>Note</b> below.)
	Respiratory protection - consult BE's OEH risk assessment
Mobile Maintenance	Eye protection and face shield. (See <b>Note</b> below.)
	Gloves
Paint Shop	Protective clothing
	Respiratory protection - consult BE's OEH risk assessment
	Eye protection
	Rubber gloves
Radiator Shop (during boiling out	Eye protection

<b>PPE Requirements For Frequently Performed Vehicle Maintenance Operations Where PPE Is Required</b>	
<b>Operation</b>	<b>PPE Type</b>
operation)	Gloves
Refueler Vehicle Maintenance	Cotton/polyester uniform (50/50), JP-8 Coveralls
	Non-sparking safety shoes
	Respiratory protection may be required - consult BE's OEH risk assessment
Repair Pits	Eye protection
	Head protection
	Rubber boots
	Gloves as appropriate
Soldering	Vented goggles
	Face shield
	Head covering (when soldering overhead)
Tire Shop	Gloves
	Eye protection
	Foot protection
	Hearing protection
Welding	Eye protection and face shield. (See <b>Note</b> below.)
	Head protection (when welding overhead)
	Foot protection
	Flame resistant clothing
	Gloves
	Apron
	Welder's goggles or welding helmet (refer to <b>Chapter 27, Welding, Cutting and Brazing</b> , for lens shade requirements)
Respiratory protection (may not be required when adequate exhaust ventilation is used - consult BE's OEH risk assessment)	

**Note 1:** PPE listed above are the minimum requirements. Functional managers, Ground Safety office, BE, and **Chapter 14, Personal Protective Equipment (PPE)**, shall be consulted to determine specific PPE requirements for all Vehicle Maintenance Operations.

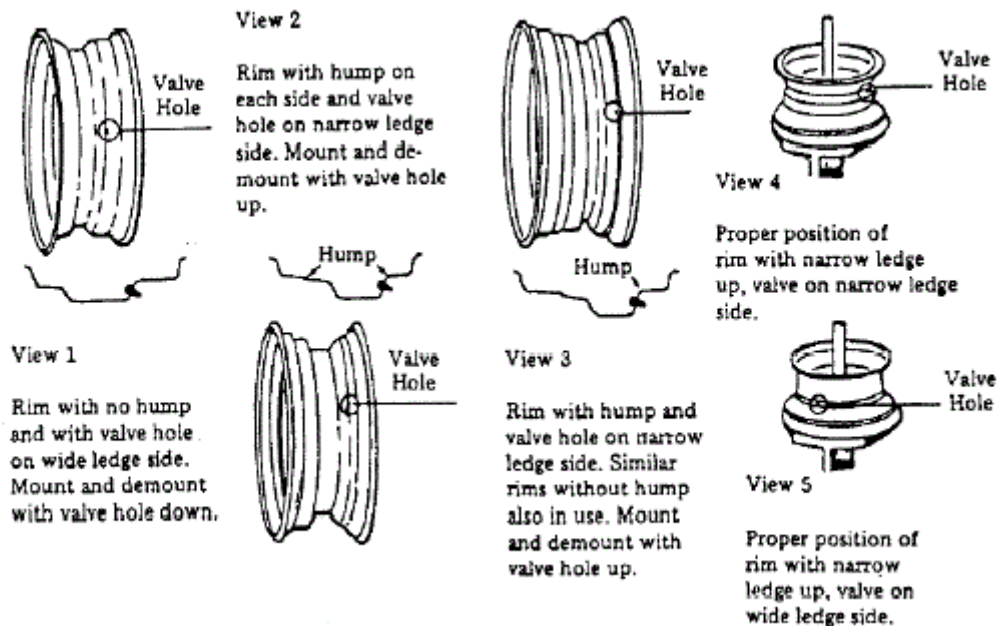
**Note 2:** Safety goggles, face shield, safety glasses (glasses with shatterproof lens and side protector shields) or a combination thereof, shall be worn during operations requiring use of power and/or hand tools where airborne fragments of the tool and/or work material may contact the eyes, face or neck. These operations include, but are not limited to, drilling, grinding, chipping, cutting (with chisel), sandblasting and scaling metals. Approved eye protection is mandatory while using stone or wire wheel grinders regardless of whether or not eye shields are installed on the grinders. However, face shields are not mandatory. Face shields are secondary protection and must be worn in conjunction with approved eye protection, i.e., goggles.



Table 32.2. Cylinder Data for Commonly Used Gases.

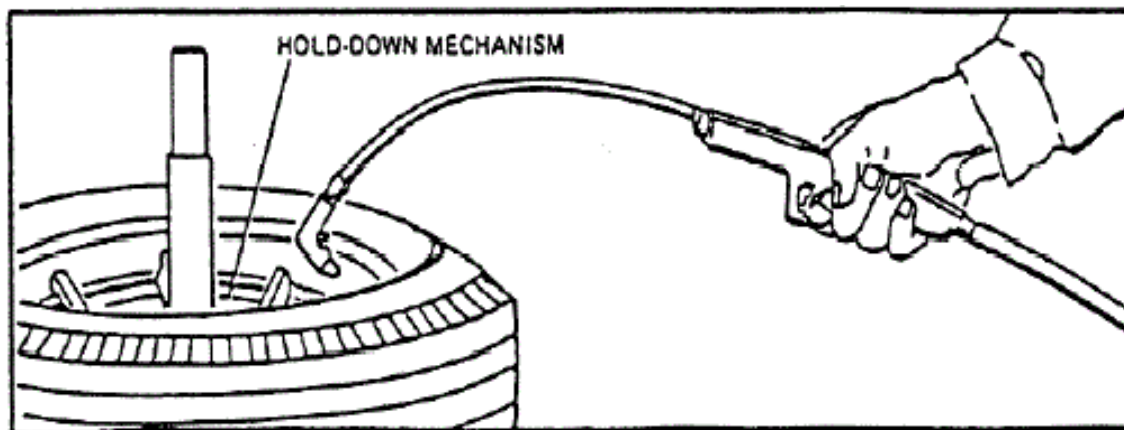
Cylinder Data for Commonly Used Gases						
Gas	Chemical Symbol	Usual Cylinder Pressure at 70°F Pressure (psi)	Capacity of Typical Cylinders		Calculated Density at 32°F Atmospheric	Fire Hazard
			Cu. Ft.	Lb.		
Acetylene	C <sub>2</sub> H <sub>2</sub>	250	300	22	0.91	Severe
Air, Compressed	...	1600 – 3600	200	15	1.0	None
Argon	A	1600 – 2000	200	21	1.38	None
Butane	C <sub>4</sub> H <sub>10</sub>	19	780	122	1.87	Severe
Carbon Dioxide	CO <sub>2</sub>	830	440	50	1.53	None
Helium	He	1600 – 2000	200	2.2	0.138	None
Hydrogen	H <sub>2</sub>	1600 – 2000	200	1.0	0.069	Severe
Nitrogen	N <sub>2</sub>	1600 – 3600	225	16	0.97	None
Oxygen	O <sub>2</sub>	1600 – 3000	245	20	1.11	Intensifies
Propane	C <sub>3</sub> H <sub>8</sub>	110	850	100	1.56	Severe

Figure 32.1. Effects of Rim Design On Proper Mounting Position.



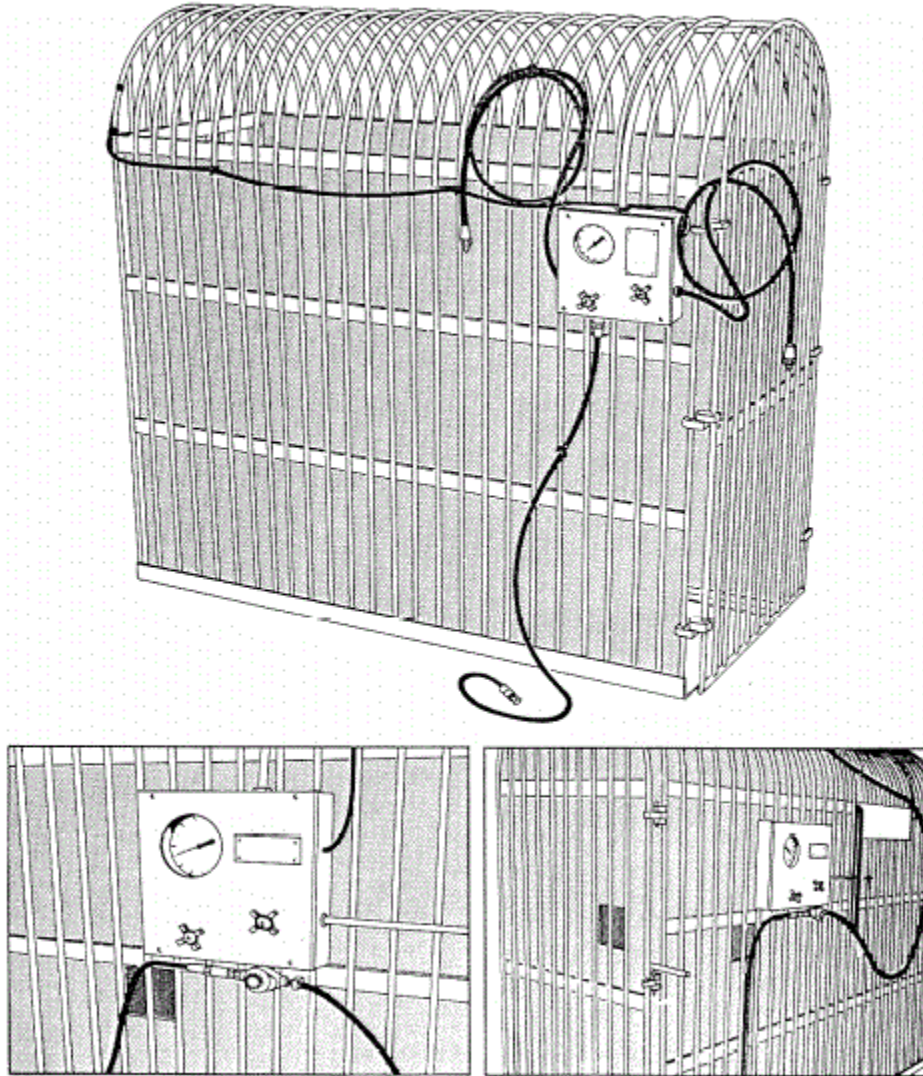
**IMPORTANT: Proper Procedures For Demounting and Mounting Tubeless Passenger Car Tires. In Both Mounting and Demounting, Always Start With the Narrow Bead Ledge.**

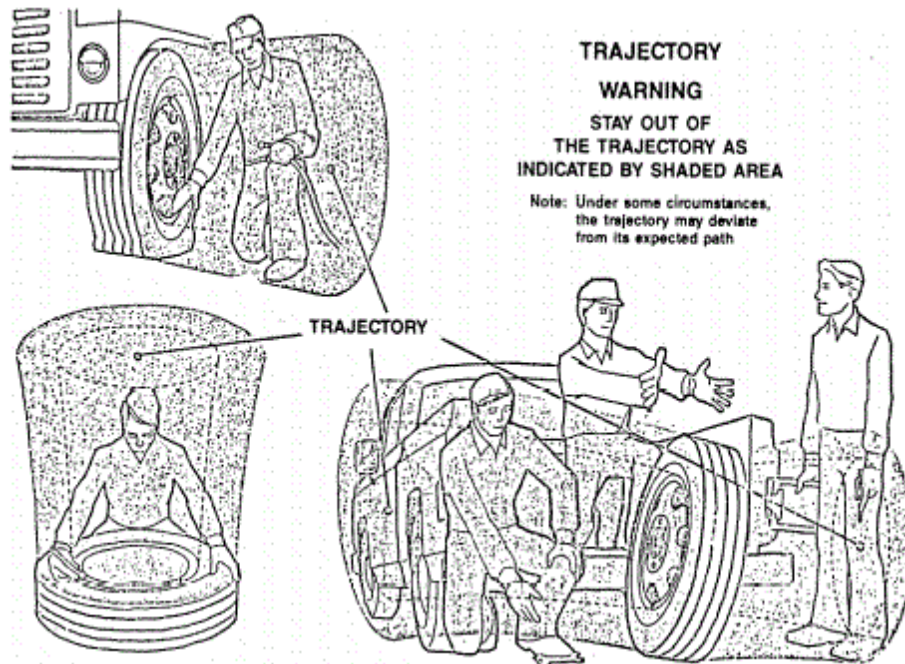
Figure 32.2. Using Extension Hose to Inflate a Tire.



**TIRE MOUNTING WARNING!** Failure to comply with these procedures may result in faulty positioning of tire rim parts and may cause assembly to burst with explosive force, sufficient to cause serious physical injury or death. Never mount or use damaged tires or rims.

Figure 32.3. Tire Inflator Cage.



**Figure 32.4. Trajectory for Rim and Tire Fragments.**

**32.16. Motor Vehicles – Operation and Maintenance Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

32.16.1. Are vehicle maintenance operations, such as painting, welding, battery work, and wheel and tire maintenance operations performed in separate parts of the facility to prevent operations of one kind from being hazardous to another? Reference [32.2.4.2](#)

32.16.2. Are vented lockers provided for workers' clothing? Reference [32.2.4.4](#)

32.16.3. Is the consumption of foods or drinks prohibited in paint shops? Reference [32.3.5](#)

32.16.4. Do vehicle operators and mechanics sound vehicle horns before backing, intermittently during backing (unless vehicle is equipped with backup alarms) and prior to entering or leaving the maintenance shop? Reference [32.4.3](#)

32.16.5. Do vehicle operators and mechanics ensure roll down or side sliding doors are completely opened before a vehicle enters or exits the maintenance shop? Reference [32.4.3](#)

32.16.6. Are emergency eyewash station(s) provided for workers who may come in contact with corrosive materials? Reference [32.4.7](#)

32.16.7. Do workers remove all items of jewelry before working on or around shop equipment or vehicles? Reference [32.4.8](#)

32.16.8. Where compressed air is used for cleaning, is the discharge end of the air line restricted to less than 30 psi? Reference [32.4.14.4](#)

- 32.16.9. Are tools not in use kept in suitable containers? Reference [32.4.15.4](#)
- 32.16.10. Is the use of flame-producing equipment prohibited in refueler maintenance shops? Reference [32.5.1.1](#)
- 32.16.11. Are workers prohibited from storing fuel-contaminated clothing in lockers or other confined areas? Reference [32.7.1.1](#)
- 32.16.12. Is the storage, use and handling of flammable and combustible liquids accomplished according to [Chapter 22](#) and local FES Flight requirements? Reference [32.7.2.1](#)
- 32.16.13. Is clear, unrestricted access maintained to on-off power control switches and stations? Reference [32.8.2](#)
- 32.16.14. Is the use of flammable liquid for cleaning shop floors prohibited? Reference [32.9.1.4](#)
- 32.16.15. Are all compressed gas cylinders stored upright with valves closed and protective caps in place? Reference [32.12.2.5.4](#)
- 32.16.16. Do operators using hydraulic vehicle lifts ensure vehicle doors, hood and trunk are closed, no one is inside the vehicle prior to lifting it? Reference [32.13.3.1.1](#)
- 32.16.17. Are workers prohibited from working under vehicles supported only on hydraulic floor jacks, post jacks or mechanical jacks? Reference [32.13.3.3](#)
- 32.16.18. Are current OSHA tire charts (such as OSHA 3086), rim manuals, and applicable TOs available to ensure extensive damage to equipment and serious or fatal injuries to personnel are prevented? Reference [32.14.1.1](#)
- 32.16.19. Are tires on multi-piece rim wheels completely deflated by removing the valve core before the rim wheel is removed from the axle? Reference [32.14.4.1](#)
- 32.16.20. When reinflation of tires installed on multi-piece rims is approved for tires already mounted on the vehicle, are safeguards used to encase the wheel and tire (chains, remote control inflation equipment, etc.)? Reference [32.14.4.3](#)
- 32.16.21. Are personnel out of the trajectory when inflating tires? Reference [32.14.5.8](#)
- 32.16.22. Is the loosening of lug nuts on dual wheels prohibited until all air is exhausted from both tires? Reference [32.14.6.2.2](#)
- 32.16.23. Are all gas tanks, oil barrels or drums purged and inerted before any welding or cutting is attempted? Reference [32.15.2.1.2](#)
- 32.16.24. Are hot pressurized radiators not opened while the engine is hot? Reference [32.15.5.1](#)
- 32.16.25. Are vehicles with leaking fuel tanks immediately removed from the maintenance shop? Reference [32.15.6.1](#)
- 32.16.26. Are open flame and spark-producing devices kept at least 50 feet from the refueling maintenance shop? Reference [32.15.7.1](#)
- 32.16.27. Are refueling vehicles and/or equipment grounded when in the refueler maintenance facility or when undergoing maintenance? Reference [32.15.7.2](#)

32.16.28. Are refueling vehicle tank pumping systems, filter separator and the tank cleaned out and purged prior to performing major maintenance on the main tank? Reference [32.15.7.6](#).

32.16.29. Is maintenance of fuel servicing vehicles prohibited in maintenance shops with other vehicular equipment? Reference [32.15.8.1](#)

32.16.30. Are vehicle maintenance repair pits guarded? Reference [32.15.9.1](#)

## Chapter 33

### COMPOSITE MATERIALS

**33.1. Hazards and Human Factors.** Composite materials (e.g., fiberglass, carbon fiber, Kevlar, etc.) are widely used in Air Force operations. These materials can present potentially serious health and safety hazards to personnel unless specific precautions are taken. Environmental, Safety and Occupational Health (ESOH) personnel must evaluate operations involving fabrication, repair and handling of composite materials to assure adequate precautions are taken to prevent injury or illness to personnel and/or damage to equipment. Guidance contained in this document refers to applicable TOs for using composite materials. JSAs, paragraph 1.5., *Job Safety Analysis*, AFI 90-901, *Operational Risk Management*, and AFPAM 90-902, *Operational Risk Management (ORM) Guidelines and Tools*, shall be observed and adhered to when working with composite materials. For additional information, the OSHA Technical Manual, Section III, Polymer Matrix Materials: Advanced Composites, is available at [http://www.osha.gov/dts/osta/otm/otm\\_iii/otm\\_iii\\_1.html](http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_1.html). Managers, supervisors and workers shall be aware of human factors that can lead to worker error, injury or adverse effects on their operations. Refer to **Chapter 2**, *Human Factors*, for additional guidance. Composite operations involving confined spaces shall follow guidance in **Chapter 23**, *Confined Spaces*.

### 33.2. Specific Responsibilities.

33.2.1. Functional Managers and Supervisors shall:

33.2.1.1. Ensure all personnel who work with or handle composite materials receive the appropriate level of training associated with required tasks.

33.2.1.2. Ensure workers performing composite repair and fabrication tasks, or handling or using hazardous materials, receive the appropriate level of hazard communication training IAW AFI 90-821, *Hazard Communication*.

33.2.1.3. Ensure Materials Safety Data Sheets (MSDS) are available for all hazardous materials used in composite work tasks.

33.2.1.4. Ensure workers handling and storing flammable or combustible chemicals are trained in fire prevention and protection. Refer to **Chapter 6**, *Fire Protection and Prevention*, for additional guidance.

33.2.1.5. Ensure appropriate spill and containment control procedures, and materials are readily available in areas where composite materials are stored, dispensed or used.

33.2.1.6. Ensure appropriate PPE is available and worn when handling composite materials and chemicals.

33.2.1.7. Ensure all hazardous composite materials and chemicals are authorized through the Hazardous Material Pharmacy.

33.2.1.8. Coordinate with the installation Environmental Management office to establish procedures for hazardous waste disposal.

### 33.3. General Requirements.

33.3.1. Composite materials require careful handling at all times. Many of the chemicals and materials used in composite fabrication and repairs pose serious health or fire hazards and must be used and handled with care. Air Force personnel must be made aware of the potential hazards associated with composite materials through appropriate training. Workers shall refer to the MSDS prior to starting any work when hazardous materials or chemicals are involved or needed for the process. As a minimum, job safety training shall include: need for and use of approved PPE; maintenance and care of PPE; safe chemical handling procedures; and emergency treatment practices in case of exposure, ingestion or inhalation of liquids, vapors or dusts from composite operations. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, and AFI 90-821, for additional guidance.

33.3.2. Training. All personnel who work with composite materials shall be trained on the hazardous properties of chemicals and materials used. This training shall be documented on the individual's **AF IMT 55**, *Employee Safety and Health Record*, IAW AFI 91-202, *The US Air Force Mishap Prevention Program*.

33.3.3. Hazard Communication. Workers performing composite repair and fabrication tasks shall receive the appropriate level of hazard communication training and shall ensure MSDS are available for all hazardous materials prior to performing work. Refer to AFI 90-821 for additional guidance.

33.3.4. Eyewash and Emergency Showers. Due to the potential for eye and skin contact with resins, catalysts and fibrous materials, eyewash and emergency shower facilities for composite repair shops shall be installed as required by **Chapter 19**, *Emergency Shower and Eyewash Units*. Coordinate with the installation Ground Safety office to determine the appropriate type and location.

33.3.5. Exposure Monitoring. Supervisors shall consult with BE to ensure workers who may be potentially exposed to airborne composite materials are monitored, and appropriate respiratory protection requirements are established IAW AFOSH Standard 48-137, *Respiratory Protection Program*. Additional protective equipment for workers handling composite materials shall be provided IAW **Chapter 14**. To minimize employee exposure to chemicals, unless otherwise directed, catalyze only enough resin for immediate use. **Note:** Do not exceed manufacturer's maximum batch size or a violent exothermic reaction may result.

33.3.6. Fire protection. All facilities and operating areas shall have fire protection appropriate for their fire hazard classification. Fire protection includes portable fire extinguishers, alarm systems, and evacuation and emergency plans. For additional details regarding applicable Air Force and NFPA fire protection requirements, consult with the installation Fire Emergency Services (FES) Flight. All fire protection equipment shall be inspected annually IAW **Chapter 6**.

33.3.7. Ventilation Requirements. Ventilation for all composite repair and fabrication shops, as well as locations where composites are installed and repaired (i.e., on-aircraft repairs) must be based upon the recommendations of BE's OEH risk assessment and installed IAW the manufacturer's instructions.



33.3.8. Handling Flammable and Combustible Liquids and Materials. Refer to **Chapter 22**, *Flammables and Combustibles*, regarding appropriate procedures for handling flammable and combustible materials.

33.3.9. Storage Of Composite Materials. Composite materials, including resins and catalysts, shall be stored IAW technical order requirements or, if not available, the manufacturer's instructions. If neither are available, storage shall be IAW locally developed guidance prepared in coordination with the installation FES Flight, Ground Safety office, BE and Environmental Management office. **Note:** Composite materials may be destroyed or damaged by improper storage conditions.

33.3.9.1. Storage Inside Buildings. When inside storage of composite materials is required, and the storage is incidental and not the primary purpose of the area, storage shall comply with **Chapter 22**, NFPA 30, *Flammable and Combustible Liquids Code*, or the manufacturer's suggested guidelines.

33.3.9.2. Outside Storage. **Table 22.5** and **22.6** provide maximum quantities and separation criteria for outside storage of flammable and combustible liquids. Some chemicals used in composite operations are toxic or pose other environmental hazards. To minimize the potential for environmental contamination, the installation Environmental Management office shall coordinate on the siting of all outside storage areas. Refer to **Chapter 22** and NFPA 30 for additional guidance and information.

33.3.10. Electrical Requirements for Flammable Vapor Areas. Facility wiring shall be installed and maintained IAW NFPA 70, *National Electrical Code*, Air Force Civil Engineer Fire Protection guidance and any specialized criteria necessary to maintain the safety of the operation. Design and installation shall be IAW UFC 3-600-01, *Fire Protection Engineering for Facilities*.

33.3.11. Powered and Non-powered Equipment and Tools Used Near Flammable and Combustible Materials. Tools and equipment used in composite operations shall be procured, installed and maintained such that they pose no ignition source to chemicals, chemical byproducts and finished products of the operation.

### **33.4. Specific Applications.**

33.4.1. Laboratories. All laboratories shall have fire protection appropriate for their fire hazard classification. For additional details regarding required fire protection requirements, refer to NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, and AFOOSH Standard 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories*. Guidelines for storage and handling of flammable and combustible materials are contained in paragraph **22.5.1**.

33.4.2. Military Exchanges, Commissaries and Associate Retail Stores. Facilities offering un-reacted composite materials (i.e., auto body fillers, fiberglass repair kits, etc.) shall ensure the materials are kept in their original containers and that all manufacturer's precautions and use information is provided to purchaser at time of sale. Damaged or leaking packages shall be removed from sale and disposed of properly. Contact the installation Environmental Management office for disposal guidelines. In rooms or areas accessible to the public, storage shall be limited to quantities needed for display and normal merchandising purposes.

For flammable and combustible materials, see paragraph [22.6](#), and NFPA 30, *Flammable and Combustible Liquids Code*.

**33.5. Hazardous Waste Disposal.** Supervisors shall coordinate with the installation Environmental Management office to establish a hazardous waste material list for their unit and establish procedures for hazardous waste disposal. Refer to AFI 32-7042, *Waste Management*, for additional guidance.

**33.6. Special Mishap Considerations.** Mishaps involving composite materials require special handling. Although burning composites may be extinguished, these materials may continue to smolder and outgas toxic vapors. The installation FES Flight, BE and Environmental Management office shall establish appropriate measures to handle mishaps involving composite materials. Special fire fighting and debris handling requirements are identified in TO 00-105E-9, *Aerospace Emergency Rescue and Mishap Response Information (Emergency Services)*. Refer to the Mishap Composite Awareness Computer Based Training, available at <https://hillnet.hill.af.mil/aco>, for additional guidance.

**33.7. Use of Composite Materials in New System Acquisition, and System and Process Modifications.** Introduction of composite materials by new system acquisition or modification of existing systems and processes shall be carefully reviewed for fire protection, ground safety, health (bioenvironmental concerns), and environmental impact prior to use by the appropriate Air Force Systems Program Office, Item Manager or Design/Process Engineer, and the technical data developing organization. These organizations shall ensure necessary safeguards are identified and in place before Air Force personnel are exposed to the equipment, system or process. When composite handling/repair/fabrication processes are turned over to a contractor, the contracting officer shall ensure associated Air Force fire, safety, health and environmental data is provided to the contractor.

**33.8. Composite Materials Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

33.8.1. Are all operations involving fabrication, repair and handling of composite materials evaluated by local ESOH personnel to assure adequate precautions are taken to prevent injury to personnel, damage to equipment or fire hazards? Reference [33.1](#)

33.8.2. Do all composite operations involving confined spaces follow guidance in [Chapter 23](#), *Confined Spaces*? Reference [33.1](#)

33.8.3. Are all workers and handlers of composite materials provided with the appropriate level of training associated with tasks and hazards related to the work environment? Reference [33.2.1.1](#)

33.8.4. Are MSDSs available for all hazardous materials used in composite work tasks? Reference [33.2.1.3](#)

- 33.8.5. Are appropriate spill and containment control procedures and materials readily available in areas where composite materials are stored, dispensed or used? Reference [33.2.1.5](#)
- 33.8.6. Is the appropriate PPE available and worn when handling composite materials and chemicals? Reference [33.2.1.6](#))
- 33.8.7. Are all personnel aware of the potential hazards associated with the use of composite materials they work with, or are exposed to? Reference [33.3.1](#)
- 33.8.8. Are all personnel who work with composite materials trained on the hazardous properties of chemicals and materials used, and is training documented IAW AFI 91-202? Reference [33.3.2](#)
- 33.8.9. Do all workers performing composite repair and fabrication tasks receive the appropriate level of hazard communication training? Reference [33.3.3](#)
- 33.8.10. Are eyewash and emergency shower facilities in composite repair shops installed as required by [Chapter 19, Emergency Shower and Eyewash Units](#)? Reference [33.3.4](#)
- 33.8.11. Do employees catalyze only enough resin for immediate use, unless otherwise directed? Reference [33.3.5](#)
- 33.8.12. Is the ventilation for all composite repair and fabrication shops, as well as locations where composites are installed and repaired (i.e., on-aircraft repairs) based upon the recommendations of BE? Reference [33.3.7](#)
- 33.8.13. Are composite materials, including resins and catalysts, stored IAW technical order requirements or, if not available, the manufacturer's instructions? Reference [33.3.9](#)
- 33.8.14. Are tools and equipment used in composite operations procured, installed and maintained such that they pose no ignition source to chemicals, chemical byproducts and finished products of the operation? Reference [33.3.11](#)
- 33.8.15. Do laboratories which use composite materials have fire protection appropriate for their respective fire hazard classification? Reference [33.4.1](#)
- 33.8.16. Do facilities offering unreacted composite materials (i.e., auto body fillers, fiberglass repair kits, etc.) ensure the materials are kept in their original containers and that all manufacturer's precaution and usage information is provided to purchaser at time of sale? Reference [33.4.2](#))
- 33.8.17. Do supervisors coordinate with the installation Environmental Management office to establish a hazardous waste material list for their unit and establish procedures for hazardous waste disposal? Reference [33.5](#)
- 33.8.18. Has the installation FES Flight, Ground Safety office, BE and Environmental Management office established appropriate measures to handle mishaps involving composite materials? Reference [33.6](#)
- 33.8.19. Do organizations developing, acquiring, modifying or using composite materials ensure necessary safeguards are identified and in place before AF personnel are exposed to the equipment, system or process? Reference [33.7](#)

33.8.20. When composite handling/repair/fabrication processes are turned over to a contractor, does the contracting officer ensure associated AF fire, safety, health and environmental data is provided to the contractor? Reference [33.7](#)

## Chapter 34

### PRECISION MEASUREMENT EQUIPMENT LABORATORY (PMEL)

#### 34.1. General Information.

34.1.1. Housekeeping. A high standard of housekeeping is essential to safe operations in laboratories. Dry floors are essential to physical safety. Liquid spills on floors shall be immediately cleaned and dried to minimize the possibility of slipping and falling. In addition, wet floors provide a conductive surface which may cause electrical shock, injury or death. All work and storage areas shall be kept clean and free of unnecessary obstructions. Equipment and materials shall be stored in a safe and orderly manner. Refer to [Chapter 5](#), *Housekeeping*, for additional guidance and information.

34.1.2. Due to the inherent differences between C-E system maintenance and PMEL operations, guidance in [Chapter 30](#), *Communication Cable, Antenna and Communication Electronic (C-E) Systems*, shall not be used in PMEL operations.

34.1.3. PPE Requirements. [Table 34.1](#) contains a partial list of PPE required for frequently performed PMEL operations. Consult applicable technical data and Material Safety Data Sheets (MSDS) for specific safety guidance for equipment and chemical use. Ground safety office and BE should be consulted for additional guidance.

34.1.3.1. Noise Suppression Devices. In noise hazard areas (85 dBA or greater), as determined by BE's OEH risk assessment, require all personnel to wear appropriate hearing protection. Refer to paragraphs [2.3](#) and [3.1.2.11](#) for additional guidance.

34.1.3.2. Laser Eye Protection (LEP). Appropriate LEP shall be worn when working with laser equipment. The installation Laser Safety Officer and BE's OEH risk assessment shall be consulted for the type of LEP required. Lasers shall be used in a controlled area and guarded by the required warning devices. Refer to AFOSH Standard 48-139, *Laser Radiation Protection Program*, for additional information.

34.1.3.3. Respiratory Protection. Inhalation of toxic levels of hazardous materials may cause adverse health effects. These exposures may be short-term or long-term (chronic), low-level or high level (acute), or both. Health effects from these exposures may vary from minor irritation and temporary illness to permanent organ damage, cancer and death. The proper use of approved respirators shall protect the wearer from toxic levels of airborne chemicals. AFOSH Standard 48-137, *Respiratory Protection Program*, provides guidance on the proper use and application of respiratory protection. BE's OEH risk assessment will identify RPP, if necessary. Refer to paragraph [2.3](#) and [Chapter 14](#) for additional guidance.

**34.2. Specific Hazards.** Personnel engaged in PMEL operations are exposed to several potential hazards. They include, but are not limited to, exposure to electrical and electromagnetic energy, hazardous chemicals/materials and flammable and combustible liquids and gases. PMEL personnel are also subject to physical injuries associated with on-site job environments. Particular attention must be given to protection against exposure to toxic chemicals and ionizing radiation, because the effects of any exposures are not always immediately apparent. Potential

health hazards can be managed by following guidance in this standard, adhering to proper work procedures, engineering controls and facility design, and by using proper PPE and clothing.

34.2.1. Electrical Hazards. All sources of electrical energy are potentially hazardous if proper safety precautions are not routinely followed. Personal injury from electric shock, arcing and resulting physical reactions may cause severe or fatal injuries. Safe electrical work practices, safe equipment and approved grounding procedures are essential to prevent electrical mishaps.

34.2.1.1. Electric Shock. Personal contact with any voltage source, alternating current (AC) or direct current (DC), capable of producing a current flow of 50 milliamperes or more through the body, can cause cardiac arrest. The severity of electric shock injury is determined by the amount of current flowing through the body, the path of current flow, the time of exposure and the body's physical condition. Additionally, tissue damage may occur to any part of the body exposed to high electrical energy.

34.2.1.2. Electric Arcing. When a metallic object, such as a tool, comes in contact or near contact with a high current source and ground, it becomes a conductor. An instantaneous surge of current will flow from the terminal through the tool to ground, resulting in a high intensity, high temperature arc. This arc can cause serious burns to the body and temporary or permanent blindness.

34.2.1.3. Physical Reaction to Electric Exposure. A natural reaction after making contact with an electric current or exposure to 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.

34.2.1.4. Personnel working on, with or near energized electrical circuits or equipment shall not wear rings, watches or other conductive objects. These items could increase shock risk, be the source of potentially severe burns or cause a short circuit if dropped into equipment. Metal-rimmed eyeglasses shall be secured by a non-metallic band or cord to prevent them from falling into energized circuits.

34.2.2. Radiation Hazards. Radiation is electromagnetic energy in the form of waves or particles that radiate into space from an emitting source. Hazardous radiation in PMEL operations may be classified as either ionizing radiation or non-ionizing radiation.

34.2.2.1. Ionizing Radiation. Ionization of matter occurs when an electron orbiting a stable atom is expelled. Because ions are charged particles, they are chemically more active than their electrically neutral forms. Atoms of all elements can become ionized, but only gamma rays, x-rays, alpha particles and beta particles have enough energy to create ions. Ionizing radiation can cause chemical changes in biological systems that may be cumulative and can be detrimental, and even fatal. Radioactive materials found in calibration sources, detection instrument check sources and electron tubes produce ionizing radiation. Calibration sources pose the greatest hazard because of the intensities involved and can become hazardous when broken or touched directly. Damage to the body can occur through exposure to gamma rays from open calibration sources and from unsealed radioactive materials if they are inhaled, ingested, passed through openings in the body or open wounds. Radioactive electron tubes may pose a hazard when broken or

stored in large quantities. Refer to AFI 48-148, *Ionizing Radiation Protection*, for guidance on ionizing radiation hazards and AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, for guidance on use of ionizing radiation detection devices.

34.2.2.2. Non-ionizing Radiation. Non-ionizing radiation is electromagnetic radiation that includes radio waves, microwaves, infrared light and visible light. Unlike ionizing radiation, non-ionizing radiation does not have enough photon energy to remove an electron from an atom. However, it can still be hazardous. High levels of radio frequency and microwave radiation can heat tissue, and if the temperature increase is high enough, can adversely affect health. Refer to 29 CFR 1910.97, *Nonionizing Radiation*, for additional guidance on the management of non-ionizing radiation hazards.

34.2.2.3. Laser Radiation. Laser energy presents a significant hazard to the eyes and skin under direct or reflected viewing conditions. The use of optical viewing aids, i.e., binoculars, telescopes, etc., can significantly increase the eye hazard from laser radiation, particularly when used to view a point source of radiation. The radiant energy entering the eye is increased by the magnifying power of the optical device. Refer to AFOSH Standard 48-139 for additional guidance and information on managing laser radiation hazards.

34.2.2.4. Radio Frequency Radiation (RFR). RFR produces heat in body tissues. Absorption by specific body organs depends upon the frequency and intensity of the RFR. It is possible for a person to absorb damaging amounts of RFR in deep tissue and organs with little or no sensation of skin heating. Refer to AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, for additional guidance and information on managing RFR hazards.

34.2.3. Chemical Hazards. PMEL operations use and may expose personnel to hazardous chemicals. OSHA defines a hazardous chemical as any chemical which is a physical or health hazard. This definition clearly applies to most of the chemicals typically used in PMEL operations. Refer to AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, for additional guidance and information on the management of hazards associated with chemical exposure.

34.2.3.1. Hydrazine. Hydrazine, a clear, oily liquid having an ammonia-like odor, is one of several common and potentially harmful chemicals used in PMEL operations. It can be absorbed through the skin, swallowed or inhaled. Because individual sensitivity to the odor may vary and prolonged exposure can overcome sensory recognition, the odor cannot be relied upon as a warning indicator. If exposed to high concentrations of hydrazine for short periods, individuals may experience dizziness, nausea or irritation of the eyes, nose, throat or lungs. A yellow discoloration of the skin and eyes may also be apparent. Liquid contact may cause skin burns. Very high concentrations may cause unconsciousness. Liver and kidney damage may occur if a worker is exposed to concentrations above the permissible exposure limits over a long period of time. All incidents of hydrazine overexposure as indicated by BE hydrazine sampling results and/or any symptoms mentioned above shall be reported IAW AFI 91-204, *Safety Investigations and Reports*. Emergency Power Unit (EPU) test sets and/or pressure gauges exposed to hydrazine during normal use or exercises shall be marked/identified to prevent accidental exposure or ventilation of gases.

34.2.3.2. Mercury. Liquid mercury is used in pressure and temperature measuring instruments. This liquid can be absorbed through the skin, swallowed or inhaled, but breathing the vapor is the most common cause of mercury poisoning. Mercury vaporizes at temperatures as low as 10°F. Since mercury vapors are colorless and odorless, they may be present anywhere mercury is used. When spilled, liquid mercury breaks up into tiny beads that lodge in cracks, mix with dust, and penetrate such porous materials as wood or tile. Exposures to high levels of mercury can cause acute poisoning characterized by a metallic taste, tightness and pain in the chest, difficulty breathing, fever, diarrhea and headaches. However, acute poisoning is rare. A more common condition is chronic poisoning, which is caused by long-term exposure to lower levels of mercury. Symptoms of chronic poisoning include tremors, emotional changes (e.g., mood swings, irritability, nervousness, excessive shyness), insomnia, decreased mental function, inflammation of the mouth and gums, increase in saliva, weakness, loss of appetite and weight, and impaired digestive and kidney functions. Workers shall be very cautious when working with or near mercury. Mercury can accumulate on working surfaces and cause a serious health hazard by clinging to clothing, especially knitted fabrics, and the soles of shoes, which can cause serious health hazards if inadvertently taken home.

34.2.3.2.1. All equipment containing mercury shall be properly maintained to prevent escape of mercury liquid or vapor. Containers of mercury shall be kept tightly capped to prevent vapors from escaping. Waste mercury or materials contaminated by mercury shall be placed in vapor-tight containers until disposal. Consult BE and Environmental Management office for local procedures for disposal of mercury-contaminated materials. A copy of these procedures shall be maintained by the PMEL shop supervisor. Areas where mercury is used shall be kept separate from other work areas and shall be restricted to those workers directly involved in the mercury operations. Carpets shall not be placed in areas where mercury is used. Exposure to mercury may be controlled through use of enclosed systems that isolate mercury processes, regular monitoring of the work environment, good housekeeping and good personal hygiene to prevent contamination of clothing, food and tobacco products. If mercury is spilled, contact BE and Environmental Management office for local clean-up procedures. Refer to TO 42C-1-18, *Control, Decontamination, and Disposal of Mercury*, for guidance on routine handling procedures.

34.2.3.3. Flux/Solder. The health hazard potential of any soldering operation depends on the types of filler metals, fluxes, coatings, cleaning agents, gases, and base metals used, and the method of exposure. It is important to know what types of chemicals and materials are in use. Electrical solder, such as resin core and lead alloy, is commonly used in PMEL operations. Exposure to lead fumes or ingestion of lead residue can present a severe hazard. Repeated exposures can result in a gradual accumulation of lead absorbed into the bloodstream and stored in bones and tissues. Liquid Solder Flux is commonly used in PMEL operations. It may be flammable and is toxic to skin, eyes and respiratory tract. Avoid skin and eye contact and all sources of ignition. Adequate ventilation shall be provided when using flux and solder to prevent inhalation of fumes and vapors. Refer to [Chapter 27](#), *Welding, Cutting, and Brazing*, and TO 00-25-234, *General Shop Practice*



*Requirements for the Repair, Maintenance, and Test of Electronic Equipment*, for additional guidance on proper soldering measures.

34.2.3.4. Solvents/Test Chemicals. Trichloroethylene, trichloroethane, trichlorotrifluoroethane and methylene chloride solvents are commonly used for cleaning PMEL equipment. Chemical hazards include skin irritations, burns, defatting of skin and irritating or harmful vapors. These solvents can be absorbed through the skin and may cause liver damage. Sodium hydroxide, ammonium hydroxide and ammonium chloride are commonly used oxygen test chemicals. Chemical hazards include skin irritations, burns and irritating or harmful vapors.

34.2.4. Compressed Gas Hazards. Many laboratory operations require compressed gases for analytical operations. Depending on the particular gas, there is a potential for simultaneous exposure to both chemical and mechanical hazards. Gases may be combustible, explosive, corrosive, poisonous, inert or a combination of hazards. If the gas is flammable, flash points lower than room temperature present a fire/explosion hazard, especially when compounded by high rates of diffusion, which allow for fast permeation throughout the laboratory. Additional hazards of reactivity and toxicity of the gas, as well as asphyxiation, can be caused by high concentrations of even seemingly “harmless” gases, such as nitrogen. Since the gases are contained in heavy, highly pressurized metal containers, the large amount of potential energy resulting from compression of the gas makes the cylinder a potential rocket or fragmentation bomb. Compressed gas cylinders shall be properly identified, handled, secured and stored. Laboratory personnel shall be aware of the proper procedures for handling the various compressed gases, the cylinders containing the compressed gases, regulators or valves used to control gas flow, and the piping used to confine gases during flow. Compressed gases commonly found in PMEL operations are air, methane, nitrogen and oxygen. Refer to TO 42B5-1-2, *Gas Cylinders (Storage Type) Use, Handling and Maintenance*, for gas cylinder precautions. Some common and potentially harmful gases used in PMEL operations are:

34.2.4.1. Methane. Methane is one of several common and potentially harmful gases used in PMEL operations. It is a colorless, odorless, tasteless, highly flammable gas that may also be an asphyxiant if it displaces available oxygen. This can create an oxygen-deficient atmosphere, causing a worker to become dizzy, unconscious or to possibly die.

34.2.4.2. Nitrogen (N<sub>2</sub>). A colorless, odorless and tasteless gas which liquefies at -195°C or -320.44°F. By displacing available oxygen, it can create an oxygen-deficient atmosphere, causing a worker to become dizzy, unconscious or to possibly die. Due to its extremely low temperature, liquid nitrogen (LIN) can cause cryogenic burns to body tissues similar to frostbite. Refer to **Chapter 43**, *Liquid Nitrogen (LIN) and Oxygen (LOX)*, for additional guidance and information on the safe use and handling of these cryogens.

34.2.4.3. Oxygen (O<sub>2</sub>). Oxygen mixed with hydrocarbon contamination can cause fires and violent explosions. Because of its extremely low temperature, liquid oxygen (LOX) can cause cryogenic burns to body tissues similar to frostbite. The expansion ratio of LOX can also result in oxygen enrichment, producing fire and explosion hazards. Refer to **Chapter 43** for additional hazards and guidance concerning LOX.

34.2.5. Compressed Oil Hazards. Some testing and calibrating operations require use of compressed oil at pressures of 30,000 psi. An oil leak above 4000 psi produces a high velocity stream of oil that may penetrate the skin and inject oil into body tissue. These high-pressure injections can cause severe localized circulatory system damage and loss of the injured extremity. Even low pressure, high volume systems pose a danger to personnel because of the amount of energy stored in the system. **Warning:** Injected oil may be life threatening and requires immediate medical treatment.

34.2.6. Fire Hazards. Flammable and combustible liquids must be properly handled, stored and used. Refer to **Chapter 22, *Flammables and Combustibles***, for additional guidance. Also, consult the installation Fire Emergency Services (FES) Flight for guidance on the selection and placement of fire extinguishers within the workplace.

### **34.3. Supervisor Responsibilities.**

34.3.1. Supervisors shall ensure:

34.3.1.1. Personnel are trained on the location, selection and use of fire extinguishers, alarm systems, main power switches and evacuation procedures.

34.3.1.2. CPR training is provided for workers required to perform work on energized high voltage electric circuits. Workers requiring CPR training shall receive refresher training before current CPR certification expires.

34.3.1.3. Personnel performing maintenance on ionizing radiation equipment receive the proper ionizing and non-ionizing radiation safety training from the installation Radiation Safety Officer (RSO).

34.3.1.4. Applicable technical data and MSDSs are consulted for specific safety guidance prior to equipment or chemical use.

34.3.1.5. Fire extinguishers are properly mounted, readily accessible, in a serviceable condition and clearly visible.

34.3.1.6. All exits are clearly identified, posted with signs, doors unlocked, easily accessible and clear paths of egress are provided. Consult the installation FES Flight for guidance on emergency lighting and exit requirements.

34.3.1.7. Smoking is not permitted in the immediate area where flammable materials are being dispensed, stored or used.

34.3.1.8. Soiled rags, paper towels, Kraft paper and other trash contaminated with oil or grease are placed in self-closing metal safety cans marked and color-coded to indicate contents. At the end of each shift, these containers shall be emptied or placed in an approved location outside the work center for pickup or disposal. Clean rags shall be clearly identified and kept in appropriate containers.

34.3.1.9. All new chemicals, machines and processes are evaluated by the installation Ground Safety office, FES Flight, Environmental Management office and BE, as appropriate, prior to introduction into the work area. Once approved, supervisors shall ensure all personnel are trained prior to using the new chemicals, machines or processes.

Training shall be documented as required for personnel and the supervisor shall keep a list of trained personnel on each chemical, machine or process.

**34.4. Ventilation Systems.** As a minimum, PMEL cleaning areas and laboratory work areas must have appropriate ventilation. Ventilation shall continue for a sufficient time after job completion to minimize residual vapors and provide adequate makeup air. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, AFMAN32-1094, *Criteria for Air Force Precision Measurement Equipment Laboratory Design and Construction*, and TO 00-20-14, *Air Force Metrology and Calibration Program*, for additional information on workspace ventilation including information on permissible exposure levels, flow rate requirements and design criteria. BE will determine what, if any, periodic testing of ventilation systems is required.

**34.5. Electrical Safety for PMEL Operations.** Refer to **Chapter 8**, *Electrical Safety*, for additional guidance and information pertaining to the following:

34.5.1. Laboratory Floors. The floor covering of calibration/repair areas shall be as specified in AFMAN 32-1094, *Criteria for Air Force Precision Measurement Equipment Laboratory Design and Construction*. Floor coverings that are damaged or do not meet specified requirements, shall be repaired or replaced. Insulated mats, NSN 7220-00-255-0765 (Black – 24 inches wide), 7220-00-267-4630 (Blue – 36 inches wide), 7220-00-913-8751 (Green – 36 inches wide), or suitable substitutes, are required when personnel are exposed to and working on energized high voltage circuits.

34.5.2. Equipment Grounding. Unless the equipment is made with double insulated construction (which does not require grounding), most equipment can and shall be grounded using a three wire cord/plug/wall receptacle system. All wall receptacles shall be checked for ground continuity and for ground resistance of 10 ohms or less. Equipment requiring 220 volt or higher input voltage shall be grounded IAW NFPA 70, *National Electric Code*, or manufacturer's recommendations. Fixed electrical equipment shall be electrically bonded to a grounding connector. Special protection shall be provided to safeguard grounding wires from mechanical damage. Most electrical equipment is assembled with the outer case electrically isolated from internal components and the case shall be separately grounded. However, some equipment shall not operate with their cases grounded. Other equipment may require an ungrounded case for calibration. Local in-house procedures shall be developed and defined to cover these situations. Refer to TO 33-1-32, *Input Power Wiring of Electrical/Electronic Support Equipment*, the manufacturer's manual or 29 CFR 1910.303, *General Requirements*, 1910.304, *Wiring Design and Protection*, 1910.305, *Wiring Methods, Components, and Equipment for General Use*, and 1910.308, *Special Systems*, for additional guidance and information.

34.5.3. Workbenches. Metal topped workbenches shall be grounded to the facility ground. Workbenches with insulated, nonconductive tops are considered isolated from ground. All isolated workbenches shall have a grounding point provided and used when a grounded workbench is required, such as electrostatic discharge (ESD) sensitive operations. Refer to TO 00-25-234, *General Shop Practices Requirements for the Repair, Maintenance and Test of Electrical Equipment*, for ESD control procedures and workstation grounding.

34.5.4. Mobile Equipment Grounding. System grounding of mobile equipment shall be done by a separate insulated equipment grounding conductor.

34.5.5. Buss Bars. Buss bars shall be clean, free of corrosion and connections periodically checked for tightness.

34.5.6. Facility Ground. The facility ground shall be marked at its connection to the ground buss bar. If the connection is outdoors, it shall be coated with an anti-oxidant grease and marked IAW TO 31-10-24, *Installation Practices, Communication Systems Ground, Bonding and Shielding*, and any requirements established by the installation CE. The facility custodian shall visually inspect the electrical and grounding systems on a monthly basis for security and damage. After repairs, they shall be tested for continuity and polarity by a qualified electrician.

34.5.7. Equipment Electrical Safety Devices.

34.5.7.1. The doors to equipment racks and enclosures shall be closed at all times except to facilitate necessary and authorized repairs.

34.5.7.2. Interlocks shall not be disabled during maintenance or adjustments unless prescribed by the manufacturer's manual or applicable TOs. During these periods, a sign stating "Danger Interlocks Disabled" or other suitable commercially available substitute shall be placed on the equipment. Interlocks shall not be permanently disabled or bypassed. Refer to **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, **Chapter 29**, *Mishap Prevention Signs and Tags*, and 29 CFR 1910.306, *Specific Purpose Equipment and Installations*, for additional information on lockout and tagout procedures and requirements.

34.5.7.3. Only authorized maintenance personnel shall perform repair work on equipment with defective interlocks. Refer to 29 CFR 1910.303, 1910.305 and 1910.306, for additional guidance regarding interlocks.

34.5.7.4. When personnel are exposed to and working on energized high voltage circuits, i.e., 600 volts nominal or more, safety observers trained in CPR shall be present, unless the area supervisor determines the risk of the operation does not warrant a safety observer. Personnel shall follow guidance in UFC 3-560-01, *Electrical Safety*, when an arc-fault hazard exists.

34.5.8. Fuses and Circuit Breakers.

34.5.8.1. Circuit breakers or fuses shall be installed in all electrical circuits to interrupt the current flow when it exceeds the current carrying capacity of the conductor and/or circuit. Circuit breakers and fuses shall not be bypassed. Refer to 29 CFR 1910.306 for additional guidance and information.

34.5.8.2. Equipment fuses shall always be replaced by fuses of the size and type required by the TO or manufacturer's manual. Insulated fuse pullers shall be used to remove and replace cartridge fuses. Wire, foil, solder or other conductive materials shall not be used as substitutes for fuses. A lower amperage fuse of the same type may be used as a temporary measure until the proper fuse is available. An AFTO Form 350, *Repairable*

*Item Tag*, must be attached stating the unit is under fused. Refer to 29 CFR 1910.306 for additional guidance and information.

34.5.9. Grounding Sticks. A grounding stick shall be available for use at electronic workstations where residual voltages may be encountered during maintenance on deenergized equipment.

34.5.10. Adjustments and Testing of Equipment.

34.5.10.1. Electrical power shall be disconnected before technicians perform mechanical adjustments or repairs not involving alignment of mechanical/electrical components. Mechanical/electrical adjustments with power on shall only be accomplished when required by applicable TOs or manufacturer's manual. Technicians performing the adjustment/alignment shall use insulated tools to minimize the possibility of shock or damage to equipment components. Refer to **Chapter 21** for proper lockout and tagout procedures.

34.5.10.2. Technicians shall not use lead pencils, screwdrivers or other hand tools to make radio-frequency energy tests on any piece of electronic equipment.

34.5.11. Power Distribution Panels/Controls. Main power switches shall be conspicuously marked. All personnel shall know the location and on-off operation of the main power distribution panels in their work areas. This knowledge is essential to de-energize electrical circuits in the event of a fire or accidental electrical contact. Except for 110 volt 60 hertz outlets, all electrical fuse, switch and circuit-breaker boxes shall be plainly marked with the voltage, phase and frequency of the circuit, and exactly what they control. Refer to 29 CFR 1910.304 and 1910.306 for additional information.

34.5.12. Electrical Safety Boards. Refer to paragraph **8.12**, for required items included in an emergency equipment kit or board.

### **34.6. Radioactive Material Safety.**

34.6.1. Radioactive material shall be handled in a manner that results in as low as reasonably achievable (ALARA) exposures to personnel. The installation RSO and BE shall prescribe special procedures and precautionary measures as necessary. In overseas areas, follow disposal procedures as dictated by host nation agreements. Refer to AFI 40-201, *Managing Radioactive Materials in the US Air Force*, for additional guidance.

34.6.2. Personnel shall not handle or expose a radioactive source except as required in the performance of duty. Personnel involved in the actual use of radioisotopes shall receive formal training in their use and any precautionary measures, followed by continuing on-the-job training (OJT). No one shall be authorized to use, handle or access any area with an exposed or open ionizing radiation source without the worker and task being evaluated by the installation Radiation Safety Officer for possible entry into the US Air Force Dosimetry Program and placed on the dosimetry program, if deemed necessary. Refer to AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, for additional guidance and information.

34.6.3. In restricted areas where radioactive material is used or stored, appropriate placards shall be conspicuously posted at each entrance and around the exterior perimeter of each area so at least one placard is clearly visible from any direction of approach. Obstacles, such as

rope, barricades, etc., shall be used to discourage unauthorized entry into controlled areas. Individual containers of radioactive material within the area shall be appropriately identified.

34.6.4. Pregnant military and civilian workers must report to Public Health (PH), who will, in coordination with BE and the Primary Care Manager, document health risks and preventive actions on the AF Form 469, *Duty Limiting Condition Report*. A copy of this report will be sent to the supervisor. Refer to AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, for additional guidance.

34.6.5. Smoking, eating or drinking in any area in which a radiation ingestion hazard may exist is strictly forbidden. Personnel working with radioactive materials shall wash their hands and face before eating, drinking or smoking and upon leaving a contaminated area.

34.6.6. Regardless of radiation intensity, radioactive items used in PMEL operations shall not be carried in pockets or clothing of personnel.

34.6.7. In addition to placards, positive measures, such as locked or guarded gates or doors, shall be established to prevent unauthorized entry into high radiation areas, as defined in AFI 48-148, *Ionizing Radiation Protection*. Entry of personnel into a high radiation area will energize a conspicuously visible or audible alarm signal designed to alert personnel present or cause the exposure to terminate.

34.6.8. If containers of radioactive materials are broken or damaged, the area shall be cleared of all personnel not required in evaluation of the condition, recovery of the radioisotope or decontamination of the area or material. Once the area is cleared, it shall be secured. If radioactive material becomes airborne, doors and windows shall be closed and ventilation equipment turned off. The PMEL supervisor and installation RSO shall be notified immediately. A survey of the area shall be conducted to determine the extent of the radiological hazard. Personnel who have been, or may have been, exposed shall be monitored to determine the extent of medical action required. The RSO shall direct the decontamination or recovery operation, as necessary. Broken or damaged items shall be safely packaged and disposed of. Refer to AFI 40-201, *Managing Radioactive Materials in the US Air Force*, for additional disposal and handling instructions.

**34.7. Cathode Ray Tubes (CRTs).** The following precautions shall be taken to minimize the danger of breaking the glass envelope of CRTs.

34.7.1. Prior to handling a tube, momentarily ground all pin connections, including the high voltage connection, to preclude electrical shock.

34.7.2. Avoid scratching the glass of a tube since scratches weaken the tube and can cause the tube to implode.

34.7.3. Remove tube from its carton “face up” by grasping the larger (bell) end. Avoid handling large tubes by the neck since this narrow portion of the tube is particularly susceptible to breakage from bumping or striking other objects. This procedure also minimizes strain due to mechanical misalignment.

34.7.4. Follow manufacturer’s special handling instructions for tubes with an external insulation coating applied to areas of the bell end. Avoid touching the coated areas.

34.7.5. Do not place a tube on its side on a flat surface. Instead, place the tube face down on a protective nonabrasive pad. If possible, do not remove the CRT from the carton until ready for use.

34.7.6. Dispose of tubes using the same handling precautions as for new ones. Destroy CRT tubes prior to disposal by placing them face down in an empty CRT carton and breaking the center guide (keying) pin. Remove the tube's high vacuum by breaking off the tip of the glass vacuum seal. Seal the container and make an access hole so a crowbar or other heavy rod can be driven through to break the glass envelope. Contact the installation Environmental Management office for additional CRT disposal guidance.

34.7.7. If broken glass from a tube cuts the skin, immediately wash cuts with soap to remove dirt, phosphorus or other contaminants, then obtain medical attention.

34.7.8. Use dry chemical extinguishers to control fires involving equipment with CRTs. The thermal shock from cold CO<sub>2</sub> may cause CRT implosion.

### **34.8. Equipment/Component Cleaning.**

34.8.1. Vacuuming using a nonmetallic wand and suction nozzle is the preferred method for cleaning electronic equipment. If compressed air is used, the air pressure shall be limited to the lowest possible level. Generally, 5 psi is adequate for equipment cleaning; however, pressures shall not exceed 30 psi. A diffuser nozzle shall be provided. Refer to TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance and Test of Electrical Equipment*, and TO 31-1-75, *Maintenance Engineering Standard – General Maintenance Practices*, for additional information.

34.8.2. Only approved and authorized solvents shall be used. Adequate ventilation shall be provided. BE's OEH risk assessment shall be consulted if the characteristics of a solvent are in question. Refer to paragraph 2.3 and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance and information on ventilation requirements. Appropriate PPE, as required in maintenance data and MSDS, shall be worn. PPE listed in **Table 34.1** shall be worn when guidance is not provided in the maintenance data or MSDS. Additionally, refer to **Chapter 14, Personal Protective Equipment (PPE)**, for additional PPE requirements when working around solvents.

34.8.3. Ultrasonic Cleaning. When using ultrasound-cleaning equipment, workers shall always follow the manufacturer's instructions for parts and equipment cleaning. TO 00-25-234 and Mil Spec C-24196, *Cleaning System Ultrasonic Console*, provide guidance on equipment cleaning and proper use of ultrasonic-cleaning equipment.

34.8.4. Cleaning Oxygen Equipment. Consult TO 15X-1-102, *General Care and Cleaning of Oxygen Gauges and Oxygen Device Related Test Equipment*, and TO 37C11-1-1, *Cleaning of Pressure Gauges Used on Liquid Oxygen Systems*, when cleaning oxygen equipment. Positive controls shall be used to ensure that oxygen equipment handled by PMEL is not contaminated by any foreign material.

### **34.9. Tools and Equipment.**

34.9.1. Insulated tools shall be used when performing work on energized equipment. Placing rubber grips or tape on un-insulated tools does not make them acceptable insulated tools. Wooden handle tools shall not be used on energized equipment.

34.9.2. Only wood or fiberglass ladders are acceptable for work on or near electrical equipment. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrials Stairs, and Portable and Fixed Ladders*, for additional guidance on portable ladders.

34.9.3. Ground wrist straps shall be disconnected when personnel are exposed to or working on energized electrical circuits.

34.9.4. Industrial equipment such as floor hoists, cranes, drill presses, grinders and polishers may pose hazards to technicians. Consult applicable maintenance, commercial data, **Chapter 18**, *Machinery*, and TO 34-1-3, *Inspection and Maintenance of Machinery and Shop Equipment*, for proper operation and maintenance of such equipment.

34.9.5. Radar and Microwave Equipment. Radar and microwave equipment are sources of radio frequency radiation (RFR). Personnel shall be instructed on RFR hazards prior to working on this equipment and shall not be exposed to RFR levels above permissible exposure limits. Caution shall be observed with any open waveguide connected to an energized source of microwave radiation, as high power densities can be found at the waveguide opening. An RFR warning sign shall be posted in areas where access to power density levels exceed the permissible exposure limit. Refer to AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, for additional information.

34.9.6. Hydraulic and Pneumatic Pressure Systems. TO 00-25-223, *Integrated Pressure Systems and Components (Portable and Installed)*, explains safe operating procedures for this equipment and shall be followed when using this equipment.

34.9.7. Calibration/Repair of Fluid Analysis Equipment. Exposure to acids, electric current and petroleum distillates may occur when performing oil analysis operations and maintenance. Workers shall wear appropriate PPE when using this equipment and associated chemicals.

34.9.8. Calibration/Repair of Radiation Measuring Equipment. Personnel shall follow AFOSH Standard 48-9, AFOSH Standard 48-139, *Laser Radiation Protection Program*, and AFI 40-201, when calibrating or repairing radiation test, measuring and diagnostic equipment (TMDE). Problems not covered in this standard or referenced AFOSH standards, manuals and TOs shall be referred to the installation RSO and BE.

**Table 34.1. Frequently Performed PMEL Operations Where PPE is Required.**

<b>Frequently Performed PMEL Operations Where PPE is Required</b>	
<b>Operation</b>	<b>Type PPE</b>
Battery Servicing/Handling (Wet Cell)	Side and frontal eye protection Gloves, rubber Apron, rubber
Cathode Ray Tube Installation or Removal	Face shield/Safety glasses Gloves



<b>Frequently Performed PMEL Operations Where PPE is Required</b>	
<b>Operation</b>	<b>Type PPE</b>
Heavy Lifting	Safety-toe shoes
Compressed Air Cleaning	Side and frontal eye protection
Laser Operations	Laser Eye Protection (LEP)
Use of Hydrazine Related Equipment	Respirators (when engineering controls and work practices are not sufficient to reduce exposures to below the permissible exposure limit) Impervious gloves
Liquid Nitrogen Handling	Face shield Apron, rubber Gloves, insulated Long sleeve garment
Oil Analysis Instrument Testing	Light Shields and Filters
Mercury Servicing/Clean-up	Rubber gloves Respirator approved for use with mercury Goggles
Working in Hazardous Noise Area (Noise Level 85 Decibels (dB) or Greater)	Approved hearing protection
Soldering	Respirator (when BE's OEH risk assessment requires) Eye protection (side and frontal) Face shield or safety goggles
Liquid Fluorocarbon (Freon)	Impervious gloves Side and frontal eye protection

**Note:** PPE listed below are the minimum requirements. Functional managers, ground safety office, BE and Chapter 14, *Personal Protective Equipment (PPE)*, shall be consulted to determine specific PPE requirements for all PMEL Operations.

**34.10. Precision Measurement Equipment Laboratory (PMEL) Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

34.10.1. Is the appropriate PPE used by workers and others in the work area during PMEL operations? Reference [34.1.3](#)

34.10.2. Are applicable Material Safety Data Sheets available to workers prior to performing a PMEL operation? Reference [34.1.3](#)

34.10.3. Is the appropriate LEP worn by workers when working with laser equipment? Reference [34.1.3.2](#)

34.10.4. Do workers remove rings, watches or other conductive objects when working on, with or near energized electrical circuits? Reference [34.2.1.4](#)

- 34.10.5. Are all items containing mercury properly maintained and safely located to prevent escape of mercury liquid or vapor? Reference [34.2.3.2.1](#)
- 34.10.6. Are there approved local procedures for the proper disposal of contaminated mercury and for handling mercury spills? Reference [34.2.3.2.1](#)
- 34.10.7. Is adequate ventilation provided for soldering operations to prevent inhalation of gases, fumes, and vapors? Reference [34.2.3.3](#)
- 34.10.8. Are stored gas cylinders properly identified, handled, secured and stored? Reference [34.2.4](#)
- 34.10.9. Are flammable and combustible liquids properly handled, stored and used? Reference [34.2.6](#)
- 34.10.10. Have workers received ionizing and non-ionizing radiation safety training from the Radiation Safety Officer? Reference [34.3.1.3](#)
- 34.10.11. Are fire extinguishers readily accessible, in serviceable condition, and clearly visible? Reference [34.3.1.5](#)
- 34.10.12. Are all exits clearly identified, posted with signs, kept unlocked, easily accessible, and clear paths of egress provided? Reference [34.3.1.6](#)
- 34.10.13. Have all workers been adequately trained in the use of all new chemicals, machines or processes? Reference [34.3.1.9](#)
- 34.10.14. Do only authorized maintenance workers perform repair work on equipment with defective interlocks? Reference [34.5.7.3](#)
- 34.10.15. Is a safety observer present when personnel are exposed to or working on energized high voltage circuits? Reference [34.5.7.4](#)
- 34.10.16. Do all personnel know the location and on-off operation of the main electrical power distribution panels in their work area? Reference [34.5.11](#)
- 34.10.17. Do all persons handling radioactive material, including anyone who contacts a radioactive device, wash their hands and face before eating, drinking or smoking and upon leaving contaminated work area? Reference [34.6.5](#)
- 34.10.18. Are positive measures established to prevent unauthorized entry into high radiation areas? Reference [34.6.7](#)
- 34.10.19. Are proper precautions taken to minimize the danger of CRT handling and disposal hazards? Reference [34.7](#)
- 34.10.20. Are only approved and authorized solvents used for cleaning? Reference [34.8.2](#)
- 34.10.21. Are insulated tools available for use on energized equipment? Reference [34.9.1](#)
- 34.10.22. Do personnel disconnect ground wrist straps when they are exposed to or working on energized equipment? Reference [34.9.3](#)

## Chapter 35

### MATERIALS HANDLING EQUIPMENT

#### 35.1. General Information.

35.1.1. Documentation. This chapter specifies use of AFTO Form 95, *Significant Historical Data*, AFTO Form 244, *Industrial/Support Equipment Record*, and general purpose forms for documenting maintenance and inspection actions. With the growing use of automated systems for tracking these activities, requiring specific paper forms may impede use of more efficient automated processes. Therefore, use of MAJCOM or locally devised paper or automated system for documenting inspections, maintenance and other activities is acceptable in place of specified AFTO Forms 95 and 244 and general purpose forms. Electronic signatures are acceptable. While this standard eliminates the requirement for paper AFTO Forms 95 and 244 and general purpose forms, MAJCOMs, NAFs, local procedures, Technical Orders and other Air Force guidance may continue to require use of these forms. Please check the prescribing directive(s) before discontinuing use of any forms. Maintenance units shall follow documentation guidance in AFI 21-101, *Aircraft and Equipment Maintenance Management*, and 00-20 series TOs.

35.1.2. Training Currency for Deployment. Supervisors shall ensure personnel scheduled for deployment are current/trained in operations on this equipment prior to deploying. Additionally, supervisors at deployed locations shall verify personnel are current in operations before they operate the equipment, and provide additional training as needed for personnel to safely operate any new type equipment. A copy of the training records shall accompany the members when they deploy.

#### 35.1.3. Materials Handling Equipment (MHE) Not in Regular Service.

35.1.3.1. Cranes, hoists and derricks idle for at least one month, but less than six (6) months, shall be inspected prior to placing in service.

35.1.3.2. Cranes idle for a period of six (6) months or more shall be inspected IAW paragraphs [35.8.2.5.1](#), [35.8.2.5.2](#) and [35.11.2.2.2](#) prior to placing in service. Standby cranes shall be inspected at least semiannually IAW paragraphs [35.9.2.4.2](#), [35.9.2.4.3](#) and [35.11](#). The need for more frequent inspections of cranes exposed to an adverse environment shall be determined by the user.

35.1.3.3. Any hoist idle for six (6) months or more shall be given a complete inspection IAW paragraph [35.6.3.5.2](#) prior to placing in service.

35.1.3.4. A derrick idle for over six (6) months shall be given a complete inspection IAW requirements of paragraph [35.6.3.5.2](#) before placing in service. Standby derricks shall be inspected at least semiannually IAW paragraph [35.6.3.5.2](#). Those exposed to adverse environments shall be inspected more frequently.

35.1.4. Dimensions. While dimensions mentioned in this document refer to inch measurements, equipment built with metric measurements shall be maintained and repaired with metric dimensioned parts, unless inch dimensioned parts are permitted by applicable TO, item manager or manufacturer. If the manufacturer is no longer in business or technical

guidance is not available, parts selection shall be based on the recommendation of a licensed professional engineer.

35.1.5. Inspections. MHE (specifically hoists, slings, cranes, derricks) and associated components will be inspected for damage or wear at intervals specified (frequent and/or periodic), including observations during operation. Deficiencies will be carefully examined and a determination made by the operator and the shop or facility supervisor as to whether they constitute a safety hazard.

35.1.5.1. Frequent. A visual/prior to use inspection will be performed by the operator or designated person daily or prior to use. A daily inspection is only required if specified by a TO, manufacturer's instructions or other governing directive. Otherwise, a prior to use inspection will be required prior to the first use of the day for any MHE, unless MAJCOM or installation has more stringent directives. The inspection shall be documented on an AFTO Form 244 or MAJCOM or locally devised paper or automated systems IAW paragraph [35.1.1](#), annotating the date, time, initials of the person performing the inspection and any discrepancies noted during the inspection. The record of inspection shall be maintained by the using agency until the next periodic inspection has been performed.

35.1.5.2. Periodic. A complete inspection will be performed by a qualified person at intervals between 1 and 12 months. The required intervals of periodic inspections will be based on the type of use experienced by the equipment: Normal service – annually; heavy service – semiannual; severe service – quarterly (see [Attachment 1](#), Terms-Service). Follow periodic inspection schedules outlined in applicable technical orders and/or manufacturer's instructions where intervals between 1 and 12 months are established. The inspection will be documented on AFTO Form 95, AFTO Form 244 or MAJCOM or locally devised paper or automated systems IAW paragraph [35.1.1](#) and maintained on file 36 months after the periodic inspection is complete, unless otherwise noted. During the periodic inspection, some systems may require the removal of covers or parts to gain access. Appropriate lockout/tagout procedures will be used where removal of covers or parts expose individuals to an uncontrolled energy source (e.g., an electrical or mechanical hazard) and result in accidental start-up of equipment. Refer to [Chapter 21](#), *Hazardous Energy Control (Lockout and Tagout)*, for additional guidance. Disassembly of the MHE or major components, not designed to be removed or opened, is not required for the sole purpose of the inspection. If the individual performing the periodic inspection finds evidence of damage or wear that constitutes a potential hazard, further inspection to determine cause or to repair the system may be required and total disassembly or removal of major components may be necessary. Consult manufacturer's instructions, where available, for additional guidance. **Exception:** For nuclear-certified MHE, perform the periodic inspection semiannually.

35.1.5.3. Mandatory Monthly Inspections. Wire ropes, chains and hooks shall be thoroughly inspected monthly (every 30 days). Inspections for each item shall be documented (separate documentation) on the AFTO Form 95 or MAJCOM or locally devised paper or automated system IAW paragraph [35.1.1](#) and maintained on file for one year. Documentation will include date and time of the monthly inspection, signature of

the inspector, an identifier for the equipment inspected and condition of the equipment. Inspection criteria will be IAW applicable paragraphs from this chapter.

35.1.5.4. Frequency. Inspections identified as monthly and annual inspections will be considered as such and not a 30 or 365 day inspection. The next inspection must occur by the last day of the perspective month. For example, a monthly inspection conducted on 4 February, the next inspection must be completed by 31 March. An annual inspection conducted on 4 February 2009, the next inspection must be completed by 31 March 2010.

35.1.5.5. New or Modified MHE. Prior to initial use, all newly procured or modified (altered or repaired) MHE shall be inspected to ensure compliance with the provisions of this instruction.

35.1.5.6. Hook, Sling and Hook Certification. Hook, sling and hook certification documents received from the manufacturer when hoists, slings or hooks are purchased or repaired shall be maintained for the life of the equipment (or until the hooks are replaced). For repaired items, the previous certification shall be replaced with the new documentation.

35.1.6. For cranes and derricks used in construction, consult with installation CE and refer to 1926.1400, *Cranes and Derricks in Construction*.

## **35.2. Special Requirements.**

35.2.1. Material Handling Equipment Parked Inside Warehouses. The decision to park gasoline- or diesel-powered material handling equipment in general purpose warehouses is the responsibility of the installation commander and requires approval in writing by the installation commander with recommendations by the installation Fire Emergency Services (FES) Flight and Ground Safety office. The following safety considerations/operating rules shall be considered prior to parking:

35.2.1.1. The warehouse shall be equipped with an automatic fire suppression system or heat sensor devices.

35.2.1.2. The equipment shall be parked so it does not block fire aisles, fire-fighting equipment, fire alarm boxes, stairways, elevators or fire exits.

35.2.1.3. An oil absorbent compound shall be placed under any equipment leaking oil or grease. A metal pan may be used in conjunction with the compound. Leaking equipment shall be repaired.

35.2.1.4. The warehouse supervisor shall conduct daily inspections to ensure powered materials handling equipment is parked in designated locations, equipment does not contain excessive grease and lint, and gasoline lines, tanks, oil seals and so forth are not leaking.

35.2.1.5. A minimum of 10-foot clearance shall be maintained between parked equipment and combustible materials.

35.2.1.6. Gasoline or diesel powered equipment used in multistory buildings shall be parked on the ground floor when not in use. Refer to paragraph [35.3.5.2](#) for additional guidance.

35.2.2. Battery Charging and Servicing Operations. Refer to **Chapter 31, Batteries – Maintenance, Handling and Storage Requirements**, and NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, for charging installation design and servicing batteries requirements.

35.2.3. Liquid Petroleum (LP) Gas Powered Materials Handling and Lifting Equipment.

35.2.3.1. Operators shall not park LP-gas industrial and lift trucks near sources of heat, open flames or similar sources of ignition, or near inadequately ventilated pits.

35.2.3.2. Trucks equipped with a permanently mounted LP-gas container shall be refueled outdoors.

35.2.3.3. Exchange of removable fuel containers shall be done outdoors. The exchange may be done indoors if the exchange is made in a well ventilated area away from ignition sources and one of the following methods is used to minimize release of fuel from the fuel lines:

35.2.3.3.1. Use an approved quick-closing coupling (a type closing in both directions when uncoupled) in the fuel line.

35.2.3.3.2. Close the shutoff valve at the fuel container and allow the engine to run until the fuel in the line is exhausted. **Note:** Ensure all indoor container change-out operations are approved by the installation FES Flight.

35.2.3.4. Containers shall be kept secured at all times.

35.2.4. Petroleum Equipment Servicing.

35.2.4.1. Units with internal combustion engines shall not be refueled inside warehouses or while the engine is running. Refueling shall be accomplished in outside areas approved by the installation FES Flight.

35.2.4.2. When fuel is spilled during servicing, operations shall be stopped and equipment cleaned up according to local procedures prior to restarting fuel servicing operation. Notify the FES Flight if a significant spill occurs.

35.2.5. Storage Racks/Shelving.

35.2.5.1. The load size and rating of storage racks/shelving shall be determined by the manufacturer's specifications or by a qualified person if manufacturer's specifications do not specify the load size and rating for the storage racks/shelving.

35.2.5.2. The load size and rating shall be posted on the storage rack/shelving unit.

35.2.5.3. Storage racks/shelving shall be properly aligned, plumb, secured and level as per manufacturer's installation instructions/specifications.

35.2.5.4. Keep aisles clear. Insufficient clearance may result in rack/shelving damage from handling equipment operations.

35.2.5.5. Inspections of storage racks/shelving units shall follow manufacturer's instructions and/or recommendations and include:

35.2.5.5.1. Frequency of inspection and preventative maintenance.

35.2.5.5.2. Inspection of all recommended storage racks/shelving components.

35.2.5.5.3. Inspections shall be documented on AFTO Form 95, or MAJCOM or locally devised automated systems. Refer to paragraph [35.1.1](#) for additional guidance.

35.2.5.6. Defective storage racks/shelving shall be tagged with AF Form 979, *Danger*, or AF Form 981, *Out of Order*.

35.2.5.7. Workers shall report any damage to racks at time of incident, specifically damage due to mechanical equipment, and shall be documented on AFTO Form 95, or MAJCOM or locally devised automated systems. Refer to paragraph [35.1.1](#) for additional guidance.

35.2.5.8. Repair defective storage racks in a timely manner. Document repairs on MAJCOM or locally devised automated systems.

### **35.3. Powered Industrial Trucks.**

35.3.1. Hazards. Injury or death may occur when powered industrial trucks are improperly operated, inadvertently driven off loading docks, tipping, striking personnel, etc. Most incidents also involve property damage, including damage to overhead sprinklers, racking, pipes, walls and machinery. Most injuries and property damage are caused by unsafe operating procedures, lack of safety-rule enforcement, insufficient or inadequate training and operator error. Refer to 29 CFR 1910.178, *Powered Industrial Truck*, for additional guidance. Common operator errors associated with powered industrial trucks include:

35.3.1.1. Jerky starts and stops.

35.3.1.2. Failure to give proper signals when turning.

35.3.1.3. Traveling too fast and turning too sharply.

35.3.1.4. Failure to sound horn at intersections or when entering or exiting a building.

35.3.1.5. Turning too wide on corners.

35.3.1.6. Cutting corners too sharply.

35.3.1.7. Positioning forklift truck tines too high when traveling, either empty or loaded. Tines shall be no higher than six (6) inches above the surface, as measured from bottom most part of load to surface.

35.3.1.8. Lowering loads too fast.

35.3.1.9. Failure to ensure pallet load is properly balanced and stacked.

35.3.1.10. Failure to ensure forks (tines) are fully under the load before lifting.

35.3.1.11. Striking the pallet or floor with the tines.

35.3.1.12. Driving across bridge plates too fast, and failure to observe load carrying capacity on bridge plates.

35.3.1.13. Failure to release parking brake before traveling.

35.3.1.14. Driving forward when vision is restricted by the load.

35.3.1.15. Failure to secure load to mast or tie down points when transporting over a distance.

35.3.1.16. Traveling in reverse without a spotter, too quickly and failure to see obstructions.

35.3.1.17. Raising/lowering the load while still in motion.

### 35.3.2. General Requirements.

35.3.2.1. Acquisition. Commercially procured materials handling and lifting equipment or parts shall conform to the specifications in 29 CFRs 1910.176, *Handling Materials--General*, 1910.177, *Servicing Multi-Piece and Single Piece Rim Wheels*, and 1910.178, *Powered Industrial Truck*, ANSI B56.1, *Safety Standard for Low Lift and High Lift Trucks*, and NFPA 505, *Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*.

35.3.2.2. Local modifications of centrally procured materials handling equipment shall be done only with approval of equipment item managers and requirements referenced in paragraph [35.3.4.2](#). Local purchase acquisition requests shall be coordinated with the installation Ground Safety office. Refer to [Figure 35.1](#) through [Figure 35.17](#) for examples of materials handling and lifting equipment.

### 35.3.3. Training.

35.3.3.1. Each activity requiring training on powered materials handling and lifting equipment shall designate qualified personnel as instructors to train and supervise the operator trainee. The names and grades of instructor candidates shall be provided to the vehicle operations officer who shall thoroughly screen each for background and experience in the type of equipment for which instruction shall be given. A list of approved instructors shall be retained on file by the using agency and the vehicle operations section.

35.3.3.2. Lesson plans for each vehicle shall be accomplished by the unit IAW AFI 24-301, *Vehicle Operations*. Lesson plans (course content) shall include formal instruction, hands-on demonstrations by the instructor with practical exercises performed by the trainee and an evaluation of the trainee's performance to confirm their knowledge of equipment operations and service instructions. Refer to paragraph [35.3.3.5](#) for additional guidance on documenting training.

35.3.3.3. The trainee shall furnish the Operator Records and Licensing (OR&L) staff with written certification on the AF Form 171, *Request for Driver's Training and Addition to U. S. Government Driver's License*.

35.3.3.4. Materials handling and lifting equipment training will include:

35.3.3.4.1. Equipment design, to include restrictions, limitations and hazards relative to the environment where used, e.g., steering, maneuvering and visibility.

35.3.3.4.2. Operating and maintenance instructions, including manufacturer's instructions and those contained in this standard.

35.3.3.4.3. Safe loading and unloading requirements.



- 35.3.3.4.4. Operating techniques inside and outside of warehouses.
- 35.3.3.4.5. Flight line rules and regulations, when applicable.
- 35.3.3.4.6. Fire extinguisher training (initial and annual). Refer to **Chapter 6**, *Fire Protection and Prevention*, for additional guidance.
- 35.3.3.4.7. Use of attachments such as extended forks or tines or personnel lift pallets.
- 35.3.3.4.8. Clearances, heights and limitations.
- 35.3.3.4.9. Safety clothing and equipment. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.
- 35.3.3.4.10. Fire protection, fuel spills, maintenance of equipment, smoking, etc. Refer to **Chapter 6** for additional guidance.
- 35.3.3.4.11. Operating restrictions in potentially hazardous storage areas, which include flammable, toxic, lumber, coal, etc. Refer to **Chapter 22**, *Flammable and Combustible Liquids*, for additional guidance.
- 35.3.3.4.12. Load composition and stability.
- 35.3.3.4.13. Damage that may be caused by acid or caustic material.
- 35.3.3.4.14. Workplace related topics such as surface condition; local policies on stacking, unstacking, and load manipulation; pedestrian traffic; and narrow aisles.
- 35.3.3.4.15. Applicable information contained in paragraphs **35.2** and **35.3.2.1** of this standard.

35.3.3.5. Document initial and, as required, refresher training in appropriate records, e.g., AF Form 623, *Individual Training Record Folder*, AF Form 971, *Supervisor's Employee Brief*, AF Form 1098, *Special Task Certification and Recurring Training*, AF IMT 55, *Employee Safety and Health Record*, or MAJCOM directed record system.

35.3.3.6. In addition to initial training and certification, a qualified instructor shall evaluate each operator at least once every three (3) years and provide refresher training in relevant topics any time there is reason to believe there is a need. The evaluation shall include, but not be limited to, changes in types of equipment in use, change in operating environment; direct observation of performance; reportable mishaps, reports of near-misses; complaints regarding an operator's bad driving habits; physical fitness; and other indications that an operator is not capable of safely performing assigned duties. A written/automated record of each operator's evaluation shall be kept on file by the instructor for review.

#### 35.3.4. Safeguarding Requirements.

35.3.4.1. Materials lifting equipment powered by an internal combustion engine shall have an adequate fire extinguisher available. Size, type and location shall be determined by the installation FES Flight and owning organization, and shall be based on the risk assessment for the operation being conducted. Additional requirements may be mandated by AFIs, TOs or other directives for specific environments and operations.

35.3.4.2. The maximum load capacity shall be posted on each piece of lifting equipment, in view of the operator. Modifications and additions which affect capacity and safe operation require manufacturer's written approval. If modifications and/or additions are completed, capacity, operation and maintenance instruction plates, tags or decals shall be changed accordingly. Refer to paragraph [35.3.2.1](#) for additional guidance.

35.3.4.3. All high-lift rider trucks shall be equipped and operated with overhead guards to protect the operator from falling objects. Overhead guards shall not be covered with material that could obstruct the operator's vision.

35.3.4.4. Where steering must be accomplished with one hand and a steering hand wheel is used, steering knobs or equivalent may be used, provided they do not protrude beyond the outside periphery of the hand wheel.

35.3.4.5. Load backrest extensions shall be used when necessary to minimize the possibility of the load falling rearward.

35.3.4.6. When a forklift is used to elevate personnel, an approved safety pallet, as illustrated in [Figure 35.1](#), shall be used. It shall be equipped with the features identified in the figure.

35.3.4.7. The operator shall remain at the controls at all times when personnel are on the safety pallet, but shall not move the forklift.

35.3.4.8. Instructions prohibiting movement of the forklift with personnel on the safety pallet shall be posted on the pallet in plain sight, visible to the operator and all personnel.

### 35.3.5. Safe Operations.

35.3.5.1. Whenever possible, electric or battery powered equipment shall be used indoors. Internal combustion engines shall not be operated inside buildings unless an exhaust system or other ventilation approved by BE is installed and used. Administrative areas, e.g., offices, must be protected from exhaust buildup either by distance or positive air flow pressure in relation to the warehouse activities. When internal combustion engine equipment is used inside warehouses, ventilation requirements shall be determined by BE personnel to preclude exposure of workers to carbon monoxide gas. Refer to AFMAN 91-201, *Explosives Safety Standards*, for operating in explosives and weapons areas.

35.3.5.2. Internal combustion engine equipment shall not be warmed up inside a building and shall be turned off when not in use.

35.3.5.3. Liquid Petroleum (LP) gas fuel industrial trucks may be used in buildings or structures approved by the installation FES Flight, Ground Safety office and BE. If used inside buildings or structures, there shall be no more than two 10-gallon fuel containers on the truck, and the truck shall not be left unattended with the engine running. Refer to paragraph [35.3.5.1](#) for additional guidance.

35.3.5.4. Operation of high and low lift trucks, which include platform, pallet trucks, rider trucks, reach trucks, side loader trucks, picker trucks, straddle lift trucks, etc.

35.3.5.4.1. Personnel shall not ride on powered lift equipment unless a passenger seat is part of the manufacture design.

35.3.5.4.2. The operator shall not extend any portion of body between the uprights of the mast or outside the running lines of the equipment.

35.3.5.4.3. When leaving powered lifts unattended, operators shall fully lower the forks, neutralize controls, shut power off and set brakes. They shall chock the wheels if the vehicle is parked on an incline. At the close of business each day, LP powered and gasoline operated MHE shall be parked on the warehouse parking ramp, drip pans in place.

35.3.5.4.4. Operators shall use caution when traveling on docks or loading platforms and remain clear of the edge.

35.3.5.4.5. Operators shall not use forklifts to push or pull objects, such as freight cars, or to open and close freight and warehouse doors. Exception: When side loading vans are not available, munitions containers with permanently installed skids may be pushed or pulled into open-ended vans with the use of a spotter. Ensure safety precautions, such as keeping personnel clear of potentially hazardous areas, have been considered and included in the procedure.

35.3.5.4.6. Operators shall set brakes and dock locks or put wheel chocks in place to prevent any movement of trucks, trailers or railroad cars while loading or unloading. Fixed jacks shall be used to support semi-trailers during loading or unloading when the trailer is not coupled to the tractor. The operator shall check the flooring of trucks, trailers and railroad cars for breaks and weakness before driving onto them. Loads shall not be transferred across the tailgate when it is supported solely by its chain. The tailgate must be supported by the mating surface across its entire width or a bridge plate shall be used. Refer to paragraph [35.3.5.5.13](#) for additional requirements.

35.3.5.4.7. Operators shall ensure sufficient head room or clearance under overhead installations, lights, pipes, sprinkler systems, etc.

35.3.5.4.8. Personnel shall not stand or pass under the elevated portion of a lift when loaded or empty.

35.3.5.5. When traveling, operators shall:

35.3.5.5.1. Observe all established driving procedures and shall not exceed five (5) miles per hour inside warehouses. Under normal traffic conditions, operators shall keep to the right and maintain a safe distance (approximately three truck lengths) from the truck ahead. Operators shall keep trucks under control at all times, especially during turns and while traveling over slippery or wet floors and rough surfaces.

35.3.5.5.2. Not pass other vehicles or pedestrians at intersections, blind corners or at other dangerous locations.

35.3.5.5.3. Slow down and sound the horn at cross aisles, warehouse entrances and exits or at other dangerous locations where vision is obstructed. Operators shall be prepared to stop and will not proceed until the way is clear.

35.3.5.5.4. Travel with the load trailing when loads obstruct the forward view.

35.3.5.5.5. Cross railroad tracks diagonally whenever possible to avoid jarring of the load.

- 35.3.5.5.6. Not park lifts closer than eight (8) feet from the center of railroad tracks.
  - 35.3.5.5.7. Look in the direction of travel and keep a clear view.
  - 35.3.5.5.8. Drive a loaded lift with the load upgrade when traveling up or down ramps or grades. A spotter shall be used if the operator's vision is obscured by the load. Unloaded trucks shall be operated on all grades with the forks downgrade. Caution shall be used on all grades. The load on the forks shall be tilted back as far as necessary to clear the road surface.
  - 35.3.5.5.9. Operate the lift at a speed that will permit it to stop in a safe manner. Horseplay or stunt driving shall not be permitted.
  - 35.3.5.5.10. Not travel with lift forks elevated more than six (6) inches above the ground or surface or as necessary to clear surface projections.
  - 35.3.5.5.11. Tilt the mast back when transporting loads when operating a mast with tilt capability.
  - 35.3.5.5.12. Make smooth starts, turns and stops to prevent the load from shifting or the truck from overturning.
  - 35.3.5.5.13. Ensure dock boards or bridge plates:
    - 35.3.5.5.13.1. Are anchored or equipped with stops at both ends near the edges of the platform of the car or truck to prevent them from sliding.
    - 35.3.5.5.13.2. Are strong enough to carry the load.
    - 35.3.5.5.13.3. Have handholds or other effective means to permit safe handling.
    - 35.3.5.5.13.4. Are of proper width and length.
    - 35.3.5.5.13.5. Contain a nonskid surface.
  - 35.3.5.5.14. Approach elevators slowly and enter squarely after the elevator car is properly level. Once on the elevator, the operator will neutralize the controls, shut off the power and set the brakes.
  - 35.3.5.5.15. Ensure motorized hand trucks enter elevators or other confined areas with the load end first.
- 35.3.5.6. When loading, the operator shall:
- 35.3.5.6.1. Ensure only stable or safely arranged loads are transported.
  - 35.3.5.6.2. Not exceed the rated capacity of the lift.
  - 35.3.5.6.3. Take extra care in securing, manipulating, positioning and transporting the load when attachments are used.
  - 35.3.5.6.4. Use extreme care when tilting loads forward or backward, particularly when high tiering. The operator shall not tilt equipment forward with a fork's engaging means elevated, except to pick up a load. An elevated load shall not be tilted forward except when the load is in a deposit position over a rack or stack. When stacking or tiering, operators shall only use enough backward tilt to stabilize the load.

35.3.5.6.5. Not use more than the manufacturer's specified counterweight system to increase lifting capacity.

35.3.5.6.6. Not align, bump or push stacks with a lift.

35.3.5.7. When operating warehouse tractor (tug)-trailer trains, operators shall:

35.3.5.7.1. Obey all traffic regulations and shall not exceed 10 miles per hour when towing trailers. When traveling on base roads, trains shall keep to the extreme right and, if operated at night or in periods of low visibility, lights shall be used. Towing of aircraft engines shall be IAW **Chapter 4**, *Manual Material Handling and Lifting Techniques*, and TO 00-85-20, *Engine Shipping Instructions*.

35.3.5.7.2. Not permit passengers to ride on tractors unless adequate seats are installed.

35.3.5.7.3. Tow no more than four (4) loaded or empty trailers with a tractor or tug. **Exception:** Six (6) A/M326 palletized cargo trailers may be towed behind one tractor.

35.3.5.7.4. Ensure the train is arranged with the most heavily loaded trailer next to the towing vehicle, the next heaviest second in line, and so on to avoid jackknifing trailer trains.

35.3.5.7.5. Make sure couplings are secure before moving a trailer or train. Pintle assemblies and towing connections shall be secured with a pintle hook and safety pin that will positively lock towing connections.

35.3.5.7.6. Ensure loads placed on the trailer directly behind the towing tractor are not stacked so high that they prevent or obstruct the operator's view of the remaining trailers.

35.3.5.7.7. Reduce speeds on uneven roadways to reduce jarring of material.

35.3.5.8. When operating a straddle-lift truck, operators shall:

35.3.5.8.1. Ensure all loads placed on trucks are blocked sufficiently to prevent any part of the cargo coming in contact with the surface over which the cargo is transported.

35.3.5.8.2. Use extreme caution any time the vehicle is operated in congested areas.

35.3.5.8.3. Carry hoist shoes in the up position to avoid striking any obstruction when the truck is not loaded.

35.3.5.8.4. Operate vehicles on solid ground at all times.

35.3.5.8.5. Avoid sudden stops, especially when the truck is loaded.

35.3.5.8.6. Ensure all guards and safety devices are in proper repair at all times.

35.3.5.8.7. Ensure straddle trucks, operated on base roads at night or in periods of low visibility, are equipped with headlights and taillights.

35.3.5.9. Operators who load and unload aircraft using materials handling and lifting equipment will ensure the instructions in TO 36M-1-141, *Operator and Operation Instruction—463L Materials Handling Equipment (MHE) System*, TO 36M2-3-35-11S-2,

*Operation and Operator Maintenance Instructions, Truck, Aircraft Cargo Loading/Unloading 60,000 Pound Capacity, TO 36M2-3-45-1, Halvorsen 25K Aircraft Cargo Loaders*, applicable aircraft Dash 9, and the following are complied with:

- 35.3.5.9.1. Ensure center of gravity is as close to the forklift frame as possible, but no further than 1/2 the length of the tines, raise the load until clear of the surface and tilt the tines backward prior to transporting.
- 35.3.5.9.2. When leaving powered lifts or cargo loading equipment unattended, fully lower the forks, neutralize the controls (place the transmission in the lowest gear or park if an automatic transmission), shut the power off and set the brakes. Chock the wheels if the vehicle is parked on an incline.
- 35.3.5.9.3. Always use a spotter when a K-loader or forklift is operated in congested areas or is approaching or in close proximity to an aircraft.
- 35.3.5.9.4. Do not pitch K-loader cargo platforms forward to aid on- or off-loading of cargo.
- 35.3.5.9.5. Depending upon K-loader design, the rear of the loader may track/swing outward or inward cutting a corner during sharp turns. Operators must ensure turn clearances are adequate and use a spotter when necessary.
- 35.3.5.9.6. Ensure an approved tie-down is used when securing loads to K-Loaders.
- 35.3.5.9.7. Secure dunnage to equipment prior to transport.
- 35.3.5.9.8. Never leave cargo loading equipment on the ramps or taxiways where it could be a hazard to taxiing or towed aircraft.
- 35.3.5.9.9. Do not exceed 5 miles per hour within 50 feet of aircraft and 10 miles per hour on ramps.
- 35.3.5.9.10. Remove ice or snow from equipment before loading or unloading.
- 35.3.5.9.11. When using hand pallet trucks inside an aircraft, use at least two (2) people.
- 35.3.5.9.12. Exercise extreme care when using pry bars to move cargo inside an aircraft and be thoroughly familiar with pry bar use limitations and techniques to prevent damage.
- 35.3.5.9.13. Do not allow personnel to position themselves between:
  - 35.3.5.9.13.1. Pallets that are locked in place.
  - 35.3.5.9.13.2. Pallets being loaded or unloaded.
  - 35.3.5.9.13.3. Moving pallets and materials handling equipment positioned outside the aircraft when off-loading.
- 35.3.5.9.14. To prevent damage to pallets or aircraft flooring, check all floor areas prior to loading or unloading to ensure loose items are removed. Immediately report any damage resulting from aircraft loading or unloading to the supervisor.

35.3.6. Inspections. All powered industrial trucks shall be inspected daily or prior to use as defined in **Attachment 1, Terms**, by the operator. Equipment shall be kept clean. When inspecting equipment, operators will use AF Form 1800, *Operator's Inspection Guide and Trouble Report*. Refer to paragraph **35.1.1** concerning use of paper forms and automated systems. When available, manufacturer's instructions shall be consulted for additional inspection items appropriate to the specific equipment. Equipment with safety defects shall be immediately removed from service until corrected. Examples of safety defects are malfunctioning brakes, steering mechanisms, control mechanisms, warning devices, lights, lifting mechanisms, guards or tilt mechanisms, fuel leaks, worn or damaged tires, or damaged exhaust systems.

#### 35.3.7. Maintenance.

35.3.7.1. Repairs to MHE assets under Vehicle Management's control shall be accomplished by Vehicle Maintenance (maintenance agreement may be necessary for locally procured assets). Deviations to this requirement shall be approved by host Vehicle Maintenance or installation vehicle maintenance contractor.

35.3.7.2. Equipment shall be cleaned in designated locations and only with cleaning agents approved by the installation FES Flight and BE.

### 35.4. Conveyors.

35.4.1. Hazards. Hand and finger injuries may occur when personnel place their hands between boxes or other objects on conveyors or attempt to remove or free jammed objects. Injuries also occur from hand or finger contact with conveyor rollers.

#### 35.4.2. Requirements.

35.4.2.1. Acquisition. Refer to ASME B20.1, *Safety Standard for Conveyors and Related Equipment*. Ensure:

35.4.2.1.1. All chains, sprockets, belts, couplings and other moving parts to drive conveyors are enclosed or guarded.

35.4.2.1.2. A safety device is installed to prevent hands from being pinched between power and idler rollers.

35.4.2.1.3. All electric motors, controls, wiring and their installation comply with NFPA 70, *National Electrical Code*.

35.4.2.1.4. Manually-operated hinged sections are designed with spring tension to minimize effort required to move them.

35.4.2.1.5. Mechanically-operated sections have positive catches or stops to hold them.

35.4.2.1.6. Horizontally-hinged sections are designed so they cannot roll, vibrate or shift out of the intended position.

35.4.2.1.7. All overhead conveyors have rails or roller guards to hold objects on the conveyor, and sheet metal guards, wire mesh or suitable material under the conveyor line to guard against material falling from the conveyors.

- 35.4.2.1.8. Rails or guards are installed whenever there is danger of material falling from any conveyor.
- 35.4.2.1.9. All conveyors installed within seven (7) feet of the floor or surface have crossovers or passages.
- 35.4.2.1.10. If clear passageways cannot be provided under or around a conveyor, that crossover stiles are installed if possible so workers don't have to climb on the conveyor.
- 35.4.2.1.11. Stiles have stairs with non-slip treads, standard handrails and 4-inch toeboards.
- 35.4.2.1.12. If a crossover cannot be installed to clear objects on the conveyor, that a hinge is installed so it can be swung out of the way when not in use.
- 35.4.2.1.13. If crossover stiles are not feasible, that metal plates with non-slip treads are installed in the conveyor just below and between the rollers.
- 35.4.2.1.14. Handrails that clear the load on the conveyor are provided.
- 35.4.2.1.15. All starting and stopping devices are clearly marked, clear of obstructions and readily accessible.
- 35.4.2.1.16. All starting and stopping devices are recessed or guarded to prevent accidental contact by persons or moving objects.
- 35.4.2.1.17. If a conveyor has two or more stop switches, that such switches are arranged so the conveyor cannot be restarted until the actuating stop switch (the switch that originally broke the circuit) has been reset to running or "on" position.
- 35.4.2.1.18. Electrical or mechanical interlocking devices, which will automatically stop a conveyor to prevent jam-ups, are provided.
- 35.4.2.1.19. The open end of every roller conveyor is equipped with a stop that projects automatically above the rollers when a hinged section is opened, and retracts automatically when closed.
- 35.4.2.1.20. Retarders, brakes or similar devices are used to prevent loads from "running away" at or near the end of an inclined reciprocating conveyor.
- 35.4.2.1.21. Hinged sections of a power conveyor are interlocked so they cannot be raised while the conveyor is in operation, or so the conveyor will stop automatically when a section is opened.
- 35.4.2.1.22. Powered conveyors have lockout switches so power can be locked out during maintenance Refer to **Chapter 21**, *Hazardous Energy Control (Lockout/Tagout)*, for additional guidance.
- 35.4.2.2. Training. Workers using conveyors shall be thoroughly trained on procedures for:
- 35.4.2.2.1. Starting and stopping conveyors.
- 35.4.2.2.2. Loading and unloading conveyors to prevent overloading and jamming.



35.4.2.2.3. Clearing jams.

35.4.2.2.4. Making adjustments.

35.4.2.2.5. Lockout/tagout procedures. Refer to **Chapter 21** for additional guidance.

35.4.2.2.6. Safe operations outlined in paragraph **35.4.2.3**.

35.4.2.3. Safe Operations. Workers shall:

35.4.2.3.1. Not ride on, step on or cross over conveyors except at designated locations.

35.4.2.3.2. Not operate conveyors unless all guards are in place.

35.4.2.3.3. Check the entire conveyor before starting the system, to ensure it is clear of personnel.

35.4.2.3.4. Place small objects in tote boxes on conveyors.

35.4.2.3.5. Not place hands or fingers between moving objects, fixed parts of the conveyor rollers or on the rollers.

35.4.2.3.6. Not take off guards at end of conveyor or from belts feeding the conveyor.

35.4.2.3.7. Use caution in clearing jam-ups of boxes or other objects on the conveyor to prevent hand or finger injuries.

35.4.2.3.8. Remain outside of the path of overhead conveyors to prevent being struck by falling objects.

35.4.2.3.9. Report defective or worn shafts, rollers or bearings that may break and permit rollers to fall from the frame.

35.4.2.3.10. Not wear loose clothing, loose sleeves or jewelry that may catch in the conveyor.

35.4.2.3.11. Not wear hair long enough that it may become caught in moving parts of the equipment unless tied back or contained by another appropriate means.

35.4.2.3.12. Keep the area around them free of obstructions to permit a clear view of the conveyor and ready access to the devices.

35.4.2.4. Inspections. Supervisors shall ensure the entire conveyor system is inspected daily. Defective parts that affect safe operation of the system shall be replaced prior to continued operation. Operators shall ensure crossover walkway surfaces are in good condition.

35.4.2.5. Maintenance. No work shall be initiated on a power conveyor until the power switch or disconnect has been locked and tagged out. Refer to **Chapter 21** for lockout/tagout procedures.

### **35.5. Manual Hoisting and Pulling Devices.**

35.5.1. Hazards. Some common hazards associated with misuse of lever-operated hoists can be attributed to use of extensions (cheater bars), indirect pulls and the lack of proper storage and maintenance procedures.

### 35.5.2. Requirements.

35.5.2.1. Acquisition. Lever-operated hoists shall meet the requirements and specifications of recognized industry standards.

35.5.2.1.1. Capacity of all lever-operated devices shall be permanently and conspicuously marked in a readily visible place on the hoist.

35.5.2.1.2. Only ratchet and pawl and load brake hoists, which include a means to prevent a suspended load from self-lowering, shall be procured. Lowering under load shall be by operation of the hoist lever.

### 35.5.2.2. Safe Operations.

35.5.2.2.1. Lever-operated hoists shall only be used in a direct pull. Where indirect pulls are permitted by design of the hoist, a sheave or pulley of adequate size shall be used.

35.5.2.2.2. Hoist cables, ropes and chains shall not be wrapped around the load. Use only slings or other approved lifting fixtures. For example, cargo straps shall not be used for lifting, unless stated in approved Air Force technical data. Refer to paragraph [35.7](#) for additional information on slings.

35.5.2.2.3. Positive action safety latches shall be installed on all hooks.

35.5.2.2.4. Hooks shall not be point loaded unless designed for this purpose. All loads shall be seated in the saddle of the hook.

35.5.2.2.5. Extensions to levers, such as cheater bars or pipes, unless designed and permanently installed by the manufacturer, shall not be used to increase leverage.

35.5.2.2.6. Manually operated lever hoists shall only be operated by personnel trained on use of the equipment. Operator qualifications shall be as determined by the facility manager, shop supervisor or designated representative.

35.5.2.2.7. The rated capacity shall not be exceeded except for authorized load tests.

35.5.2.2.8. Hoists shall be attached to well defined dead-end points capable of withstanding the intended load.

**Note:** Lifeline attach points shall not be used for hoists.

35.5.2.2.9. Operators must be careful to avoid pinch points during handling.

### 35.5.2.3. Inspections.

35.5.2.3.1. Frequent. The inspection will include checking for:

35.5.2.3.1.1. Loose or worn parts, nuts, bolts, etc.

35.5.2.3.1.2. Cracked or broken welds or parts.

35.5.2.3.1.3. Damage to hooks: deformation, chemical damage, cracks or defective safety latches. Hooks having more than 5 percent of normal throat opening or any apparent bend or twist from the plane from the original baseline measurements shall be replaced. Refer to paragraph [35.11.5.1.1](#).

35.5.2.3.1.4. Bent or deformed pawls.

35.5.2.3.1.5. Lubrication.

35.5.2.3.2. Periodic.

35.5.2.3.2.1. Complete inspection of all wire rope, chain and fittings or attachments.

35.5.2.3.2.2. Inspection of brakes, pawls or other holding features.

35.5.2.3.2.3. Inspection of chain length. Chains elongated more than 1/4 inch in 12 inches shall be removed from service.

35.5.2.3.3. Identification tags shall be attached to all hoists. Tags shall include the following information:

35.5.2.3.3.1. Date of annual inspection.

35.5.2.3.3.2. Date of load test.

35.5.2.3.3.3. Capacity of hoist.

35.5.2.3.3.4. Identification number of hoist.

35.5.2.4. Maintenance. Maintenance shall be performed IAW the manufacturer's instruction or applicable TO.

35.5.2.5. Testing.

35.5.2.5.1. Operational Tests. All new hoists, those which have had load-suspension parts altered, replaced or repaired, and hoists that have not been used within the preceding 12 months shall be operationally tested before use. The test shall consist of operating all functions of the hoist under a no-load condition to test all functions of the hoist, including hoisting and lowering, operation of brakes and testing of all limit, locking and safety devices.

35.5.2.5.2. Load Tests.

35.5.2.5.2.1. Prior to initial use, all new hoists shall be tested at not less than 100 percent or more than 125 percent of the rated load by the manufacturer or a qualified person, as defined in **Attachment 1, Terms**. Using organizations shall maintain written certification on AFTO Form 95 that all required load testing has been accomplished.

35.5.2.5.2.2. Before being returned to service, all hoists with altered, replaced or repaired load-suspension parts shall be load tested by the manufacturer or a qualified person at not less than 100 percent or more than 125 percent of the rated load. This load test shall include all functions outlined in paragraph **35.5.2.5**. The replacement of load chain or rope is specifically excluded from this test; however, an operational test under a no-load condition shall be conducted prior to putting the hoist back into service.

35.5.2.5.2.3. Records of these tests shall be maintained indefinitely in a location determined by the user.

**35.6. Hoists.** This section outlines basic requirements for power-operated hoists used for vertical lifting and are not permanently mounted to other equipment, i.e., a crane, monorail or derrick, that serves as a supporting structure. Refer to paragraph **35.8** for additional requirements associated with hoists used as components of overhead, gantry and underhung cranes and monorail systems. See additional requirements in paragraph **35.9** for mobile and locomotive cranes and paragraph **35.10** for derricks. Requirements for hoists in these applications are more detailed due to the equipment's capability for lateral movement in addition to a straight vertical lift.

35.6.1. Hazards. The most common hazards associated with hoists are overloading, dropping or slipping of the load from improper hitching or slinging, obstruction to load passage and failure to stabilize the load during the movement. Injury severity is increased by personnel not wearing required PPE, such as hard hat, gloves, safety-toe shoes and eye protection.

35.6.2. Human Factors. Human factors, such as inattention and failure to keep the load clear of people and objects, are also factors which result in mishaps.

35.6.3. Requirements.

35.6.3.1. Acquisition. Overhead hoists shall meet design specifications, characteristics and rules of ANSI/ASME B30.7, *Base-Mounted Drum Hoists*, B30.10, *Hooks*, and B30.16, *Overhead Hoists (Underhung)*. When applicable, a system safety program shall be established. The guidelines of Crane Manufacturers Association of America, Inc. (CMAA) Specification 70, *Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes*, and CMAA 74, *Specification for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist*, shall be followed. **Note:** Nuclear-certified hoists must also meet requirements in AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*.

35.6.3.2. General.

35.6.3.2.1. Platforms. Hoist platforms shall have suitable side and overhead protection to prevent operator injury from a falling load.

35.6.3.2.2. Signals. Standard operating signals, understood by operators and signalers, shall be used in hoist operations. Refer to **Figure 35.21** for examples of approved signals.

35.6.3.2.3. Engines and Motors. Hoist engines and motors shall be guarded to protect personnel.

35.6.3.2.4. Brakes. Self locking brakes, capable of holding at least 125 percent of the rated capacity, shall be installed on all hoists.

35.6.3.2.5. Electric Hoists. The conductors and switches of electric hoists shall be guarded against accidental contact.

35.6.3.2.6. Loads. All loads shall be balanced on hoist carriages and secured to prevent slipping or shifting.

35.6.3.2.7. Slack Chain. A chain container shall be provided where slack chain hanging from a hoist may be a hazard.

35.6.3.2.8. Hooks. Latch-type safety hooks shall be installed on all hoists.

35.6.3.2.9. Load Rating. The rated capacity shall be permanently marked on the hoist or its load block and shall be legible from the operating position. The rated capacity for each member of the suspension device, when used as intended, shall be equal to the other suspension members to which it is attached. When this is not feasible, a plan shall be developed to identify special precautions that shall be taken to ensure the lowest rated suspension member's rated capacity is not exceeded.

35.6.3.2.10. Warnings. Information concerning operating procedures shall be posted by all hoists or displayed on a label affixed to the hoist, controls or block, as referenced in ANSI B30.16, *Overhead Hoists (Underhung)*, and shall include cautions regarding:

35.6.3.2.10.1. Lifting more than the rated capacity.

35.6.3.2.10.2. Operating the hoist when the hook is not centered under the hoist.

35.6.3.2.10.3. Operating a damaged or malfunctioning hoist.

35.6.3.2.10.4. Operating a rope hoist with a rope not properly seated in its groove.

35.6.3.2.10.5. Lifting people or loads over people.

35.6.3.2.10.6. Operating the hoist with twisted, kinked or damaged chain or rope.

35.6.3.2.10.7. Removing or obscuring the warning label.

35.6.3.2.11. Pendants. The pendant station shall be supported by a cable, chain or rope that will protect the electrical conductors against strain. Pendant control stations shall be constructed to prevent electrical shock and shall be clearly marked for identification of functions.

35.6.3.2.12. Support. The supporting structure of the hoist, including tripod, trolley, monorail, crane or facility beam shall be designed to withstand the load and forces imposed by the hoist.

35.6.3.2.13. Location. The hoist shall be installed to give the operator room to remain clear of the load at all times.

35.6.3.2.14. Remote Operated Hoists. Remote operated hoists shall function so that if the central signal for any hoist motion becomes ineffective, hoist motion shall stop.

35.6.3.2.15. Tag Lines. Tag lines shall be used on free-swinging loads to help guide and prevent striking nearby objects.

35.6.3.2.16. Upper Limit Switches. Upper limit switches shall be installed and operable on all powered hoists.

35.6.3.3. Qualification of Operators. Manually operated hoists shall be operated only by personnel trained and qualified to use the equipment or trainees under direct supervision of a qualified trainer/instructor. Power operated hoists shall be operated only by trained

and qualified persons designated by the appropriate supervisor. The operator shall be familiar with all hoist operating controls and be instructed in the operations to be performed. Training shall include the warnings on the hoist, manufacturer's instructions and requirements outlined in paragraphs [35.6.3.4.1](#) and [35.6.3.4.2](#) below. Maintenance and test personnel and qualified inspectors may also operate hoists in the performance of their duties.

#### 35.6.3.4. Safe Operations.

##### 35.6.3.4.1. Operating Practices.

35.6.3.4.1.1. Operators who must divert their attention while operating a hoist will stop the hoist.

35.6.3.4.1.2. When an **AF Form 979**, *Danger*, **AF Form 981**, *Out of Order*, **AF Form 982**, *Do Not Start*, or **AF Form 983**, *Danger – Equipment Lockout*, tag is attached to the starting controls, the hoist operator shall not apply power to the unit or start operations until the condition has been corrected and the tag and any lock(s) are removed. Requirements for tags and locks are prescribed in [Chapter 21](#), *Hazardous Energy Control (Lockout and Tagout)*, and [Chapter 29](#), *Mishap Prevention Signs and Tags*. Refer to paragraph [35.6.3.6.5.1](#) for additional guidance.

35.6.3.4.1.3. Before starting the hoist, the operator shall ensure all personnel are clear of the area.

35.6.3.4.1.4. The operator shall be familiar with the equipment and its proper care. If adjustments or repairs are necessary or any damage is observed or suspected, the operator shall promptly report the problem to the supervisor.

35.6.3.4.1.5. Operators shall ensure their hands are clear of all moving parts before operating hoists.

35.6.3.4.1.6. On chain hoists, the operator shall have safe access to the hand chain.

35.6.3.4.1.7. Manual hoists shall never be operated by other than hand power.

##### 35.6.3.4.2. Handling the Load.

35.6.3.4.2.1. The rated capacity shall not be exceeded except for properly authorized tests. If it is known or suspected that a hoist may have been overloaded (other than a required and approved test load), the supervisor shall ensure that all frequent and periodic inspections are completed prior to use. Refer to paragraphs [35.6.3.5.1](#) and [35.6.3.5.2](#).

35.6.3.4.2.2. The hoisting rope or chain shall not be wrapped around the load.

35.6.3.4.2.3. The load shall be attached to the hook, equipped with a safety latch, by means of slings or other devices designed specifically for the load being lifted.

35.6.3.4.2.4. Slings or other devices shall be seated properly in the saddle of the hook before lifting operations begin.

35.6.3.4.2.5. The load shall not be moved or lifted more than a few inches until it is well balanced in a sling or lifting device and center of gravity is known.

35.6.3.4.2.6. Hoisting the load. Ensure that:

35.6.3.4.2.6.1. Hoist ropes or chains are not twisted about each other.

35.6.3.4.2.6.2. The load does not contact any obstruction.

35.6.3.4.2.6.3. Ropes or chains are protected against sharp edges of the load.

35.6.3.4.2.7. The rope or chain shall be properly seated on the drum sheaves or sprockets before starting the lift.

35.6.3.4.2.8. Hoists shall not be operated until the hoist unit is centered over the load.

35.6.3.4.2.9. A hoist shall not be used for hoisting personnel unless specifically designed for this purpose and only if it is the safest means of accomplishing the work.

35.6.3.4.2.10. Loads shall not be carried over personnel.

35.6.3.4.2.11. The operator shall test the brakes each time a load is handled by raising the load just enough to clear the floor or supports and checking for brake action. The lift shall be continued only after ensuring the braking system is operating properly.

35.6.3.4.2.12. No loaded rope hoist drum shall be lowered where less than two (2) wraps of rope remain on the drum. Distinctive rope markings may be used to warn the operator the rope wrap limit is being reached.

35.6.3.4.2.13. The operator shall inch the hoist upward to engage a load and avoid unnecessary stops and starts.

35.6.3.4.2.14. Suspended loads shall not be left unattended.

35.6.3.4.2.15. The upper limit device shall not be used as a normal operating control except to inch the hook into place for storage between uses.

35.6.3.4.2.16. If a load must remain suspended for a considerable time, a pawl or other equivalent means, rather than the brake alone, shall be used to hold the load. The ground area below the suspended load shall be barricaded to prohibit entry of personnel or equipment.

35.6.3.4.2.17. Excessive jogging or inching (rapid, repeated starts and stops) of hoist controls shall be avoided. Premature wear or possible uncontrolled movement could occur.

35.6.3.4.3. Personal Protective Equipment (PPE).

35.6.3.4.3.1. Protective helmets shall be worn if there is a potential for injury from falling objects or moving equipment.

35.6.3.4.3.2. Safety-toe shoes shall be worn by all personnel involved in materials handling when there is a danger of injuries.

35.6.3.4.3.3. Safety goggles shall be worn when eye injury hazards, such as work-generated dirt, dust or other airborne particles are present.

35.6.3.4.3.4. Gloves shall be worn by workers performing hooking, unhooking, loading, handling tag lines or unloading operations, when there is a potential for injury from punctures and severe cuts, lacerations and abrasions.

35.6.3.5. Inspections. The following items shall be inspected for damage or wear at intervals specified, including observations during operation. Deficiencies shall be carefully examined and the operator and shop or facility supervisor shall determine if they are a safety hazard.

35.6.3.5.1. Frequent. The inspection will include:

35.6.3.5.1.1. Past inspection records — review for discrepancies and inspection dates.

35.6.3.5.1.2. All controls and operation mechanisms — inspect for proper operation as described in paragraph [35.6.3.7.1](#). On pendant controls, inspect the electrical and support cable for condition and ensure all labels are present and legible.

35.6.3.5.1.3. All safety devices, including the upper limit switches — check for proper operation as described in paragraph [35.6.3.7.1](#). The block or hoist shall be “inched” into the limit switch, or running at slow speed on multi- or variable-speed hoists, to prevent possible damage.

35.6.3.5.1.4. Air and hydraulic systems — inspect for deterioration or leakage.

35.6.3.5.1.5. Hoist chains — inspect and document as outlined in paragraph [35.11.3.1](#).

35.6.3.5.1.6. Hoist braking system — check for proper operation.

35.6.3.5.1.7. Hooks — inspect and document as outlined in paragraph [35.11.5.1](#). Hooks having more than five (5) percent of normal throat opening or any apparent bend or twist from the plane from the original baseline measurements shall be replaced.

35.6.3.5.1.8. Wire ropes — inspect and document as outlined in paragraph [35.11.2.2](#).

35.6.3.5.1.9. Other components or hardware — inspect for general security and serviceability.

35.6.3.5.2. Periodic. The periodic inspection shall include items in paragraph [35.6.3.5.1](#), plus the following:

35.6.3.5.2.1. Past inspection records, AFTO Forms 95 and 244, and any other paper or electronic system records — review for anomalies and discrepancies.

35.6.3.5.2.2. Drums, load sprockets, and sheaves — check for cracks, uneven wear or other damage. Sheave grooves shall be smooth and free from surface irregularities which could cause rope damage.



35.6.3.5.2.3. Motor or load brake — inspect for excessive wear.

35.6.3.5.2.4. Wire ropes — inspect and document as outlined in paragraph [35.11.2.2](#).

35.6.3.5.2.5. Hoist chains — inspect and document as outlined in paragraph [35.11.3.1](#).

35.6.3.5.2.6. Hooks — inspect and document as outlined in paragraph [35.11.5.1](#). Hooks having more than five (5) percent of normal throat opening or any apparent bend or twist from the plane from the original baseline measurements shall be replaced.

35.6.3.5.2.7. Friction disc — check for wear, glazing or oil contamination.

35.6.3.5.2.8. Pawls, cams or ratchets on brake mechanisms — check for wear.

35.6.3.5.2.9. Pawl springs — look for corroded, stretched or broken springs.

35.6.3.5.2.10. Hook blocks, suspension housing, outrigger, hand chain wheels, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins, rollers, locking and clamping devices — look for worn, cracked, corroded or distorted parts.

35.6.3.5.2.11. Supporting structure — check continued ability to support the imposed loads.

35.6.3.5.2.12. Controller contactors, limit switches and push button stations on electrical apparatus — look for signs of pitting or deterioration.

35.6.3.5.2.13. Fasteners — check for evidence of loosening.

35.6.3.5.2.14. Nuclear-certified hoists—see additional requirements in paragraphs [35.6.3.7.3](#) and [35.11.5.1.4](#).

#### 35.6.3.6. Maintenance.

35.6.3.6.1. Preventive Maintenance. The using organization shall establish a preventive maintenance program based on the manufacturer's recommendations. If manufacturer's instructions cannot be obtained, the using organization shall contact the Air Force equipment item manager for assistance. Preventive maintenance shall be documented on the AFTO Form 244, AFTO Form 95 or MAJCOM or locally devised paper or automated system IAW paragraph [35.1.1](#), as appropriate. These records shall be maintained for the life of the equipment at a location determined by the user.

35.6.3.6.2. Lubrication. All moving parts of the hoist for which lubrication is specified shall be regularly lubricated. Manufacturer's or TO recommendations for points and frequency of lubrication and quantity and type of lubricant to be used shall be followed. Machinery shall be stationary, with energy sources locked out, while lubricants are applied. Refer to paragraph [35.6.3.6.5.3](#) for additional information.

35.6.3.6.3. Rope Replacement and Maintenance. Refer to paragraphs [35.11.2.3](#) and [35.11.2.4](#).

35.6.3.6.4. Adjustments and Repairs. Repair, replacements or adjustments shall be made as necessary to ensure correct performance of all hoist components.

35.6.3.6.4.1. Replace all worn braking components such as friction discs, ratchets, pawls and pawl springs.

35.6.3.6.4.2. Replace worn, corroded or otherwise damaged load chain and rope.

35.6.3.6.4.3. Replace hooks showing defects (see paragraph [35.11.5.1](#)). Repair or replace damaged hook safety latches.

35.6.3.6.4.4. Replace load supporting components which are cracked, bent or excessively worn.

35.6.3.6.4.5. Replace missing or illegible warning labels.

35.6.3.6.4.6. Replace pitted or burned electrical contacts in sets only. Lubricate controller parts as recommended by the manufacturer.

35.6.3.6.4.7. Keep pendant control stations clean and function labels legible.

35.6.3.6.4.8. Adjust all functional operating mechanisms, brakes and pawls, limit switches and other limiting devices to ensure correct functioning.

35.6.3.6.5. Maintenance Procedures. The following precautions shall be taken before adjustments or repairs are started on a hoist:

35.6.3.6.5.1. A lock and **AF Form 983**, *Danger – Equipment Lockout*, tag shall be placed on the hoist and all energy controls (air, electrical, hydraulic, etc.) locked out IAW [Chapter 21](#) when adjustments, modifications or repairs are scheduled. The hoist operator will not apply power to the equipment or start operations until the conditions have been corrected and the tag and lock removed IAW [Chapter 21](#).

35.6.3.6.5.2. Drum pawls shall be engaged or other means provided to prevent load ropes from inadvertently rotating the mechanism.

35.6.3.7. Testing.

35.6.3.7.1. Operational Tests. All new hoists and those which have had load-suspension parts altered, replaced or repaired shall be operationally tested before use. The test shall consist of operating all functions of the hoist under a no-load condition to test all functions of the hoist, including hoisting and lowering, operation of brakes and testing of all limit, locking and safety devices. Trip-setting of limit devices shall be determined by tests under no-load conditions. Conduct tests first by hand, if practical, and then under slowest possible speed. Test with increasing speeds up to maximum speed. Actuated mechanisms shall be located so they trip switches or limiting devices in sufficient time to stop motion without damage to the hoisting arrangement. On hoists having adjustable trip-setting limit devices, care shall be exercised to achieve adjustment setting without the load block striking the hoist frame or without all the slack being taken out of the unloaded chain or less than one wrap of rope on the drum.

35.6.3.7.2. Load Tests. Prior to initial use, all new hoists shall be tested at not less than 100 percent or more than 125 percent of the rated load by the manufacturer or a qualified person. Using organizations will maintain written certification that all required load testing has been accomplished. A hoist with altered, replaced or repaired load suspension parts shall be tested at not less than 100 percent or more than 125 percent of the rated load prior to being returned to service. This load test shall include all functions outlined in paragraph [35.6.3.7.1](#). The replacement of load chain or rope is specifically excluded from this test; however, an operational test under a no-load condition shall be conducted prior to putting the hoist back into service. Refer to paragraph [35.6.3.7.1](#). Maintain records of these tests as required by paragraph [35.6.3.8](#).

35.6.3.7.3. Test nuclear-certified hoists, as required, in paragraphs [35.6.3.7.1](#) and [35.6.3.7.2](#) and annually thereafter at not less than 100 percent or more than 125 percent of rated capacity. Perform annual tests in conjunction with one of the two semiannual inspections. Refer to note in paragraph [35.6.3.5.2](#).

35.6.3.7.4. Hoists required to lift critical loads, as defined in [Attachment 1, Terms](#), shall be tested as stated in paragraphs [35.6.3.7.1](#) and [35.6.3.7.2](#) and annually thereafter at not less than 100 percent or more than 125 percent of rated capacity. Air Force materials shall be designated as critical loads for purposes of lifting or hoisting by an appropriate Program Manager or the functional manager at the facility where the lift will occur. Items for consideration in making a critical load determination include, but are not limited to:

35.6.3.7.4.1. Personnel injury or significant adverse health impact.

35.6.3.7.4.2. Damage resulting in serious economic consequences (non-availability of funds to repair or replace item).

35.6.3.7.4.3. Damage resulting in unacceptable delay to schedule (mission impairment) or adverse programmatic impact (e.g., loss of vital data).

35.6.3.7.4.4. Undetectable damage that would jeopardize future operations or safety of a facility.

35.6.3.7.4.5. Damage that may occur without exceptional care in handling because of close-tolerance installation, high susceptibility to damage or other unusual characteristic.

35.6.3.7.4.6. Damage that would result in significant release of hazardous materials.

35.6.3.7.4.7. Damage that may occur because the item, although non-critical, must be lifted above a critical item, e.g., loads of any sort in close proximity to a nuclear component or near concentrations of hazardous materials.

35.6.3.7.5. Test weights utilized for rated load tests shall be tagged or adequately marked indicating total weight in pounds and owner or agency identification number. Reinforcing (rebar) steel shall not be used for test weight lift points.

35.6.3.7.6. Inspections shall be documented on AFTO Form 95 or MAJCOM or locally devised paper or automated systems as outlined in paragraph [35.6.3.8](#).

35.6.3.8. Historical Records. A MAJCOM or locally devised paper or automated system, with dated and signed record of all periodic inspections, repairs and tests shall be maintained indefinitely in a location determined by the user. Refer to paragraph **35.1.1** for additional guidance.

### **35.7. Slings.**

35.7.1. Hazards. Improper use of slings can cause injury, death and property damage. Mishaps often occur when loads are dropped or slip because the sling or its attachments break. Most sling mishaps can be attributed to inadequate design, improper selection, poor inspection, failure to make sure loads are properly attached and secured, or improper storage and care. Common causes for sling mishaps include:

35.7.1.1. Use of damaged or defective slings.

35.7.1.2. Unauthorized modifications to slings.

35.7.1.3. Kinks in supporting ropes and cables.

35.7.1.4. Overloaded slings.

35.7.1.5. Improperly balanced loads which allow them to slip.

35.7.1.6. Loads not securely attached to the slings.

35.7.1.7. Not using pads to protect sling from sharp edges or corners.

35.7.1.8. Loads hitting obstructions.

35.7.1.9. Personnel standing or walking under suspended loads.

35.7.1.10. Personnel placing hands between sling and load before sling is tightened around load.

35.7.1.11. Sling failure caused by damage when slings are pulled from under a load.

35.7.1.12. Improperly rigged loads.

35.7.1.13. Use of unauthorized equipment such as cargo straps, as slings.

### **35.7.2. General Requirements.**

35.7.2.1. Acquisition. Slings procured for Air Force use shall comply with design and manufacturing requirements in 29 CFR 1910.184, *Slings*, and ANSI/ASME B30.9, *Slings*. Specifications for procurement of slings shall contain enough information to ensure that manufacturers comply with all design, construction and testing criteria contained in references above. **Note:** Locally manufactured slings that do not meet the engineering requirements of ANSI/ASME B30.9 are prohibited and shall be disassembled and removed from service.

35.7.2.2. Identification and Marking. Slings shall be marked or identified on the sling or on durable and legible tags or labels as follows:

35.7.2.2.1. Alloy steel chain slings shall be permanently marked with size, manufacturer's grade, rated capacity and angle upon which the rating is based, its reach, number of legs and manufacturer's name.

35.7.2.2.2. Wire rope slings shall be marked with the rated capacity and manufacturer.

35.7.2.2.3. Metal mesh slings shall have a durable marking permanently attached that states the rated capacity for vertical basket hitch and choker hitch loadings, and marked with the manufacturer's name.

35.7.2.2.4. Synthetic web slings shall be permanently marked with the name of the manufacturer, the manufacturer's code or stock number, the rated capacity for types of hitches used and the type of synthetic material used.

### 35.7.2.3. Inspections.

35.7.2.3.1. Frequent. A visual inspection shall be performed by the operator or designated person daily or prior to use. If damage, defects or abuse is detected, the sling shall be removed from service until periodic testing is done. This inspection will be documented on AFTO Form 244. Refer to paragraph [35.1.1](#) concerning use of paper forms and automated systems.

35.7.2.3.2. Periodic. The following items will be inspected:

35.7.2.3.2.1. Remove all dirt, grease or oil from all sling components.

35.7.2.3.2.2. Visually inspect all parts for excessive wear, deformations, fraying, stretching and any other defects that may reduce the sling's rated capacity. Refer to the specific requirements of paragraphs [35.7.3.1](#) through [35.7.3.5](#).

35.7.2.3.2.3. Remove sling from service if any component shows defects or deterioration as noted in paragraphs [35.7.3.1](#) through [35.7.3.5](#).

35.7.2.4. Testing. (**Note:** For nuclear-certified slings and wire rope assemblies, use the appropriate 11N series TOs for testing criteria.)

35.7.2.4.1. Proof Testing. Prior to initial use, all new slings shall be proof tested by the manufacturer or a qualified person. See requirements for specific types of slings in paragraphs [35.7.3.1.1](#), [35.7.3.2.1](#), [35.7.3.3.1](#), [35.7.3.4.1](#), and [35.7.3.5.1](#). Using organizations shall maintain written certification that all required proof testing has been accomplished. **Note:** Written proof test certification is not required for new synthetic rope and web slings manufactured IAW ASME B30.9 and not used to lift nuclear or critical loads. However, repaired synthetic rope and web slings shall be proof tested IAW paragraph [35.7.2.4.2](#).

35.7.2.4.2. All repaired and reconditioned slings shall be proof tested by the manufacturer or a qualified person IAW the specific requirements of paragraphs [35.7.3.1.1](#), [35.7.3.3.1](#), and [35.7.3.5.1](#) prior to being returned to service. A record of the most recent proof test shall be retained on file.

35.7.2.4.3. Load Testing. Any periodic load testing of slings, spreader-bars, lifting beams or other specialized lifting attachments at any load above rated capacity is not a recognized inspection procedure under OSHA's interpretation of 29 CFR 1910.184(e)(4). Periodic load testing shall only be accomplished with written permission and procedural guidance from the sling manufacturer or equivalent Air

Force organization (e.g., the specific equipment TO or the item manager for locally manufactured equipment).

### 35.7.3. Specific Requirements.

#### 35.7.3.1. Alloy Steel Chain Slings.

35.7.3.1.1. Prior to use, all new, repaired or reconditioned alloy steel chain slings, including all welded components in the sling assembly, shall be proof tested to 200 percent of rated capacity.

35.7.3.1.1.1. For multiple leg slings, each leg shall be proof tested to 200 percent of the single leg rated load.

35.7.3.1.1.2. Master links and master coupling links for double or triple leg slings shall be proof tested to 200 percent of the single leg rated load times the number of legs connected to the link.

35.7.3.1.2. Hooks, rings, oblong or pear-shaped links, welded or mechanical coupling links or other attachments shall have a rated capacity at least equal to that of the alloy steel chain with which they are used. The sling shall not be proof tested in excess of the rated capacity of the weakest component.

35.7.3.1.3. Unauthorized makeshift links or fasteners, such as those formed from bolts or rods, shall not be used.

35.7.3.1.4. Alloy steel chain slings shall not be used with loads more than the rated capacities prescribed in **Table 35.1**. Slings not included in this table shall be used only IAW the manufacturer's recommendations.

35.7.3.1.5. Alloy steel chain slings shall be permanently removed from service if exposed to heat above 1,000 degrees Fahrenheit (F). When exposed to service temperature in excess of 600 degrees F, maximum working load limits permitted in **Table 35.1** shall be reduced according to the chain or sling manufacturer's recommendations.

35.7.3.1.6. Worn or damaged alloy steel chain slings and attachments shall not be used until repaired (or reconditioned) and proof tested by the manufacturer or a qualified person.

35.7.3.1.7. Mechanical coupling links or low carbon steel repair links shall not be used to repair broken lengths of chain.

35.7.3.1.8. If the chain size at any point of any link is less than that stated in **Table 35.2** the sling shall be removed from service.

35.7.3.1.9. Alloy steel chain slings with cracked or deformed master links, coupling links or other components shall be removed from service.

35.7.3.1.10. Slings will be removed from service if hooks are cracked, have any visibly apparent bend or twist from the plane of the unbent hook (original manufacturer or baseline measurements), any distortion causing an increase in throat opening of five (5) percent, not to exceed ¼ inch (or as recommended by the

manufacturer), or any wear exceeding 10 percent (or as recommended by the hook manufacturer) of the original manufacturer or baseline section dimension of the hook. Refer to paragraph [35.11.5.1](#).

#### 35.7.3.2. Wire Rope Slings.

35.7.3.2.1. Prior to initial use, all new wire rope slings shall be proof tested as follows:

35.7.3.2.1.1. Proof load for swaged-socket and poured-socket assemblies shall be IAW the wire rope or fitting manufacturer's recommendations.

35.7.3.2.1.2. Proof load for single leg hand tucked slings shall be not less than 100 percent or more than 125 percent of the rated capacity.

35.7.3.2.1.3. Proof load for mechanical splice single leg slings and endless slings shall be 200 percent of the vertical rated capacity.

35.7.3.2.1.4. Proof load for multiple leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single leg sling of the same size, grade and construction of rope.

35.7.3.2.2. Wire rope slings shall not be used with loads in excess of capacities shown in [Table 35.3](#) through [Table 35.14](#) Slings not included in these tables shall be used only IAW the manufacturer's recommendations.

35.7.3.2.3. Minimum sling lengths are determined as follows:

35.7.3.2.3.1. Cable laid and 6 by 19 and 6 by 37 slings shall have a minimum clear length of wire rope between splices, sleeves or end fittings 10 times the component rope diameter.

35.7.3.2.3.2. Braided slings shall have a minimum clear length of wire rope between loops or end fittings 40 times the component rope diameter.

35.7.3.2.3.3. Cable laid grommets, strand laid grommets and endless slings shall have a minimum circumferential length of 96 times their body diameter.

35.7.3.2.4. Fiber core wire rope slings of all grades shall be permanently removed from service if exposed to temperatures in excess of 200 degrees F. When nonfiber core wire rope slings of any grade are used above 400 degrees F or below minus 60 degrees F, sling manufacturer recommendations regarding use at that temperature shall be followed.

35.7.3.2.5. End attachments, except covers to thimbles, shall be welded before the sling is assembled.

35.7.3.2.6. Welded end attachments shall be proof tested at twice their rated capacity prior to initial use. The owning agency shall maintain a record or certificate of proof test and make it available for inspection.

35.7.3.2.7. Wire rope slings shall be removed from service if any of the following conditions are present:

35.7.3.2.7.1. Ten randomly distributed broken wires in one rope lay or five

broken wires in one strand in one rope lay.

35.7.3.2.7.2. Wear or scraping of 1/3 the original diameter of outside individual wires.

35.7.3.2.7.3. Kinking, crushing, bird caging or any other damage that distorts the wire rope structure.

35.7.3.2.7.4. Heat damage.

35.7.3.2.7.5. Cracked, deformed or worn end attachments.

35.7.3.2.7.6. Sling hooks that have any visibly apparent bend or twist from the plane of the unbent hook (original manufacturer or baseline measurements), any distortion causing an increase in throat opening of five (5) percent, not to exceed ¼ inch (or as recommended by the manufacturer), or any wear exceeding 10 percent (or as recommended by the hook manufacturer) of the original manufacturer or baseline section dimension of the hook. Refer to paragraph [35.11.4.1](#).

35.7.3.2.7.7. Corrosion of rope or end attachments.

35.7.3.2.8. Only new rope shall be used to fabricate slings. Use of repaired or reconditioned rope is prohibited.

35.7.3.2.9. Slings used in a choker hitch shall be long enough so the choke point is on the rope and never on a splice.

### 35.7.3.3. Metal Mesh Slings.

35.7.3.3.1. All new and repaired metal mesh slings, including handles, shall be proof tested at a minimum of 150 percent of their rated capacity before use. Elastomer impregnated slings shall be proof tested before they are coated.

35.7.3.3.2. Handles shall have a rated capacity at least equal to the metal fabric and exhibit no deformation after proof testing.

35.7.3.3.3. The fabric and handles shall be joined so that:

35.7.3.3.3.1. The rated capacity of the sling is not reduced.

35.7.3.3.3.2. The load is evenly distributed across the width of the fabric.

35.7.3.3.3.3. Sharp edges shall not damage the fabric.

35.7.3.3.4. Coatings which damage the sling and diminish the rated capacity shall not be applied.

35.7.3.3.5. Except for required proof tests, metal mesh slings shall not be used to lift loads in excess of their rated capacities prescribed in [Table 35.15](#) Slings not included in this table shall be used only IAW the manufacturer's recommendations.

35.7.3.3.6. Metal mesh slings not impregnated with elastomers may be used from minus 20° F to 550° F without decreasing the working load limit. Metal mesh slings impregnated with polyvinyl chloride or neoprene may be used only from 0°F to 200° F. For operations outside these temperature ranges or for metal mesh slings



impregnated with other materials, the sling manufacturer's recommendations shall be followed.

35.7.3.3.7. Metal mesh slings shall be removed from service if any of the following conditions are present:

35.7.3.3.7.1. Broken weld or broken brazed joint along the sling edge.

35.7.3.3.7.2. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.

35.7.3.3.7.3. Lack of flexibility due to distortion of the fabric.

35.7.3.3.7.4. Distortion of the female handle so slot depth is increased more than 10 percent.

35.7.3.3.7.5. Distortion of either handle so width is decreased more than 10 percent.

35.7.3.3.7.6. Reduction of 15 percent of the original cross-sectional area of metal at any point around the handle eye.

35.7.3.3.7.7. Distortion of either handle out of its plane.

35.7.3.3.7.8. Cracked end fitting.

35.7.3.3.7.9. A broken wire in any part of the mesh.

35.7.3.4. Natural and Synthetic Fiber Rope Slings.

35.7.3.4.1. Prior to use, new fiber rope slings shall be proof tested to 200 percent of the vertical rated load. **Note:** Written proof test certification is not required for new synthetic rope slings manufactured IAW ASME B30.9, *Slings*, and not used to lift nuclear or critical loads.

35.7.3.4.2. Fiber rope slings made from conventional three-strand construction rope shall not be used with loads in excess of rated capacities in **Table 35.16** through **Table 35.19**

35.7.3.4.3. Cargo straps shall not be used as a sling or part of a sling configuration.

35.7.3.4.4. Slings not included in these tables shall be used only IAW the manufacturer's recommendations.

35.7.3.4.5. Fiber rope slings shall have a diameter of curvature not less than that specified in **Figure 35.18** and **Figure 35.19**

35.7.3.4.6. Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from (minus) 20°F to (positive) 180°F without decreasing the working load. For operations outside this temperature range and for wet frozen slings, or where rope and slings have been stored in a chemically active environment, the sling manufacturer's recommendations shall be followed.

35.7.3.4.7. Spliced fiber rope slings shall not be used unless spliced IAW the following minimum requirements and any additional manufacturer recommendations:

35.7.3.4.7.1. In manila rope, eye splices shall consist of at least three (3) full

tucks. Short splices shall consist of at least six (6) full tucks, three (3) on each side of the splice center line.

35.7.3.4.7.2. In synthetic fiber rope, eye splices shall consist of at least four (4) full tucks. Short splices shall consist of at least eight (8) full tucks, four (4) on each side of the center line.

35.7.3.4.7.3. Strand end tails shall not be trimmed flush with the surface of the rope immediately adjacent to the full tucks. This applies to all types of fiber rope and both eye and short splices. For fiber rope, the tail shall project at least six (6) rope diameters beyond the last full tuck. Where a projecting tail interferes with the use of the sling, the tail shall be tapered and spliced into the body of the rope using at least two (2) additional tucks (which shall require a tail length of approximately six (6) rope diameters beyond the last full tuck).

35.7.3.4.7.4. Fiber rope slings shall have a minimum clear length of rope between eye splices equal to 10 times the rope diameter.

35.7.3.4.7.5. For all eye splices, the eye shall be sized to provide an included angle of not greater than 60 degrees at the splice when the eye is placed over the load or support.

35.7.3.4.7.6. Only clamps specifically designed for fiber ropes shall be used for splicing.

35.7.3.4.7.7. Knots shall not be used in lieu of splices.

35.7.3.4.8. Fiber rope slings shall not be used if end attachments that contact the rope have sharp edges or projections.

35.7.3.4.9. Natural and synthetic fiber rope slings shall be removed from service if any of the following conditions are present:

35.7.3.4.9.1. Abnormal wear.

35.7.3.4.9.2. Powdered fiber between strands.

35.7.3.4.9.3. Broken or cut fibers.

35.7.3.4.9.4. Variations in size or roundness of strands.

35.7.3.4.9.5. Discoloration or rotting.

35.7.3.4.9.6. Distortion of hardware in the sling.

35.7.3.4.10. Only new rope shall be used to make fiber rope slings. Use of repaired or reconditioned fiber rope slings is prohibited.

#### 35.7.3.5. Synthetic Web Slings.

35.7.3.5.1. Prior to use, all new and repaired synthetic web slings shall be proof tested to 200 percent of rated capacity. **Note:** Written proof test certification is not required for new synthetic rope slings manufactured IAW ASME B30.9, *Slings*, and not used to lift nuclear or critical loads.

35.7.3.5.2. Synthetic webbing shall be of uniform thickness and width, and selvage edges shall not be split from the webbing's width.

35.7.3.5.3. Fittings shall be:

35.7.3.5.3.1. Of a minimum breaking strength equal to that of the sling.

35.7.3.5.3.2. Free of all sharp edges that could damage the webbing.

35.7.3.5.4. Stitching shall be the only method used to attach end fittings to webbing and to form eyes. The thread shall have an even pattern and contain a sufficient number of stitches to develop the full breaking strength of the sling.

35.7.3.5.5. Except for required proof tests, synthetic web slings illustrated in **Figure 35.20** shall not be used with loads in excess of rated capacities specified in **Table 35.20** through **Table 35.22**. Slings not included in these tables shall be used only IAW the manufacturer's recommendations.

35.7.3.5.6. When synthetic web slings are used, the following precautions shall be taken:

35.7.3.5.6.1. Nylon web slings shall not be used where acid or phenolic fumes, vapors, sprays, mists or liquids are present.

35.7.3.5.6.2. Polyester and polypropylene web slings shall not be used where caustic fumes, vapors, sprays, mists or liquids of acids are present.

35.7.3.5.6.3. Web slings with aluminum fittings shall not be used where caustic fumes, vapors, sprays, mists or liquids are present.

35.7.3.5.7. Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180° F. Polypropylene web slings shall not be used at temperatures in excess of 200° F.

35.7.3.5.8. Slings, including webbing and fittings, with temporary or makeshift repairs shall not be used.

35.7.3.5.9. Synthetic web slings shall be removed from service if any of the following conditions are present:

35.7.3.5.9.1. Damage from acid or caustic materials.

35.7.3.5.9.2. Melting or charring of any part of sling surface.

35.7.3.5.9.3. Snags, punctures, tears or cuts.

35.7.3.5.9.4. Broken or worn stitches.

35.7.3.5.9.5. Distortion of fittings.

35.7.3.5.10. When not in use, slings shall be stored in clean, dry areas that will protect the sling materials.

**35.8. Overhead, Gantry, and Underhung Cranes and Monorail Systems.** This paragraph outlines requirements for overhead and gantry cranes, including top-running single or multiple girder bridge with top-running trolley hoists, top-running single-girder bridge with underhung hoists and monorails/underhung cranes and others having the same fundamental characteristics.

Hoist requirements of paragraph 35.6 are applicable to this chapter. Hoist requirements of this chapter also apply to hoists used as components of cranes or monorail systems.

35.8.1. Hazards. The most serious injury potential from cranes and monorails is caused by loads contacting personnel. Bruises, lacerations, pinching and fractures are associated with loading, unloading and load transporting operations. Common operator errors include:

35.8.1.1. Striking personnel or objects with moving loads.

35.8.1.2. Personnel falling from equipment.

35.8.1.3. Dropping or slipping loads, usually caused by improper hitching or slinging.

35.8.1.4. Personnel not wearing required PPE, such as hard hats, gloves, safety-toe shoes and eye protection.

35.8.1.5. Overloading.

35.8.1.6. Obstruction to free passage of load.

35.8.1.7. Misuse of equipment.

35.8.1.8. Inadvertent movement of equipment or loads.

35.8.1.9. Failure to use available safety devices such as brakes, locks and warning signals.

35.8.1.10. Failure to detect equipment deficiencies or malfunctions.

35.8.1.11. Acceptance of “minor” deficiencies, which can develop into major or critical deficiencies.

35.8.1.12. Deviation from approved procedures.

35.8.1.13. Improper and insufficient training.

35.8.2. Requirements.

35.8.2.1. Acquisition.

35.8.2.1.1. All new overhead and gantry cranes constructed and installed on or after 31 August 1971 will meet ANSI/ASME B30.2, *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)*, and B30.11, *Monorails and Underhung Cranes*. Cranes constructed before 31 August 1971 shall be modified to conform to these design specifications, unless a qualified person can show the crane cannot feasibly or economically be altered and substantially complies with requirements of this standard. Contracts for procurement of overhead and gantry cranes shall mandate compliance with CMAA 70, *Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes*, or CMAA 74, *Specification for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist*, as applicable, and appropriate ANSI/ASME B30 series standards. **Note:** Nuclear-certified hoists must also meet requirements in AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*.

35.8.2.1.2. Hazards shall be identified by a System Safety Analysis, MIL-STD-882, *DoD Standard Practice for System Safety*, or commercial equivalent. The procuring activity shall specify the required analyses, such as preliminary hazard analysis or operating hazard analysis. The results of these analyses shall be included in applicable contract deliverable documents.

35.8.2.2. General.

35.8.2.2.1. Cranes may be modified and re-rated, if the modifications and the supporting structures are checked thoroughly by a qualified engineer or the equipment manufacturer. The crane shall be tested IAW paragraph 35.8.2.7. The new rated capacity shall be displayed on the crane or hoist.

35.8.2.2.2. The rated capacity of the crane shall be plainly marked on each side of the crane. If the crane has more than one hoisting unit, each unit shall have its rated capacity marked on it or its load block, and this marking shall be clearly visible from the floor or ground.

35.8.2.2.3. A minimum clearance of three (3) inches overhead and two (2) inches laterally shall be maintained between crane and obstructions.

35.8.2.2.4. Where passageways or walkways are provided, obstructions shall not be placed so the safety of personnel is jeopardized by movements of the crane.

35.8.2.2.5. The general arrangement of the cab and location of control and protective equipment shall be such that all operating handles are within convenient reach of the operator when facing the area served by the load hook or while facing the direction of travel of the cab. The arrangement shall allow the operator a full view of the load hook in all positions.

35.8.2.2.6. Pendant and cab hoist controls for trolley and bridge movement shall use compass points (north, south, east and west) as the preferred identification whenever possible.

35.8.2.2.7. Hoists utilizing synchronous controls for multiple point lifting movements shall be of failsafe design to preclude inadvertent operation caused by malfunctions of selector switches, power failure or improper sequencing of controls.

35.8.2.2.8. Access to the cab and bridge walkway shall be by a conveniently placed fixed ladder, stairs or platform requiring no step over any gap exceeding 12 inches. Fixed ladders shall be designed and installed IAW ANSI A14.3, *For Ladders - Fixed - Safety Requirements*, and 29 CFR 1910.27, *Fixed Ladders*. Also, refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders*, for specific ladder requirements.

35.8.2.2.9. A carbon dioxide or dry chemical (or equivalent) fire extinguisher rated at least 10 BC shall be kept in the cab.

35.8.2.2.10. Pendant control boxes and fixed control stations shall be constructed to prevent electrical shock and be clearly and legibly marked for identification of functions.

35.8.2.2.11. Except for floor-operated cranes, a gong, buzzer or other effective warning signal shall be provided for each power traveling crane.

35.8.2.2.12. The hoist of all electric traveling cranes shall have an over-travel limit switch in the hoisting direction.

35.8.2.2.13. Emergency descent means shall be provided on all crane cabs. Rope hand line is not acceptable. Only approved controlled descent devices shall be used.

35.8.2.2.14. Crane operators shall not be placed in situations dangerous to life, health or which may pose safety hazards.

35.8.2.2.15. Lift eyes or lift points used to attach slings, clevis, shackles or hooks shall be constructed of forged or alloy steel. Rebar steel shall not be permitted as attach points for any load.

35.8.2.2.16. Monorail Hoists. Monorail hoists shall not be used to move objects by pulling side-ways, unless designed for that purpose. Each trolley frame shall be safeguarded against spreading. Monorail track and track supports shall be installed IAW ANSI/ASME B30.11, *Monorails and Underhung Cranes*, and capable of safely carrying intended loads. Rail stops shall be provided at ends of the monorail track and will extend at least as high as the radius of the wheels. At switches, turntables and transfer tables, automatic bumpers shall drop into position to prevent the trolley running off open ends of fixed and movable track if not properly lined up with each other. Conversely, the track shall be interlocked with the bumpers so the track cannot move until rail stops are in position.

35.8.2.2.17. Refer to paragraph [35.11](#) for information on hoisting equipment, such as sheaves, ropes and equalizers.

35.8.2.3. Qualification of Operators. Cranes shall be operated only by properly trained and qualified personnel or trainees under the direct supervision of a qualified trainer/instructor as designated by the appropriate supervisor. The operator shall be familiar with all operating controls of the hoist and be instructed in operations to be performed. Instructions shall include warnings on the hoist, manufacturer's instructions and requirements in this paragraph and paragraph [35.8.2.4](#) below.

35.8.2.3.1. Cab-Operated and Pulpit-Operated Equipment.

35.8.2.3.1.1. Operators shall be qualified by military Air Force specialty training, training from a qualified person or instructor, or provide satisfactory evidence of prior qualification and experience. Qualification shall be limited to the specific type equipment for which examined.

35.8.2.3.1.2. Operators shall meet the following minimum physical qualifications of ANSI/ASME B30.5., *Mobile and Locomotive Cranes (5-3.1.2: Qualifications for Operators)*:

35.8.2.3.1.2.1. Have vision of at least 20/30 in one eye, and 20/50 in the other, with or without corrective lenses.

35.8.2.3.1.2.2. Be able to distinguish red, green and yellow, regardless of

position of colors, if color differentiation is required for operation.

35.8.2.3.1.2.3. Test for ordinary conversation in one ear, with or without a hearing aid to ensure there is adequate hearing for a specific operation.

35.8.2.3.1.2.4. Evidence of physical defect, or emotional instability which could render the operator a hazard to themselves or others, or which, in the opinion of the examiner or supervisor, could interfere with the operator's safe performance, may be sufficient cause for disqualification. In such cases, specialized clinical or medical judgments and tests may be required. **Note:** A history of epilepsy or a disabling heart condition may be sufficient reason for disqualification, upon recommendation from proper medical authority.

35.8.2.3.1.3. Potential operator trainees shall have good depth perception, field of vision, reaction time, manual dexterity or coordination and no tendencies to dizziness or similar undesirable characteristics. Physical defects such as loss of arm, hand, leg, foot or gross loss of function thereof shall be considered as cause for denial of acceptance into an entry level training program for operators.

#### 35.8.2.3.2. Floor-Operated Equipment.

35.8.2.3.2.1. Operators shall pass a practical operating examination administered by a qualified operator or instructor.

35.8.2.3.2.2. Qualification shall be limited to the specific type equipment for which examined.

#### 35.8.2.4. Safe Operations.

##### 35.8.2.4.1. Cab-Operated and Pulpit-Operated Equipment.

35.8.2.4.1.1. Equipment shall only be operated only by:

35.8.2.4.1.1.1. Qualified person.

35.8.2.4.1.1.2. Trainees under the direct supervision of a qualified person.

35.8.2.4.1.1.3. Maintenance and test personnel, when necessary in performance of their duties.

35.8.2.4.1.1.4. Qualified inspectors.

35.8.2.4.1.2. No one, other than personnel specified above, will enter a cab or pulpit, except for maintainers and supervisors whose duties require them to do so, and then only when performing their duties and with the knowledge of the operator or appointed person.

##### 35.8.2.4.2. Floor-Operated Equipment. Equipment shall only be operated by:

35.8.2.4.2.1. Qualified person.

35.8.2.4.2.2. Trainees under the direct supervision of a qualified person.

35.8.2.4.2.3. Maintenance and test personnel, when it is necessary in the performance of their duties.

35.8.2.4.2.4. Qualified inspectors.

35.8.2.4.3. Remote-Operated or Automatic Equipment. Remote control or automatic equipment involves a wide variety of service requirements and conditions. Each installation shall be carefully analyzed and the operation reviewed at least monthly for the first six (6) months to determine whether paragraph 35.8.2.4.1 or 35.8.2.4.2 will apply.

35.8.2.4.4. Operating Practices.

35.8.2.4.4.1. Operators shall not divert their attention while actually engaged in operating the equipment.

35.8.2.4.4.2. An operator shall not operate equipment when physically or mentally unfit.

35.8.2.4.4.3. The operator will respond to signals only from the person directing the lift or a designated signal person, but will obey a stop signal at all times.

35.8.2.4.4.4. Each operator shall be held directly responsible for the safe operation of the equipment. When safety is in doubt, the operator will stop and refuse to handle loads until safety has been ensured.

35.8.2.4.4.5. A warning signal, if required, shall be sounded each time before traveling and intermittently during travel, particularly when approaching personnel.

35.8.2.4.4.6. Before leaving the equipment unattended, the operator will lower the load to the ground, place controls in the “OFF” position, and open the main line switch of the equipment.

35.8.2.4.4.7. If the operator finds the main or emergency switch open (off) when starting on duty, he or she will not close it (turn it on) until making certain no one is on or about the equipment. If there is a warning tag on the main switch or the switch is locked out, only the supervisor or person placing the tag or lock shall remove it as prescribed in **Chapter 21, Hazardous Energy Control (Lockout and Tagout)**.

35.8.2.4.4.8. Before closing the main switch, the operator shall ensure all controllers are in the “OFF” position.

35.8.2.4.4.9. If power goes off during operation, the operator will immediately move all controllers to the “OFF” position.

35.8.2.4.4.10. The operator shall be familiar with the equipment and its proper care. If adjustments or repairs are necessary (or any damage is observed) the operator shall report it promptly to the appointed person and notify the next operator of the deficiencies when changing shifts. The results of the above shall be carefully recorded in the logbook, in full detail, and shall be dated and signed.

35.8.2.4.4.11. Contacts with stops or other equipment shall be made with extreme caution and only after all persons on or below equipment are aware of the action.

35.8.2.4.4.12. Before departing the work area, operators of outdoor cranes shall secure them to prevent inadvertent movement.



35.8.2.4.4.13. When a wind-indicating alarm is given, the bridge on outside cranes shall be anchored.

35.8.2.4.4.14. Before performing any maintenance work, the operator or maintainer will lock the main switch in the open position. Refer to **Chapter 21** for proper lockout/tagout procedures.

35.8.2.4.4.15. All controls shall be tested by the operator when beginning a new shift except when an operation is in progress. If any controls do not operate properly, they shall be adjusted or repaired before operations begin. Refer to **Chapter 21** for proper lockout/tagout procedures.

#### 35.8.2.4.5. Handling the Load.

35.8.2.4.5.1. Equipment shall not be loaded beyond rated capacity except for tests IAW paragraph **35.8.2.7.2**.

35.8.2.4.5.2. When attaching the load, ensure:

35.8.2.4.5.2.1. Hoist chain or hoist rope is free from kinks or twists and not wrapped around the load.

35.8.2.4.5.2.2. Load is attached to load hook by slings or other approved devices.

35.8.2.4.5.2.3. Care is taken to ensure sling clears all obstacles.

35.8.2.4.5.2.4. Slings or other approved devices are seated properly in the hook saddle before operation.

35.8.2.4.5.3. When moving the load:

35.8.2.4.5.3.1. Appointed person directing the lift shall ensure the load is secured and properly balanced in the sling or lifting device before lifting more than a few inches.

35.8.2.4.5.3.2. Before starting to lift, check that:

35.8.2.4.5.3.2.1. Hoist rope or chain is not kinked or twisted.

35.8.2.4.5.3.2.2. Multiple part lines are not twisted around each other.

35.8.2.4.5.3.2.3. The hook is brought over the load in a way that prevents swinging.

35.8.2.4.5.3.2.4. The rope is seated in drum grooves and sheaves, if there is or has been a slack rope condition.

35.8.2.4.5.3.3. Tag lines shall be used on all free swinging loads.

35.8.2.4.5.4. During hoisting, care shall be taken that:

35.8.2.4.5.4.1. There is no sudden acceleration or deceleration of the moving load.

35.8.2.4.5.4.2. Load does not contact any obstructions.

35.8.2.4.5.4.3. Equipment is not used for side pulls except when specifically

authorized by a qualified person who has determined the suitability of the equipment.

35.8.2.4.5.4.4. The operator does not hoist, lower or travel while anyone is on the load or hook unless specifically recommended by the manufacturer, approved by MAJCOM, DRU or FOA, and so indicated on a permanent name plate attached to the hoist. Refer to paragraph **35.11.7** and 29 CFR 1926.1400, *Cranes and Derricks in Construction*, for additional guidance.

35.8.2.4.5.4.5. The operator does not carry loads over personnel.

35.8.2.4.5.4.6. The operator tests the brakes each time a load is handled by raising the load two (2) inches above floor or ground level and applying the brakes.

35.8.2.4.5.4.7. The load is not lowered beyond two (2) full wraps of rope remain on the hoisting drum. (**Exception:** One wrap may remain on drum if a lower limit device is provided.) Refer to ANSI/ASME B30.2., *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)*, for additional guidance.

35.8.2.4.5.4.8. When two (2) or more cranes are used to lift one load, one designated person shall be responsible for the operation. He or she shall analyze the operation and instruct all personnel involved in proper positioning, rigging of load and movements to be made.

35.8.2.4.5.4.9. The operator shall not leave his/her position at the controls while the load is suspended.

35.8.2.4.5.4.10. A warning signal shall be given when starting the equipment and when the load or hook approaches near personnel.

35.8.2.4.5.4.11. Appropriate clearance shall be maintained between electrical power sources and any part of the crane. Refer to paragraph **35.9.2.3.39** for specific guidance.

35.8.2.4.6. Signals and Instruction. Signals to the operator shall be IAW **Figure 35.21** Voice communication equipment (telephone, radio or equivalent) shall be fully operational when used. Signals and instructions shall be distinct at all times. Hand signals, as illustrated in **Figure 35.21**, shall be conspicuously posted on or immediately near all cranes.

35.8.2.4.7. Personal Protective Equipment (PPE).

35.8.2.4.7.1. Protective helmets shall be worn if falling objects or moving equipment pose a hazard.

35.8.2.4.7.2. Safety-toe shoes shall be worn by all personnel when a foot hazard exists.

35.8.2.4.7.3. Protective safety goggles shall be worn when eye hazards, such as work-generated dirt, dust, or other airborne particles are present.

35.8.2.4.7.4. Gloves shall be worn when hooking, unhooking, loading, handling tag lines or unloading operations, and to protect hands from punctures, severe cuts, lacerations and abrasions.

35.8.2.4.7.5. Before using any PPE, refer to JSA guidance in paragraph 1.5 and **Chapter 14**, *Personal Protective Equipment (PPE)*.

#### 35.8.2.4.8. Miscellaneous Requirements.

##### 35.8.2.4.8.1. Ladders and Footwalks.

35.8.2.4.8.1.1. Workers shall keep hands unencumbered while using ladders.

35.8.2.4.8.1.2. Articles too large to be carried in pockets or belts shall be lifted and lowered by hand line.

35.8.2.4.8.1.3. Footwalks shall be kept free of loose tools, parts or other tripping hazards.

##### 35.8.2.4.8.2. Cabs.

35.8.2.4.8.2.1. Necessary clothing and personal belongings shall be stored so they do not interfere with access or operation.

35.8.2.4.8.2.2. Tools shall be stored in approved tool boxes. Wastes shall be disposed of in appropriate containers. No loose articles shall be left in or about the cab.

35.8.2.4.8.3. Fire Extinguishers. Supervisors shall ensure operators are familiar with the operation and care of fire extinguishers provided. Refer to paragraph **35.8.2.2.9** for specific guidance.

#### 35.8.2.5. Inspections.

35.8.2.5.1. Frequent. This inspection will include the items in paragraph **35.6.3.5.1**, as applicable, and the following:

35.8.2.5.1.1. The track and its support for signs of weakness, wear or misalignment.

35.8.2.5.1.2. Tanks, valves, pumps, lines and other parts of air or hydraulic systems for leakage.

35.8.2.5.2. Periodic. This inspection shall include requirements in paragraphs **35.6.3.5.2** and **35.8.2.5.1**, as applicable, plus the following:

35.8.2.5.2.1. Deformed, cracked or corroded members.

35.8.2.5.2.2. Worn, cracked or distorted parts, such as pins, bearings, wheels, shafts, gears, rollers, locking and clamping devices, bumpers, switch baffles, interlock bolts and trolley stops.

35.8.2.5.2.3. Worn drive wheels and/or tires. **Note:** For suspended powered monorail or overhead gantry systems, inspect the following in addition to requirements above:

35.8.2.5.2.3.1. Power rails for misalignment at all splices, switches and rail-

end joints.

35.8.2.5.2.3.2. All rail hangers for security.

35.8.2.5.2.3.3. Idlers at switches. Clean paths and lubricate as necessary.

35.8.2.5.2.3.4. Switches throughout rail travel for alignment.

35.8.2.5.2.4. See paragraph [35.8.2.7.3](#) for additional requirements for nuclear loads.

#### 35.8.2.6. Maintenance.

##### 35.8.2.6.1. Preventive Maintenance.

35.8.2.6.1.1. The using organization shall establish a preventive maintenance program based on the manufacturer's recommendations. If manufacturer's instructions cannot be obtained, the using organization shall contact the Air Force equipment item manager for assistance. Preventive maintenance shall be documented on AFTO Form 95 or AFTO Form 244, or MAJCOM or locally devised paper or automated system IAW paragraph [35.1.1](#), as appropriate. These records shall be maintained for the life of the equipment at a location determined by the user.

35.8.2.6.1.2. All replacement parts shall be obtained from the original equipment manufacturer or a manufacturer-approved source.

##### 35.8.2.6.2. Maintenance Procedures.

35.8.2.6.2.1. The following precautions shall be taken before adjustments and repairs are started:

35.8.2.6.2.1.1. Movable equipment shall be moved to a location where it will cause the least interference with other moving equipment and operations in the area.

35.8.2.6.2.1.2. All controllers shall be placed at the "OFF" position.

35.8.2.6.2.1.3. If electrically powered, the main or emergency switch shall be locked in an open (off) position except for tests. An AF Form 983, Danger – Equipment Lockout Tag, shall be placed on the main switch. Refer to [Chapter 21](#) for specific guidance on lockout/tagout procedures.

35.8.2.6.2.1.4. Where other moving units are in operation on the same runways or monorail track, rail stops or other suitable means shall be provided to prevent interference with the idle equipment.

35.8.2.6.2.1.5. Where temporary protective rail stops are not possible or practical, a signal person shall observe the approach of an active unit and warn the operator before reaching an unsafe distance from the idle unit.

35.8.2.6.2.2. Equipment not readily moved from its operating location can be inspected and maintained at the site, providing precautions to protect inspection and maintenance personnel.

35.8.2.6.2.3. After adjustments and repairs, the equipment shall not be operated until all guards are reinstalled, safety devices reactivated and tools and maintenance equipment removed. Lockout/tagout devices shall only be removed by the supervisor or person who attached them.

35.8.2.6.3. Adjustments and Repairs.

35.8.2.6.3.1. The using agency shall ensure any unsafe conditions disclosed by inspection are corrected before operation of the crane or monorail system is resumed. Adjustments and repairs shall be done only by qualified personnel.

35.8.2.6.3.2. Adjustments shall be made to ensure correct functioning of all components such as:

35.8.2.6.3.2.1. Control systems.

35.8.2.6.3.2.2. All operating mechanisms.

35.8.2.6.3.2.3. Limit switches.

35.8.2.6.3.2.4. Drive wheels, squaring shafts, couplings, roller chain drives, bumpers and stops.

35.8.2.6.3.2.5. Interlocks, crossovers, track switches and track-openers.

35.8.2.6.3.2.6. Collector shoes or wheel limit switches, electrical control systems, pushbutton stations or controllers.

35.8.2.6.3.2.7. Brakes, hoist mechanisms, hydraulic units, hydraulic or pneumatic valves and controls.

35.8.2.6.3.2.8. Power sources.

35.8.2.6.3.3. Repairs or replacements shall be provided promptly as needed for safe operation such as:

35.8.2.6.3.3.1. Hoist mechanisms showing defects as in paragraph [35.6.3.5](#).

35.8.2.6.3.3.2. Hooks showing damage as in paragraph [35.11.5](#).

35.8.2.6.3.3.3. Damage to components listed in paragraph [35.8.2.6.3.2](#), which constitute a safety hazard.

35.8.2.6.3.3.4. Load attachment chains and rope slings showing defects.

35.8.2.6.3.3.5. All critical parts which are cracked, broken, bent or excessively worn.

35.8.2.6.3.3.6. Dirty pendant control stations and illegible function labels.

35.8.2.6.4. Rope Maintenance. Refer to paragraph [35.11.2.3](#).

35.8.2.6.5. Rope Replacement. Refer to paragraph [35.11.2.4](#).

35.8.2.7. Testing.

35.8.2.7.1. Operational Tests.

35.8.2.7.1.1. Prior to use, all new, reinstalled, altered, repaired and modified

cranes and cranes not used within the preceding 12 months shall be operationally tested by a qualified person. The operational test shall consist of operating all functions of the hoist under a no-load condition to test all hoist functions including hoisting and lowering, operation of brakes, testing of all limit, locking, safety devices and:

35.8.2.7.1.1.1. Trolley travel.

35.8.2.7.1.1.2. Bridge travel.

35.8.2.7.1.1.3. Interlocking mechanism, track switches, drop sections and lift sections.

35.8.2.7.1.2. The trip-setting of hoist limit switches shall be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The limit switch actuating mechanism shall be located to trip the switch under all conditions, in sufficient time to prevent contact of hook or load block with any part of trolley.

35.8.2.7.1.3. Hoist limit switch.

35.8.2.7.1.3.1. At the beginning of each operator shift, during each periodic maintenance, whenever a malfunction is suspected, or after unusually heavy use, the operator or maintainer will check the upper-limit switch under no load, with the block “inched” into the limit switch or run in at slow speed. If the switch does not operate properly, the operator will immediately notify the operation supervisor.

35.8.2.7.1.3.2. The hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control.

35.8.2.7.2. Load Tests. All new cranes or cranes with altered, replaced or repaired load suspension parts shall be load tested prior to use at not less than 100 percent or more than 125 percent of rated load of the equipment, unless otherwise recommended by the manufacturer. The test shall be conducted as follows:

35.8.2.7.2.1. Hoist the test load a distance to assure load is supported by the crane and held by hoist brake(s). Refer to paragraph [35.6.3.7.2](#) for hoist test.

35.8.2.7.2.2. Transport test load by the trolley or carrier for the full length of the bridge.

35.8.2.7.2.3. Transport the test load by the bridge for the full length of the runway in one direction with trolley or carrier as close to the extreme right-hand end of the crane as practical and in the other direction with trolley or carrier as close to the left-hand end of the crane as practical. When cranes operate on more than two (2) runways (multiple-truck cranes), the crane will also transport the test load the full length of the runway with the trolley or carrier positioned at each intermediate end truck.

35.8.2.7.2.4. For monorail systems, follow paragraph [35.8.2.7.2.1](#) for the hoist test and transport test load by the carrier for the full length of the monorail

system.

35.8.2.7.2.5. On hoists incorporating overload devices, a load test shall be accomplished with a test load of least 100 percent of rated capacity, after which the overload device shall be tested.

35.8.2.7.2.6. Test weights for load testing shall be tagged or marked indicating total weight in pounds and owner or agency identification number. Rebar steel shall not be used for test weight lift points.

35.8.2.7.3. For nuclear-certified hoists, perform tests as stated in paragraphs [35.8.2.7.1](#) and [35.8.2.7.2](#) and annually thereafter at not less than 100 percent or more than 125 percent of rated capacity. Users may perform annual tests in conjunction with one of the two semiannual inspections outlined in paragraph [35.8.2.5.2](#). **Exception:** The annual load test may be performed as either a static or dynamic test as determined by a qualified person.

35.8.2.8. Historical Records. A written, dated and signed record of all periodic inspections, repairs and tests shall be maintained indefinitely at a location determined by the user. Refer to paragraph [35.1.1](#) concerning use of paper forms and automated systems.

### 35.9. Mobile and Locomotive Cranes.

#### 35.9.1. Hazards.

35.9.1.1. One of the greatest hazards with mobile crane operations is electrocution from equipment contacting energized electric lines.

35.9.1.2. Other hazards include overloading; side loading; rope or hydraulic failure; striking people or objects with moving loads or movable parts of the crane; dropping or slipping of the load due to improper hitching or slinging; and slipping or falling from equipment.

#### 35.9.2. Requirements.

##### 35.9.2.1. Acquisition.

35.9.2.1.1. All crawler, locomotive and truck cranes shall meet design specifications, characteristics, and rules of ANSI/ASME B30.5, *Mobile and Locomotive Cranes*.

35.9.2.1.2. All new mobile hydraulic cranes constructed and used on or after 25 January 1982 shall meet ANSI/ASME B30.5. Equipment manufactured prior to 25 January 1982, and still in replacement codes A through J, need not be modified or retrofitted to conform to this standard. General design considerations which shall be included in procurement documents include:

35.9.2.1.2.1. Load Ratings and Charts. A substantial and durable rating chart with clearly legible letters and figures shall be securely fixed to the crane cab in a location easily visible to the operator while seated at the control station. A duplicate load rating chart (legible from the ground) shall also be provided on the outside of the crane. The load rating chart for truck cranes shall list loads for the crane operating both with and without counterweights.

35.9.2.1.2.2. Two-Blocking Prevention. A two-blocking damage preventive feature shall be provided on telescoping boom cranes to prevent damage to the hoist rope or other machine components when hoisting the load, extending the boom or lowering the boom on a crane with a stationary hoist mounted to the rear of the boom hinge.

35.9.2.1.2.3. Boom Angle Indicator. A boom angle indicator shall be provided on all cranes.

35.9.2.1.2.4. Overload Protection. Devices such as “*Load Moment Indicators*” are designed to alarm the operator and de-energize the crane when attempting to lift a load beyond the crane’s capabilities. Although these devices are of minimal value in routine base-level Air Force operations, they may be of value in construction where loads may not be defined or identified or not properly released from its transporter. The user must evaluate anticipated use of the crane to determine the need for such a device.

35.9.2.1.2.5. Color Coding for Strike Hazard. Parts of crane cabs that extend beyond the main chassis when rotated shall be color coded yellow and black on the lower areas to highlight the strike hazard to ground personnel. Colors shall be reflective for night operations.

35.9.2.1.2.6. Guarding of Machinery. Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets and reciprocating parts (a hazard to personnel) shall be guarded.

35.9.2.1.2.7. Unguarded Machinery. Some crane hazards, such as rotating equipment or holes, cannot be mechanically safeguarded. Personnel will exercise extreme care when exposed to unguarded rotating equipment or holes. Such conditions shall be clearly marked with appropriate warning decals.

35.9.2.1.2.8. Main Switch. If the mobile crane is electrically powered and incorporates a main or master switch, the switch shall be designed to be locked in the open or “*OFF*” position.

35.9.2.1.2.9. Operator Protection. Cranes shall be designed to protect operators from falling objects, swinging loads and cable failures. Cranes that are operated in inclement weather, shall protect the operator from the weather.

35.9.2.1.2.10. Warning. An audible warning device shall be provided when hoisting operations or moving equipment might endanger personnel in the work area. The device control shall be within easy reach of the operator.

35.9.2.1.2.11. Warning Sign. A permanent sign shall be posted in the cab of the crane in full view of the operator. This sign will read: “*DANGER HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines.*” *If equipment is operated in the vicinity of power lines, installation of a proximity device shall be considered.*

35.9.2.1.2.12. Night Operations. Cranes operated during darkness shall have clearance lights installed. Working areas shall be illuminated so the designated



signal person, loads, rigging, obstructions, etc., are readily visible.

35.9.2.1.2.13. Man-Rated Cranes. Man-rated cranes shall be approved prior to acquisition or use. Users will coordinate purchase with the installation safety staff and submit the following for review (see 29 CFR 1926.1400, *Cranes and Derricks in Construction*, for additional information):

35.9.2.1.2.13.1. Crane make, model, year and present modifications if applicable.

35.9.2.1.2.13.2. Present safety devices, limit switches, dead-man controls, control lowering capabilities, outriggers if applicable, etc.

35.9.2.1.2.13.3. Past major overhaul or repairs and dates of rated load tests.

35.9.2.1.2.13.4. Proposed method of use and working environment.

35.9.2.1.2.13.5. Proposed work cage or basket, attachment points and methods of attachment for personnel.

35.9.2.1.2.13.6. If necessary, illustrated drawings or photographs.

35.9.2.2. Qualification of Operators. Mobile cranes shall be operated only by designated, qualified operators with a valid AF Form 483, *Certificate of Competency*, or by persons in training under the direct supervision of a designated operator. **Exception:** Operators of Air Force special purpose vehicle/truck cranes shall be licensed IAW AFI 24-301, *Vehicle Operations*, in lieu of AF Form 483. No other personnel will enter a crane cab except for oilers, supervisors and qualified inspectors whose duties require cab entry. A list of qualified crane operators shall be kept by the using organization and appropriate entries shall be made in the individual's training records.

35.9.2.2.1. Crawler, Locomotive, Truck and Mobile Hydraulic Cranes.

35.9.2.2.1.1. Prospective operators shall pass a written examination containing the safety requirements of this chapter, TO 36C-1-5, *Sixty Rules on Safety—Operation of Power Cranes and Excavators*, and a practical operating examination, developed by the using activity, to demonstrate task-qualification to operate the crane safely.

35.9.2.2.1.2. Operators shall meet the following minimum physical qualifications of ANSI/ASME B30.5., *Mobile and Locomotive Cranes (5-3.1.2, Qualifications for Operators)*, and these physical qualifications must be clearly identified by the supervisor to the examining AF physician:

35.9.2.2.1.2.1. Have vision of at least 20/30 in one eye, and 20/50 in the other, with or without corrective lenses.

35.9.2.2.1.2.2. Be able to distinguish red, green and yellow, regardless of position of colors, if color differentiation is required for operation.

35.9.2.2.1.2.3. Test for ordinary conversation in one ear, with or without a hearing aid, to ensure hearing is adequate for a specific operation.

35.9.2.2.1.2.4. Have sufficient strength, endurance, agility, coordination and speed of reaction to meet the demands of equipment operation.

35.9.2.2.1.2.5. Evidence of physical defect, or emotional instability which could render the operator a hazard to herself, or himself or others, or, in the opinion of the examiner or supervisor, could interfere with the operator's safe performance, may be sufficient cause for disqualification. In such cases specialized clinical or medical judgments and tests may be required. Any medical condition that places the worker at risk of sudden incapacitation may be sufficient reason for medical disqualification in the interest of safety, e.g., a history of epilepsy or a disabling heart condition.

35.9.2.2.1.2.6. Operator trainees shall have good depth perception, field of vision, reaction time, manual dexterity or coordination and no tendencies to dizziness or similar undesirable characteristics. Physical defects such as loss of arm, hand, leg, foot or gross loss of function thereof may be considered as cause for denial of entry into a crane training program.

### 35.9.2.3. Safe Operating Practices.

35.9.2.3.1. If operators must divert their attention while operating the crane, they shall stop the crane.

35.9.2.3.2. The operator shall respond to signals only from the designated signal person, but will obey an emergency stop signal from anyone at any time.

35.9.2.3.3. Operators are responsible for operations under their direct control. Whenever there is any doubt as to safety, the operator will stop and refuse to handle loads until safety has been ensured.

35.9.2.3.4. The operator will sound or give an audible warning signal each time before traveling (backing), and when approaching workers or other congested areas. The signal may be mechanical (automatic) or oral.

35.9.2.3.5. Before leaving the crane unattended, the operator will:

35.9.2.3.5.1. Lower any suspended load, bucket, lifting magnet, or other device to the ground.

35.9.2.3.5.2. Disengage clutch.

35.9.2.3.5.3. Set travel, swing, boom brakes, and other locking devices.

35.9.2.3.5.4. Put controls in the "OFF" or neutral position.

35.9.2.3.5.5. Stop the engine.

35.9.2.3.5.6. Secure crane, i.e., chocks, brakes, etc., against accidental travel.

35.9.2.3.6. During periods of non-use, high winds, or weather alerts, the operator will lower the boom to ground level, a resting platform or otherwise ensure the boom is secure against movement from wind or other forces.

35.9.2.3.7. Operators will not close a switch or start the engine until any warning tag or lock has been removed by the supervisor or person who originally attached the device.

35.9.2.3.8. Operators will ensure all controls are in the “*OFF*” position and all personnel are clear of the crane before closing a switch or starting the engine.

35.9.2.3.9. If power fails during operation, operators will:

35.9.2.3.9.1. If practical, lower the suspended load to the ground under brake control. If not practical to land the load, shut down the crane and completely rope off or barricade the area around the suspended load.

35.9.2.3.9.2. Set all brakes and locking devices.

35.9.2.3.9.3. Move all clutch or other power controls to the “*OFF*” position.

35.9.2.3.10. Operators shall be familiar with the equipment and its proper care. If adjustments or repairs are necessary or any damage is known, the operator will report them promptly to the supervisor and record them on AFTO Form 244, AFTO Form 95, or MAJCOM or locally devised paper or automated system IAW paragraph **35.1.1**, as appropriate.

35.9.2.3.11. All controls shall be tested by the operator at the start of a new shift. Controls that do not operate properly shall be adjusted or repaired before continuing operation.

35.9.2.3.12. Booms being assembled or disassembled on the ground, with or without support of the boom harness, shall be securely blocked to prevent dropping the boom and boom sections.

35.9.2.3.13. To prevent injury to personnel, booms being manually telescoped shall be carefully repositioned prior to pinning.

35.9.2.3.14. No crane shall be loaded beyond its rated capacity, except for test purposes IAW paragraph **35.9.2.6** Weight of all loads shall be determined before lifting.

35.9.2.3.15. When attaching the load, the hoist rope shall not be wrapped around the load, but shall be attached to the hook by slings or other approved devices of proper capacity.

35.9.2.3.16. When moving the load, the supervisor directing the lift will ensure:

35.9.2.3.16.1. The crane is level and, where necessary, outriggers are in place and blocked IAW paragraph **35.9.2.3.24**.

35.9.2.3.16.2. The load is well secured and properly balanced in the sling or lifting device before hoisted more than a few inches.

35.9.2.3.17. Before lifting, the operator will ensure:

35.9.2.3.17.1. The hoist rope is not kinked;

35.9.2.3.17.2. Multiple part lines are not twisted around each other;

35.9.2.3.17.3. The hook is brought over the load in a manner to prevent swinging; and

35.9.2.3.17.4. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves as the load is applied.

35.9.2.3.18. During lifting, the operator will ensure there is no sudden acceleration or deceleration of the moving load; and the load and boom do not contact any obstructions.

35.9.2.3.19. Side loading of booms shall be limited to freely suspended loads. Cranes shall not be used for dragging loads sideways.

35.9.2.3.20. The crane shall not be operated while anyone is on the load or hook. MAJCOM, DRU, or FOA approved man-rated cranes and work cages are permitted. Refer to paragraph [35.9.2.3.50](#) for hoisting and lowering personnel requirements.

35.9.2.3.21. The operator shall not carry or swing load over personnel.

35.9.2.3.22. On truck mounted cranes, loads shall not be lifted over the front area of the truck unless specifically allowed by manufacturer's operating instructions.

35.9.2.3.23. The operator will test the brakes each time a load is handled by raising the load a few inches and applying brakes.

35.9.2.3.24. Outriggers shall be used when the load at a particular radius exceeds the rated load without outriggers as given by the crane manufacturer. When floats are used, they shall be securely attached to outriggers. Wood blocks used to support outriggers shall be strong enough to prevent crushing, free of defects and of sufficient size to prevent shifting or toppling of the crane under load.

35.9.2.3.25. Neither the load nor boom shall be lowered to less than two (2) full wraps of rope on their respective drums.

35.9.2.3.26. When two (2) or more cranes are used to lift one load, one designated person shall be responsible for the operation. He or she will analyze the operation and instruct all personnel involved in proper positioning, rigging the load, and movements to be made.

35.9.2.3.27. Before any crane is moved to a new job site, the route of travel shall be checked to determine that adequate clearances exist along the entire route. This survey shall be conducted by the vehicle heavy equipment supervisor and crane operator. The empty hook shall be secured to prohibit swinging, and the boom shall be lowered to the boom rest or travel position. A red cloth or warning flag, at least 12 inches square, or a warning light shall be carried at the end of any boom that extends more than 4 feet beyond the truck platform. At night or during periods of reduced visibility, a warning light shall be used. The superstructure shall be secured to prohibit rotation except when there is an operator in the cab to ensure proper boom clearances around tight spots and corners. Additional vehicles shall be used to warn other motorists if the crane boom or wide load poses a hazard to the front or rear.

35.9.2.3.28. A designated supervisor shall be responsible for determining and controlling safety before traveling a crane with a load. Decisions such as position of load, boom location, ground support, travel route and speed of movement shall be IAW his/her determination. Specified tire pressures shall be maintained. The boom shall be carried in line with the direction of motion, sudden starts and stops shall be avoided and tag or restraint lines shall be used to minimize swinging of the load.

35.9.2.3.29. A crane shall never travel with the boom so high that it may bounce back over the cab. Consult the manufacturer's operation manual.

35.9.2.3.30. Avoid sudden starts and stops when rotating the crane. Rotational speed shall be such that the load can be controlled. A tag line shall be used when rotation of the load is hazardous.

35.9.2.3.31. The boom hoist pawl or other positive locking device shall be engaged on rope supported booms if the crane is operated at a fixed radius.

35.9.2.3.32. Ropes shall not be handled on a winch head without knowledge of the operator. The operator shall be within convenient reach of the power unit control lever while a winch head is being used.

35.9.2.3.33. On cranes having a powered telescoping boom, the hook is drawn closer to the boom head when hoisting, extending the boom or lowering a boom on machines where the winch is mounted stationary to the rear of the boom hinge. If the machine is not equipped with a "two-blocking preventive feature," rope shall be let-out from the load hoist mechanism so the hook will not be jammed (two-blocked) against the boom head. The jammed condition may cause overload and result in rope or other component failure.

35.9.2.3.34. Telescoping boom sections shall be telescoped in the manner and sequence specified by the manufacturer.

35.9.2.3.35. While holding the load:

35.9.2.3.35.1. The operator shall not leave his/her position at the controls while load is suspended.

35.9.2.3.35.2. . No person shall be permitted to stand or pass under a suspended load.

35.9.2.3.35.3. If the load hoist mechanism is not equipped to hold the drum from rotating in the lowering direction, without further action by the operator, loads shall not remain suspended for a considerable length of time.

35.9.2.3.36. Standard hand signals to the operator shall be IAW **Figure 35.21**, unless voice communication equipment is used. The operator shall not respond to any signal unless he or she clearly understands it.

35.9.2.3.37. If necessary to give instructions to the operator, other than those provided herein, all crane motions shall be stopped.

35.9.2.3.38. All crane controls shall be placed in the "OFF" position and the main switch opened when equipment is not in use.

35.9.2.3.39. When operating near electric power lines, refer to 29 CFR 1926.1400, *Cranes and Derricks in Construction*, and:

35.9.2.3.39.1. Overhead power lines shall be considered energized unless definitely known by the operator and supervisor that lines are not energized.

35.9.2.3.39.2. No part of a crane or its load shall be permitted within 10 feet of any energized electrical power line. When this is impractical, the power line shall

be de-energized and visibly grounded, or a different route of travel used.

35.9.2.3.39.3. For lines rated over 50 kilovolts (kV), minimum clearance shall be 10 feet plus 0.4 inch for each kV over 50 kV, or twice the length of the line insulator, but never less than 10 feet.

35.9.2.3.39.4. A permanent sign shall be posted in the cab of the equipment in full view of the operator. This sign will read: “*DANGER -- HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines.*”

35.9.2.3.39.5. A dielectric boom shield and insulated link installed in the lifting line at the hook provide some protection against electric shock if the crane accidentally contacts energized electric lines. Proximity warning devices are not fail safe and shall be used in addition to, not as a replacement for, other controls. Even though shields, insulated hooks and proximity warning devices are used, clearance criteria in paragraphs [35.9.2.3.39.2](#) and [35.9.2.3.39.3](#) shall be followed.

35.9.2.3.39.6. If the boom of a rubber-tired crane contacts an electric power line, it is probable the entire crane may be energized since the rubber tires may insulate the crane from the ground. When this happens, operators shall not attempt to leave the crane until they are certain that the line is clear of the crane or the line is de-energized. To make such an attempt might result in electrocution since the operator’s body would complete the circuit to ground as he or she climbed or stepped from the crane. If the fuel tank ignites, or if it is impossible for the operator to remain on the crane, he or she shall jump, after first making sure all body parts are clear of the crane before their feet touch the ground.

35.9.2.3.40. Where motorized or pedestrian traffic is anticipated or encountered, the working area shall be blocked off or controlled to keep people and vehicles away. **Note:** Operators of mobile cranes will stay clear of walls, overhead trestles, columns and other structures that pose electrical, crushing, burn hazards, etc.

35.9.2.3.41. Personal Protective Equipment (PPE). Appropriate head protection shall be worn by crane crew personnel to protect against falling objects or impact type hazards. Safety-toe shoes shall be worn by all materials handling and construction personnel involved in crane operations. Refer to [Chapter 14, Personal Protective Equipment \(PPE\)](#), for additional guidance.

35.9.2.3.42. Rail clamps shall not be used to restrain tipping of a locomotive crane. Load weight shall be kept within the limit of the crane without using these clamps.

35.9.2.3.43. Cranes shall not be operated without the full amount of ballast or counterweight in place, unless specifically authorized by the manufacturer’s instructions.

35.9.2.3.44. Clothing and personal belongings shall be kept away from operator controls. Tools, oil cans, extra fuses and other necessary articles shall be stored in the tool box and not permitted to lie loose in or about the cab.

35.9.2.3.45. Firm, level (within one percent grade) footing under the crane is essential to prevent tipping or sinking as loads are lifted and swung. Where necessary,

this footing shall be provided by timbers, cribbing or other structural material sufficient to distribute the load and provide a level surface. Outriggers (on cranes so equipped) shall be fully extended per manufacturer's specifications.

35.9.2.3.46. When small, portable containers are used to refuel engines, they shall be approved safety containers with an automatic closing cap and flame arrester. The crane shall not be refueled when engine is running or hot.

35.9.2.3.47. A fire extinguisher rated for Class B and C fires shall be provided at the operator's station. Operating and maintenance personnel shall be familiar with the care and use of the extinguisher.

35.9.2.3.48. Locomotive cranes shall cease operation when railway cars on adjacent tracks are in motion.

35.9.2.3.49. All hooks and hook blocks shall be permanently marked with the manufacturer's identification. Load hooks shall be equipped with safety latches.

35.9.2.3.50. The use of a crane or derrick to hoist workers on a personnel platform is prohibited except when conventional means of reaching the worksite, such as a personnel hoist, ladder, stair-way, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible. (see paragraph [35.11.7](#)).

35.9.2.3.51. The area in the rear, in which someone could be struck or caught by the rotating super-structure, shall be barricaded. Refer to 29 CFR 1926.1400, *Cranes and Derricks in Construction*, for additional guidance.

35.9.2.3.52. Refer to paragraph [35.11.2](#) for information on wire rope inspection, replacement and maintenance.

#### 35.9.2.4. Inspections.

35.9.2.4.1. Frequent. The inspection will include:

35.9.2.4.1.1. Checking hydraulic hoses, fittings and tubing, particularly hydraulic hoses which flex in normal operation. The following are reasons for repair or replacement:

35.9.2.4.1.1.1. Evidence of hydraulic oil leakage at the surface of the flexible hose or excessive leakage at its junction with metal end couplings.

35.9.2.4.1.1.2. Blistering or abnormal deformation to the outer covering of hydraulic hose.

35.9.2.4.1.1.3. Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or recommended procedures.

35.9.2.4.1.1.4. Evidence of excessive abrasion or scrubbing on outer surface of a hose, rigid tube or hydraulic fitting. Action shall be taken immediately to eliminate or correct the cause or otherwise protect the components from additional damage.

35.9.2.4.1.2. Checking pumps and motors. The following are reasons for replacement or repair:

- 35.9.2.4.1.2.1. Loose bolts or fasteners.
  - 35.9.2.4.1.2.2. Leaks at joints between sections.
  - 35.9.2.4.1.2.3. Shaft seal leaks.
  - 35.9.2.4.1.2.4. Unusual noises or vibration.
  - 35.9.2.4.1.2.5. Loss of operating speed.
  - 35.9.2.4.1.2.6. Suspected overheating of hydraulic oil.
  - 35.9.2.4.1.2.7. Inability to hold proper pressure.
- 35.9.2.4.1.3. Checking valves. The following are reasons for replacement or repair:
- 35.9.2.4.1.3.1. Cracks in valve housing.
  - 35.9.2.4.1.3.2. Improper return of spool to neutral position.
  - 35.9.2.4.1.3.3. Leaks at spools or joints.
  - 35.9.2.4.1.3.4. Sticking spools.
  - 35.9.2.4.1.3.5. Failure of relief valves to attain correct pressure setting specified by manufacturer.
- 35.9.2.4.1.4. Checking cylinders. The following are reasons for replacement or repair:
- 35.9.2.4.1.4.1. Drifting caused by oil leaking across piston.
  - 35.9.2.4.1.4.2. Rod seals leaking.
  - 35.9.2.4.1.4.3. Leaks at welded joints.
  - 35.9.2.4.1.4.4. Scored, nicked or dented cylinder rods.
  - 35.9.2.4.1.4.5. Dented case (barrel).
  - 35.9.2.4.1.4.6. Loose or deformed rod eyes or connecting joints.
- 35.9.2.4.1.5. Checking filters. Rubber particles on the filter element may indicate hose, "O" ring or other rubber component deterioration. Metal chips or pieces on the filter may denote failure in pumps, motors or cylinders. Further checking shall be done as necessary to determine origin of the problem before corrective action is taken.
- 35.9.2.4.1.6. Checking control mechanisms for maladjustment.
- 35.9.2.4.2. Periodic. The periodic inspection will include inspecting items in paragraph [35.9.2.4.1](#) and the following:
- 35.9.2.4.2.1. Vehicle control mechanisms for excessive wear of components and contamination by lubricants or other foreign matter.
  - 35.9.2.4.2.2. Installed safety devices for proper operation.



35.9.2.4.2.3. Crane load hooks if cracked, have any visibly apparent bend or twist from the plane of the unbent hook (original manufacturer or baseline measurements), any distortion causing an increase in throat opening of five (5) percent, not to exceed ¼ inch (or as recommended by the manufacturer), or any wear exceeding 10 percent (or as recommended by the hook manufacturer) of the original manufacturer or baseline section dimension of the hook. Refer to paragraphs [35.9.2.5.2.4](#) and [35.11.5.1](#) for additional guidance.

35.9.2.4.2.4. Rope reeving for compliance with crane manufacturer's recommendation.

35.9.2.4.2.5. Electrical apparatus for malfunctions, signs of excessive deterioration or dirt and moisture accumulation.

35.9.2.4.2.6. Deformed, cracked or corroded members in crane structure and boom.

35.9.2.4.2.7. Loose bolts or rivets.

35.9.2.4.2.8. Cracked or worn sheaves and drums.

35.9.2.4.2.9. Worn, cracked or distorted parts such as pins, bearings, shafts, gears, rollers and locking devices.

35.9.2.4.2.10. Excessive wear on brake and clutch system parts, linings, pawls and ratchets.

35.9.2.4.2.11. Any inaccuracies of load and check boom angle indicators and other indicators over their full range.

35.9.2.4.2.12. Proper performance of gasoline, diesel, electric or other power plants.

35.9.2.4.2.13. Excessive wear of chain-drive sprockets and excessive chain stretch.

35.9.2.4.2.14. Cracks in hooks by magnetic particle or other crack detecting process.

35.9.2.4.2.15. Proper operation of travel steering, braking and locking devices.

35.9.2.4.2.16. Worn or damaged tires.

35.9.2.4.2.17. Rust on hydraulic rods and control valves.

35.9.2.4.2.18. Cleanliness of oil filters and oil strainers.

35.9.2.4.2.19. For nuclear-certified mobile hydraulic cranes, also see paragraph [35.9.2.6.2.2](#).

35.9.2.4.3. Inspection Records. Inspection records shall be maintained IAW AFI 23-302, *Vehicle Management*, or other appropriate directives. Location of inspection records shall be determined by the user.

35.9.2.5. Maintenance.

35.9.2.5.1. Maintenance Procedure. The Vehicle Fleet Manager or Vehicle Management Superintendent shall establish a preventive maintenance program based on this standard and crane manufacturers' recommendations. Crane maintenance records shall be maintained IAW AFI 23-302 or other appropriate directives.

35.9.2.5.1.1. The following precautions shall be taken before making adjustments and repairs on a crane:

35.9.2.5.1.1.1. Position the crane where it will cause the least interference with other equipment or operations.

35.9.2.5.1.1.2. Use appropriate lockout/tagout procedures on crane energy controls as prescribed by **Chapter 21**.

35.9.2.5.1.1.3. Lower the boom to the ground if possible or secure it against dropping.

35.9.2.5.1.1.4. Lower the lower load block to ground or secure it against dropping.

35.9.2.5.1.1.5. Stop the power plant.

35.9.2.5.1.1.6. Disengage and lockout all starting controls.

35.9.2.5.1.1.7. Turn off all controls and engage the pawls.

35.9.2.5.1.1.8. Relieve hydraulic oil pressure from all hydraulic systems before loosening or removing hydraulic components.

35.9.2.5.1.1.9. Retract all hydraulic cylinders used for boom hoisting and boom telescoping.

35.9.2.5.1.2. Warning tags and locks shall only be placed or removed by the maintenance supervisor or his/her representative.

35.9.2.5.2. Adjustments and Repairs: After adjustments and repairs have been made, the crane shall not be operated until all guards have been reinstalled, trapped air removed from hydraulic system, safety devices reactivated and maintenance equipment removed.

35.9.2.5.2.1. Any unsafe conditions disclosed by inspection IAW paragraph **35.9.2.4** shall be corrected before the crane is operated again. Adjustments and repairs shall be done only by qualified personnel.

35.9.2.5.2.2. Adjustments to operating mechanisms, safety devices, control systems and power plants shall be maintained to ensure correct functioning.

35.9.2.5.2.3. All critical parts of operating mechanisms or crane structures that are cracked, broken, bent, corroded or excessively worn shall be repaired or promptly replaced to ensure safe operation.

35.9.2.5.2.4. Crane hooks showing defects described in paragraph **35.9.2.4.2** or **35.11.5.1** will be removed from service and repaired or replaced. Repairs by welding or reshaping are not recommended. If such repairs are attempted, they

shall only be done by a qualified person and the hook shall be load tested IAW paragraph **35.9.2.6.1** before further use. **Note 1:** Hooks repaired by welding or reshaping are not authorized on nuclear-certified hoists or lifting equipment used to lift critical loads. **Note 2:** Painted hooks shall not be used on nuclear-certified hoists or lifting equipment or equipment used to lift critical loads.

35.9.2.5.2.5. All replacement parts or repairs shall have at least the original manufacturer's design safety factor.

#### 35.9.2.5.3. Lubrication:

35.9.2.5.3.1. All moving parts of the crane, where lubrication is specified, shall be regularly lubricated IAW manufacturer's recommendations or TO procedures as to points and frequency of lubrication, maintenance of lubricant levels and types of lubricant.

35.9.2.5.3.2. Cranes not equipped for automatic or remote lubrication shall be stationary when lubricated, with all controls in the "OFF" position, the main power control switch, if equipped, locked out or "OFF" and pawls applied.

#### 35.9.2.6. Testing.

##### 35.9.2.6.1. Operational Tests.

35.9.2.6.1.1. Prior to initial use, all new cranes shall be tested by the manufacturer and verified by the Vehicle Management Flight Commander or Vehicle Fleet Manager to ensure compliance with operational requirements of this paragraph, including the following functions:

35.9.2.6.1.1.1. Load lifting and lowering mechanisms.

35.9.2.6.1.1.2. Boom lifting and lowering mechanisms.

35.9.2.6.1.1.3. Boom extension and retraction mechanism.

35.9.2.6.1.1.4. Swinging mechanism.

35.9.2.6.1.1.5. Travel mechanism.

35.9.2.6.1.1.6. Safety devices.

35.9.2.6.1.2. Where the crane is not supplied by a single manufacturer, operational tests shall be conducted by a qualified person at final assembly.

##### 35.9.2.6.2. Load Tests.

35.9.2.6.2.1. Prior to being returned to service and initial use, extensively repaired or modified cranes shall be load tested at not less than 100 percent or more than 110 percent of rated capacity by a qualified person. When complete, stencil the load test date on the lower boom assembly per 29 CFR 1926.1400.

35.9.2.6.2.2. For nuclear-certified hydraulic mobile cranes, perform an annual load test at not less than 100 percent or more than 110 percent of the rated capacity. Perform this test in conjunction with the annual inspection. When complete, stencil the load test date on the lower boom assembly as per TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenance*.

35.9.2.6.2.3. Test loads shall not exceed 110 percent of the rated capacity at any selected working radius.

35.9.2.6.2.4. If re-rating is necessary, crawler, truck and wheel-mounted mobile cranes shall be tested IAW Society of Automotive Engineers, Inc. (SAE) *Recommended Practices, Crane Load Stability Test Code J765*. Locomotive cranes shall be re-rated IAW manufacturers' specifications. A copy of the re-rating test report shall be provided to Vehicle Management and Analysis and a copy posted in the crane cab.

35.9.2.6.2.5. Cranes shall not be re-rated in excess of original load ratings unless such rating changes are approved by the crane manufacturer.

35.9.2.6.2.6. Test weights for load testing shall be tagged or adequately marked indicating total weight in pounds and owner or agency identification number. Rebar steel shall not be used for test weight lift points.

35.9.2.6.3. A record of all tests shall be maintained indefinitely at a location determined by the user.

### **35.10. Inspection, Maintenance and Testing of Derricks.**

#### 35.10.1. Inspection.

35.10.1.1. Frequent. The inspection will include checking:

35.10.1.1.1. All control mechanisms — adjustment, wear and lubrication.

35.10.1.1.2. All chords and lacing.

35.10.1.1.3. Tension in guys.

35.10.1.1.4. Plumb of the mast.

35.10.1.1.5. Leakage of air or deterioration of hoses, seals and rams of hydraulic systems.

35.10.1.1.6. Derrick hooks— cracks and bends, wear and deformations, etc. Hooks with cracks or distortion of more than 5 percent of normal throat opening, not to exceed ¼ inch (or as recommended by the manufacturer), or with any apparent bend or twist from the plane from the original baseline measurements shall be removed from service and repaired or replaced. Refer to paragraph [35.11.5.1.1](#).

35.10.1.1.7. Rope reeving — noncompliance with derrick manufacturer's recommendations.

35.10.1.1.8. Hoist brakes, clutches and operating levers — proper functioning before beginning operations.

35.10.1.1.9. Electrical apparatus — malfunction and signs of excessive deterioration, dirt and moisture accumulation.

35.10.1.2. Periodic. The inspection will include items from paragraph [35.10.1.1](#) and the following:

35.10.1.2.1. Structural members, for deformations, cracks and corrosion.

35.10.1.2.2. Bolts or rivets, for tightness.

35.10.1.2.3. Parts such as pins, bearings, shafts, gears, sheaves, drums, rollers and locking and clamping devices for wear, cracks and distortion.

35.10.1.2.4. Gudgeon pin, for cracks, wear and distortion each time derrick is erected.

35.10.1.2.5. Power plants, for proper performance and compliance with applicable safety requirements.

35.10.1.2.6. Hooks, for cracks and bends, wear and deformations, etc. Hooks having more than 5 percent of normal throat opening or any apparent bend or twist from the plane from the original baseline measurements shall be replaced. Refer to paragraph [35.11.5.1.1](#) and [Figure 35.22](#).

35.10.1.2.7. Foundation or supports, for continued ability to sustain imposed loads.

35.10.1.2.8. Derrick electrical pendant and control box, for proper grounding.

### 35.10.2. Testing.

35.10.2.1. All new derricks shall have the manufacturer's certification that all required testing has been accomplished. Prior to initial use, all modified and altered derricks shall be operationally tested to ensure compliance with this standard, including:

35.10.2.1.1. Load hoisting and lowering.

35.10.2.1.2. Boom up and down.

35.10.2.1.3. Swing.

35.10.2.1.4. Operation of clutches and brakes of hoist.

35.10.2.2. All anchorages shall be approved by the appointed personnel. Rock and hairpin anchorages may require special testing.

### 35.10.3. Maintenance.

#### 35.10.3.1. Preventive Maintenance.

35.10.3.1.1. A preventive maintenance program based on the derrick manufacturer's recommendations shall be established. Dated and detailed records shall be readily available.

35.10.3.1.2. Replacement parts shall be obtained from the original equipment manufacturer.

#### 35.10.3.2. Maintenance Procedure.

35.10.3.2.1. The following precautions shall be taken before adjustments and repairs are started on a derrick:

35.10.3.2.1.1. The derrick to be repaired shall be arranged so it will cause the least interference with other equipment and operations in the area.

35.10.3.2.1.2. All hoist drum dogs shall be engaged.

35.10.3.2.1.3. The main or emergency switch shall be locked in the open (off)

position if an electric hoist is used. Refer to **Chapter 21** for additional lockout/tagout requirements.

35.10.3.2.1.4. Warning signs shall be placed on the derrick and hoist.

35.10.3.2.1.5. Boom repairs on derricks shall be made when booms are lowered and adequately supported or when safely tied off.

35.10.3.2.1.6. A good communication system shall be set up between the hoist operator and the appointed individual in charge of derrick operations before any work on the equipment is started.

35.10.3.2.2. Welding repairs shall be approved by a qualified person.

35.10.3.2.3. After adjustments and repairs have been made, the derrick shall not be operated until all guards have been reinstalled, safety devices reactivated, maintenance equipment removed and derrick electrical pendant and control box checked for proper grounding.

#### 35.10.4. Adjustments and Repairs.

35.10.4.1. Any unsafe conditions disclosed by the inspection and requirements of paragraphs **35.10.2** and **35.10.3** shall be corrected before derrick operation is resumed. Adjustments shall be maintained to assure correct functioning of components, including:

35.10.4.1.1. All functional operating mechanisms.

35.10.4.1.2. Tie-downs or anchorages.

35.10.4.1.3. Signal system.

35.10.4.1.4. Brakes and clutches.

35.10.4.1.5. Power plants.

35.10.4.1.6. Guys.

35.10.4.2. Repairs or replacement parts shall be provided promptly as needed for safe operation. All replacement and repair parts shall have at least the original safety factor.

35.10.4.2.1. Hooks showing defects described in paragraph **35.11.5**, as shown in **Figure 35.22**, shall be discarded. Repairs by welding or reshaping are not recommended. If such repairs are attempted, they shall only be done by a qualified person, and the hook tested to load requirements of paragraph **35.10.2.1** before further use.

35.10.4.2.2. All critical parts which are cracked, broken, bent, or excessively worn shall be replaced.

35.10.4.2.3. Pitted or burned electrical contacts shall be corrected only by replacement and in sets. Controller parts shall be lubricated as recommended by the manufacturer.

#### 35.10.5. Lubrication.

35.10.5.1. All moving parts of the derrick and hoist, for which lubrication is specified (including rope and chain), shall be regularly lubricated. Lubricating systems shall be checked for proper delivery of lubricant. Follow manufacturer's recommendations as to points and frequency of lubrication and maintenance of lubricant used.

35.10.5.2. Machinery shall be stationary while lubricants are being applied unless it is equipped for automatic lubrication.

35.10.6. Rope Inspection, Replacement and Maintenance. Follow criteria outlined in paragraph **35.11.2** For rotation-resistant rope, follow rope or equipment manufacturer's recommendations.

### **35.11. Related Hoisting Equipment.**

35.11.1. Wire ropes, chains, hooks and related hoisting equipment shall be inspected prior to initial use, when repaired and monthly thereafter IAW applicable paragraphs of this chapter. Wire ropes, chains and hooks shall be thoroughly inspected monthly. Inspections for each item shall be documented on the AFTO Form 95, or other appropriate inspection and maintenance form or automated system, and maintained on file for one (1) year. Refer to paragraph **35.1.1** Documentation will include the date of the monthly inspection, signature of the inspector, an identifier for the equipment inspected, and condition of the equipment. **Note:** A frequent inspection may also be used to document the thorough monthly inspection of hooks, chains and wire ropes, provided it includes applicable requirements above and from paragraphs **35.11.3**, **35.11.4** and **35.11.6**.

35.11.2. Wire Ropes.

35.11.2.1. Use and Attachment Considerations.

35.11.2.1.1. The rope or crane manufacturer's recommendation shall be followed when hoisting ropes are used.

35.11.2.1.2. Socketing shall be done as specified by the assembly manufacturer.

35.11.2.1.3. Swaged or compressed fittings shall be applied as recommended by the rope or crane manufacturer.

35.11.2.1.4. Rope shall be secured to the drum as follows:

35.11.2.1.4.1. Not less than two (2) wraps of rope will remain on the drum when the hook is in its extreme lowest position.

35.11.2.1.4.2. The rope end shall be anchored by a clamp securely attached to the drum or by a socket arrangement approved by the crane or rope manufacturer.

35.11.2.1.4.3. If the crane is dual-reeved with the rope terminated at the equalizer, the termination fitting shall be rated to develop 100 percent of the rope strength.

35.11.2.1.5. Rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope. Spacing and number of clips shall follow the clip manufacturer's recommendation or **Table 35.23** Clips shall be drop-forged steel in all sizes manufactured commercially. When a newly installed rope has been in operation

for an hour, all nuts on the clip bolts shall be retightened. Refer to [Figure 35.23](#) through [35.29](#) and [Table 35.23](#) for additional guidance.

#### 35.11.2.2. Inspection.

35.11.2.2.1. Frequent. All running ropes in service shall be visually inspected daily or prior to use. The inspection shall be documented on AFTO Form 244 or MAJCOM or locally devised paper or automated systems, which includes date of inspection, signature of inspector, an identifier for ropes inspected and rope condition. Inspection shall be kept on file by the supervisor for a minimum of one year and made readily available. Sections of rope normally hidden or difficult to see during inspection or maintenance procedures, such as parts passing over equalizer sheaves, shall be given close inspection, as these are points most likely to fail. Any degradation in conditions described below could result in loss of original strength, shall be carefully noted and shall be considered for rejection:

35.11.2.2.1.1. Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion or wear of outside wires. Rope calipers and micrometers are normally used to determine changes in wire rope diameters. Refer to [Figure 35.28](#) for proper measurement technique.

35.11.2.2.1.2. Broken outside wires and the degree of distribution or connection of such broken wires.

35.11.2.2.1.3. Worn outside wires.

35.11.2.2.1.4. Corroded or broken wires at end connections.

35.11.2.2.1.5. Corroded, cracked, bent, worn or improperly applied end connections.

35.11.2.2.1.6. Severe kinking, crushing, cutting or unstranding.

35.11.2.2.2. Periodic Inspection. Recommended interval of periodic inspections shall be determined by a qualified person, based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. Inspections need not be at equal calendar intervals and shall be more frequent as the rope approaches the end of its useful life. This inspection shall cover the rope's entire length and requirements of paragraph [35.11.2.2.1](#) Inspections shall be documented on the AFTO Form 95 or MAJCOM or locally devised paper or automated systems, as outlined in paragraph [35.6.3.8](#) Refer to paragraph [35.1.1](#) for additional guidance. The inspection record shall include the date of the inspection, signature of the inspector, an identifier for the rope inspected and rope condition. The inspection record shall be kept on file by the user for a minimum of one year and made readily available. **Note:** When the rope's periodic inspection schedule falls within the periodic inspection schedule of the hoist, the rope inspection shall be recorded on the periodic inspection documentation specified in paragraphs [35.6.3.5.2](#) and [35.1.1](#).



35.11.2.2.3. All rope idle for a month or more due to shutdown or storage of a hoist on which it is installed shall be given a thorough inspection before placed in service. Refer to paragraph [35.11.2.4.3](#) for additional guidance.

#### 35.11.2.3. Maintenance.

35.11.2.3.1. Rope shall be stored and handled in a manner which prevents damage or deterioration.

35.11.2.3.2. Unreeling or uncoiling of rope shall be done as recommended by rope manufacturer and with extreme care to avoid kinking or inducing twist.

35.11.2.3.3. Before cutting a rope, seizings shall be placed on each side of where the rope is to be cut to prevent unlaying of the strands.

35.11.2.3.4. During installation, avoid dragging the rope in dirt or around objects which will scrape, nick, crush or induce sharp bends in the rope.

35.11.2.3.5. Rope shall be maintained in a well-lubricated condition. The object of rope lubrication is to reduce internal friction and to prevent corrosion. Lubricant applied as part of a maintenance program shall be compatible with the original lubricant. The rope manufacturer's technical guidance/instructions shall be consulted. Lubricant applied shall not hinder visual inspection. Sections of rope located over sheaves or difficult to see during inspection and maintenance procedures require special attention when lubricating the rope. **Exception:** When used in clean rooms, factory lubricant may be removed from stainless steel ropes to prevent contamination.

35.11.2.3.6. An independent wire-rope or wire-strand core, or other temperature-damage resistant core, shall be used wherever there is exposure to temperatures at which fiber cores would be damaged.

35.11.2.3.7. Replacement rope shall be the same size, grade, and construction as the original rope furnished by the crane manufacturer, unless otherwise recommended by a wire rope manufacturer due to actual working conditions. Refer to paragraphs [35.11.2.3.4](#) and [35.11.2.4.4](#) for additional guidance.

#### 35.11.2.4. Replacement:

35.11.2.4.1. Ropes shall be removed from service and replaced when any of the following conditions exist:

35.11.2.4.1.1. In running ropes, six (6) randomly distributed broken wires in one lay or three (3) broken wires in one strand in one lay.

35.11.2.4.1.2. One outer wire broken at the contact point with the core of the rope, which has worked its way out of the rope structure and protrudes or loops out from the rope structure.

35.11.2.4.1.3. Wear or scraping of 1/3 the original diameter of outside individual wires.

35.11.2.4.1.4. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure, as seen in [Figure 35.29](#)

35.11.2.4.1.5. Evidence of any heat damage or corrosion.

35.11.2.4.1.6. Reductions from nominal diameter of more than:

35.11.2.4.1.6.1. One-sixty-fourth (1/64) inch for diameters up to and including 5/16 inch.

35.11.2.4.1.6.2. One-thirty-second (1/32) inch for diameters 3/8 inch to and including one-half inch.

35.11.2.4.1.6.3. Three-sixty-fourths (3/64) inch for diameters 9/16 inch to and including three-fourths inch.

35.11.2.4.1.6.4. One-sixteenth (1/16) inch for diameters 7/8 inch to and including one and one-eighth inch.

35.11.2.4.1.6.5. Three-thirty-seconds (3/32) inch for diameters one and 1/4 inch to and including one and one-half inch.

35.11.2.4.1.6.6. In standing ropes, more than two (2) broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

35.11.2.4.2. Special attention shall be given to the end fastenings. Ropes shall be examined at socketed fittings and when two (2) broken wires are found next to this point, the rope shall be resocketed. Portions of the rope subjected to reverse bends and operation over small diameter sheaves or drums shall be given close attention.

35.11.2.4.3. A rope which has been in service, but idle for one month or more, shall be thoroughly examined before being put back into service. This examination shall be for all types of deterioration, particularly corrosion, and shall be performed by a designated person, whose approval shall be required for further use of the rope. The inspection shall be documented on an AFTO Form 95 or MAJCOM or locally devised paper or automated systems, which includes date of inspection, signature of inspector, an identifier for ropes inspected and rope condition. The inspection shall be kept on file by the user for a minimum of one year and made readily available.

35.11.2.4.4. All replacement rope shall be of proper size, grade and construction for its particular function on the machine. **Note:** Discarded or repaired rope shall not be used for slings.

35.11.2.4.5. A continuing inspection record shall be maintained to establish a basis for judging when to replace wire rope. This record shall cover points of deterioration listed in paragraphs [35.11.2.4.1](#) and [35.11.2.4.2](#)

35.11.3. Chains.

35.11.3.1. Welded Link Chain Inspection.

35.11.3.1.1. Test hoist under load in hoisting and lowering directions and observe operation of the chain and sprockets. Ensure chain feeds smoothly into and away from sprockets.

35.11.3.1.2. If chain binds, jumps or is noisy, ensure it is clean and properly lubricated. If the trouble persists, inspect chain and mating parts for wear, distortion or other damage.

35.11.3.1.3. Clean the chain for inspection. Examine visually for gouges, nicks, weld splatter, corrosion and distorted links. Slacken the chain and move adjacent links to one side to inspect for wear at the contact points. If wear is observed, or if stretching is suspected, measure the chain according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

35.11.3.1.3.1. Select an unworn, unstretched length of the chain from the slack end.

35.11.3.1.3.2. Suspend chain vertically under tension and, using a caliper type gauge, measure outside length of any convenient number of links, approximately 12 to 14 inches overall.

35.11.3.1.3.3. Measure the same number of links in the used sections and calculate percentage increase in length. If the used chain exceeds the hoist manufacturer's recommended length, (or, in the absence of such a recommendation, if the chain is 1.5 percent longer than unused chain) replace the chain. Do not repair load chain by welding or any other means; this repair is only accomplished by the chain manufacturer.

35.11.3.1.3.4. Install load chain links which pass over hoist load sprocket on edge (alternate to those which lie flat in the pockets) with welds away from center of the sprocket.

35.11.3.1.4. Inspect hoist chains, including end connections, for excessive wear, twist and distorted links interfering with proper function or stretched beyond manufacturer's recommendations. Hoist chains inspection intervals and requirements shall follow paragraphs [35.6.3.5.1](#) and [35.6.3.5.2](#). A thorough inspection of all hoist chains shall be made at least once each month. A written report which includes the date of the monthly inspection, the signature of the inspector, an identifier for the chains inspected and chain condition shall be kept on file by the user for a minimum of one year and made readily available.

35.11.3.1.5. When chain is replaced, mating parts (chain sprockets, guides, stripper) shall be disassembled and inspected for wear and replaced if necessary.

35.11.3.1.6. For non-load bearing drive (slack) chains, inspect for cracks, weld splatter, burrs or other damage. Repair or replace as required.

#### 35.11.3.2. Roller Link Chain Inspection:

35.11.3.2.1. Test hoist under load in hoisting and lowering directions and observe operation of chain and sprockets. Ensure chain feeds smoothly into and away from sprockets.

35.11.3.2.2. If chain binds, jumps or is noisy, ensure it is clean and properly lubricated. If the trouble persists, inspect chain and mating parts for wear, distortion or other damage.

35.11.3.2.3. If possible, inspect roller link chain while in the hoist. With hoist suspended in normal position, apply a light load of approximately 50 pounds.

35.11.3.2.3.1. Check chain for elongation following hoist manufacturer's instruction. In absence of specific instructions, check the chain by determining the nominal pitch and measuring a 12-inch section of chain that normally travels over the chain sprocket. Using a vernier caliper, check the dimension from the edge of one chain pin to the corresponding edge of another pin for the number of pitches per foot. If elongation exceeds 1/4 inch in 12 inches, replace the chain. For example, a 3/4 inch pitch chain should measure 12 inches over 16 pitches. Reject chain if measurement over 16 pitches exceeds 12.25 inches.

35.11.3.2.3.2. Check chain for twist. Replace the chain if the twist in any 5-foot section exceeds 15 degrees.

35.11.3.2.3.3. Check for camber. Replace chain which has a side bow exceeding 1/4 inch in any 5-foot section.

35.11.3.2.4. Inspect the chain more thoroughly by removing chain from hoist and cleaning it thoroughly in an acid-free solvent. Then check for the following deficiencies:

35.11.3.2.4.1. Pins turned from their original position.

35.11.3.2.4.2. Rollers that do not turn freely with light finger pressure.

35.11.3.2.4.3. Joints that cannot be flexed by easy hand pressure.

35.11.3.2.4.4. Link plates that are spread open. A visual check of the pin extension at free end of chain can determine the amount of spread and the condition of the chain.

35.11.3.2.4.5. Corrosion, pitting or discoloration of chain, which is generally indicative of serious impairment.

35.11.3.2.4.6. Gouges, nicks or weld spatter.

35.11.3.3. Maintenance. All chain shall be kept clean and free from rust or any coating deposit build up and any change in dimensions or reduced flexibility. Excessively dirty chain shall be soaked in a clean acid-free solvent and agitated to ensure all joints are free from grit and foreign matter. Hand chain normally needs no lubricant. Roller and load chain shall be lubricated according to the hoist manufacturer's recommendations. In absence of recommendations, the chain may be lubricated with a good grade of SAE 20 or SAE 30 automotive motor oil. Grease shall never be applied to a chain.

35.11.4. Sheaves and Equalizers.

35.11.4.1. Sheaves.

35.11.4.1.1. Sheave grooves shall be smooth and free from surface defects which could cause rope damage.

35.11.4.1.2. Sheave-carrying ropes, which can be momentarily unloaded, shall be provided with close-fitting guards or other suitable devices to guide the rope back

into the groove when the load is applied again. **Note:** Equalizers where ropes are terminated shall be specified to have sufficient adjustment space for block leveling as the rope stretches.

35.11.4.1.3. Sheaves in the bottom block shall be equipped with close-fitting guards to prevent ropes from fouling when the block is lying on the ground with loose ropes.

35.11.4.1.4. Pockets and flanges of sheaves used with hoist chains shall be sized so the chain does not catch or bind during operation.

35.11.4.1.5. All running sheaves shall be equipped with means for lubrication. Permanently lubricated, sealed bearings meet this requirement.

35.11.4.1.6. When chain is replaced, mating parts (chain sprockets, guides, stripper) shall be disassembled, inspected for wear and replaced if necessary.

#### 35.11.4.2. Equalizers.

35.11.4.2.1. If a load is supported by more than one part of rope, the tension in the parts shall be equalized.

35.11.4.2.2. Equalizers shall be readily accessible for maintenance, lubrication and inspection.

#### 35.11.5. Hooks.

##### 35.11.5.1. Inspection.

35.11.5.1.1. Hooks that are cracked, have any visibly apparent bend or twist from the plane of the unbent hook (original manufacturer or baseline measurements), any distortion causing an increase in throat opening of five (5) percent, not to exceed ¼ inch (or as recommended by the manufacturer), or any wear exceeding 10 percent (or as recommended by the hook manufacturer) of the original manufacturer or baseline section dimension of the hook shall be removed from service and repaired or replaced. Repairs by welding or reshaping are not recommended as a standard practice. If such repairs are attempted, they shall be done by a qualified person and the hook shall be tested to the load requirements of paragraph [35.9.2.6.1](#) before further use. Compliance should not preclude the possibility of consulting a qualified person when: the equipment has been altered, repaired or modified; the manuals or documents supplied by the manufacturer are no longer available; or the manufacturer or a successor is no longer in business and the manuals are no longer available. However, the purpose of consulting a qualified person shall not be to avoid contacting the manufacturer and obtaining the information supplied by the manufacturer. If manufacturer's data is not available and a qualified person has not determined the hook to be safe, the hook shall be removed from service. **Note 1:** Hooks repaired by welding or reshaping are not authorized on nuclear-certified hoists or lifting equipment or equipment used to lift critical loads. **Note 2:** Painted hooks shall not be used on nuclear-certified hoists or lifting equipment. **Note 3:** The manufacturer's original specifications shall be used as the baseline. If the original specifications cannot be obtained through the manufacturer or item manager, the hook can continue to be used, provided the hook has been determined safe for use by a qualified individual IAW ANSI/ASME B30.10, *Hooks*.

35.11.5.1.2. Hooks shall be examined for the following (See [Figure 35.22](#)):

35.11.5.1.2.1. Distortion such as bending, twisting or increased throat opening.

35.11.5.1.2.1.1. Any apparent bend or twist from the plane from the original measurements.

35.11.5.1.2.1.2. Any wear exceeding 10 percent (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.

35.11.5.1.2.1.3. Any distortion causing an increase in throat opening of five (5) percent, not to exceed ¼ inch (or as recommended by the manufacturer).

35.11.5.1.2.2. Cracks, severe nicks or gouges.

35.11.5.1.2.3. Safety latch engagement and damaged or malfunctioning latch, i.e., any self-locking latch that does not lock or any latch that does not close the hook's throat.

35.11.5.1.2.4. Hook attachment and securing means. Hook retaining nuts on collar and pins, welds or riveting shall be used to secure the retaining member.

35.11.5.1.2.5. Lubrication of swivel point.

35.11.5.1.2.6. Hooks shall not be painted. Unless specifically permitted by TO or other technical guidance, Air Force-users are not authorized to paint hooks. Hooks received painted by the manufacturer may be used in applications not requiring them to be non-destructive inspected. Painted hooks removed from service shall be replaced.

35.11.5.1.2.7. Repairs by welding or reshaping are not recommended as a standard practice. If such repairs are attempted, they shall only be accomplished by a qualified person, and the hook shall be tested to the load requirements of the specific equipment in use. **Note:** Hooks repaired by welding or reshaping are not authorized on nuclear-certified hoists or lifting equipment.

35.11.5.1.3. Intervals of Inspections. All hooks in service shall be visually inspected daily or prior to use. The inspection shall be documented on AFTO Form 244 or MAJCOM or locally devised paper or automated system, which includes date of inspection, signature of inspector, an identifier for the hooks inspected and hook condition. The inspection shall be kept on file by the user for a minimum of one year and made readily available. Refer to paragraph [35.1.5.3](#) for additional guidance. **Note:** If the hook is part of a hoist, the frequent inspection shall be recorded on the hoist inspection documentation IAW paragraph [35.6.3.5.1](#).

35.11.5.1.4. For nuclear-certified hoist hooks and hooks used in lifting critical loads, perform a dye penetrant, magnetic particle, or other suitable nondestructive inspection (NDI) on the hook annually, in addition to the above. For nuclear-certified hoist hooks, perform the annual NDI in conjunction with one of the two scheduled semiannual hoist and crane inspections. Refer to paragraphs [35.6.3.5.2](#) and [35.8.3.5.2](#) for specific guidance. Refer to paragraph [35.6.3.7.4](#) for additional guidance on critical loads. **Note:** If the hook retaining nut is welded to the hook shank, removal of the

hook for inspection is not required. In this case, a visual inspection of the inside of the block assembly shall be performed. If the block is designed such that disassembly is not feasible, this inspection is not required. Refer to **Figures 35.22** and **35.30** for guidance. **Warning:** If hook is removed from hoist for NDI, verify that the hook is properly reinstalled before use.

35.11.5.2. Rated Capacity. Rated capacity for a hook, when used as intended, shall be equal to other suspension members to which it is attached. When this is not feasible, special precautions shall be taken to ensure the hook's rated capacity is not exceeded.

35.11.5.3. Hooks shall not be painted. Unless specifically permitted by TO or other technical guidance, Air Force-users are not authorized to paint hooks. Hooks (including hooks on slings) received painted by the manufacturer may be used in applications not requiring them to be non-destructively inspected. Painted hooks removed from service shall be replaced. **Note 1:** Painted hooks shall not be used on nuclear-certified hoists or lifting equipment or equipment used to lift critical loads. **Note 2:** Hooks with protective coatings applied by the manufacturer that do not affect or interfere with NDI may be used in applications requiring hook NDI. **Note 3:** Existing painted hooks may have the paint removed for NDI but may not be repainted unless authorized above.

35.11.5.4. Removable Hooks and Lifting Fixtures. Where operations require removal or replacement of hooks and/or lifting fixtures, the lifting capacity of the hooks/lifting fixtures shall be marked on the hook/lifting fixture and readily identifiable to the hoist/crane operator to prevent overloading the crane or hook/lifting fixture when load capacities are different.

35.11.6. Hydra sets and Load Cells. These devices allow precision placement of heavy loads during mating and demating operations. These precision positioners are especially valuable when handling critical high value items such as spacecraft payloads or astronomical optics. Users of these types of materials handling equipment will develop inspection and testing procedures based upon the type of materials lifted.

35.11.7. Personnel Hoists and Suspended Personnel Platforms. Using a crane or derrick to hoist workers on a personnel platform is prohibited except when conventional means of reaching the worksite, such as personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible. When absolutely necessary to hoist personnel, the following shall apply:

35.11.7.1. Cranes used for personnel hoisting shall have an anti-two blocking device incorporated into its design and shall have a power controlled lowering system capable of handling rated loads and speeds as specified by the manufacturer. Refer to 29 CFR 1926.1400 for additional information.

35.11.7.2. Platforms used to suspend personnel shall be designed and used IAW 29 CFR 1926.1400 and as follows:

35.11.7.2.1. Be capable of supporting at least five (5) times the maximum intended load (workers and their tools and equipment).

35.11.7.2.2. Be equipped with a guardrail system including a top rail of 42 inches, a midrail and a toe-board and shall be enclosed at least from the toeboard to the midrail.

The guardrails shall be able to withstand at least 200 pounds applied in any direction. A grab rail shall be installed inside the entire perimeter of the platform.

35.11.7.2.3. Will permit a maximum of four (4) workers to be lifted, and provide room for tools and equipment. Each worker shall be considered to weigh 250 pounds.

35.11.7.2.4. Shall not be used during high winds, thunderstorms or any other adverse weather condition which could endanger the workers on the platform.

35.11.7.3. The lifting bridle, used to suspend the working platform from the crane, shall normally consist of four (4) legs attached to ensure stability of the platform. The lifting bridle shall be attached by a hook, closed and locked or secured by a shackle with a bolt, nut and retaining pin. These bridles and associated rigging shall not be used for other purposes when not hoisting personnel.

35.11.7.4. The total weight of the loaded personnel platform and related rigging (to include the load block, ball and wire rope) shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane or derrick.

35.11.7.5. The crane shall be uniformly level within one percent of level grade and located on firm footing. If equipped, outriggers shall be fully deployed IAW manufacturer's specifications.

35.11.7.6. Requirements for trial lift, inspection and load tests per 29 CFR 1926.1400 and the following:

35.11.7.6.1. Trial lifts are required immediately before personnel are lifted. A new trial lift shall be performed any time the location or route of the planned lift changes. The platform shall be inspected after the trial lift and before lifting personnel.

35.11.7.6.2. The platform and rigging shall be load tested to 125 percent of the platform's rated capacity prior to lifting personnel at each job location and after any modifications or repairs.

35.11.7.7. Personnel Safe Work Practices.

35.11.7.7.1. Workers shall keep all body parts inside the platform during lifts and, except when over water, shall wear and secure a safety harness with lanyard to an approved attach point within the platform. The safety harness lanyard system must prevent a fall of over six (6) feet and the attach point must be capable of supporting the fall impact of the worker. Refer to paragraph [13.4.6](#) for additional fall protection guidance.

35.11.7.7.2. The crane or derrick operator shall remain at the controls when personnel are suspended and shall terminate hoisting of personnel at the first sign of a potentially dangerous condition.

35.11.8. Portable Automobile Lifting Devices (PALD).

35.11.8.1. Each PALD shall be provided with operator's instructions. The instructions shall specify the proper operating procedures and basic function of the components. The instructions shall contain the recommended replacement fluid, maintenance and inspection procedures and intervals, as applicable.



35.11.8.2. Maintenance. The PALD shall be maintained IAW the product instructions.

35.11.8.3. Inspection.

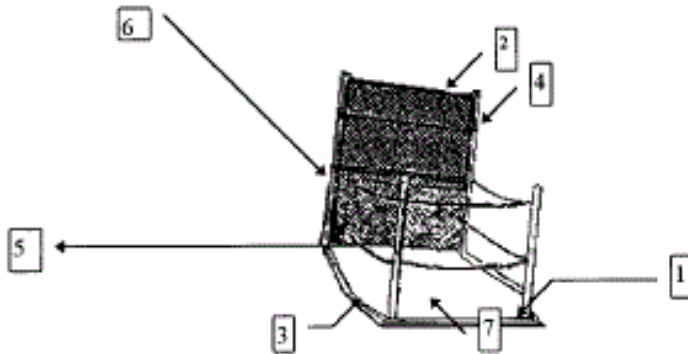
35.11.8.3.1. Visual inspection shall be made before each use of the PALD by checking for abnormal conditions, such as cracked welds, leaks and damaged, loose or missing parts.

35.11.8.3.2. Other inspections shall be made per product operating instructions.

35.11.8.3.3. Each PALD shall be inspected immediately if the lift is believed to have been subjected to abnormal load or shock. It is recommended that this inspection be made by qualified personnel or a manufacturer's or supplier's authorized repair facility. **Note:** Supervisors and/or operators should be aware that repair of this equipment may require specialized knowledge and facilities.

35.11.8.3.4. An annual inspection of PALD will be accomplished by qualified personnel or by a manufacturer's or supplier's repair facility. Any defective parts, decals or safety labels or signs will be replaced with manufacturer's or supplier's specified parts.

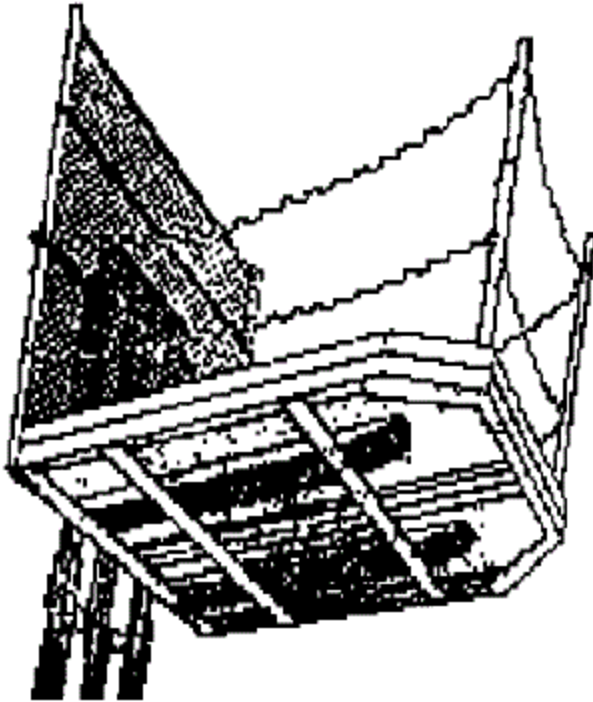
**Figure 35.1. Approved Safety Pallet.**



**Note:** The following correspond to the numbers 1 through 7 positioned around the figure.

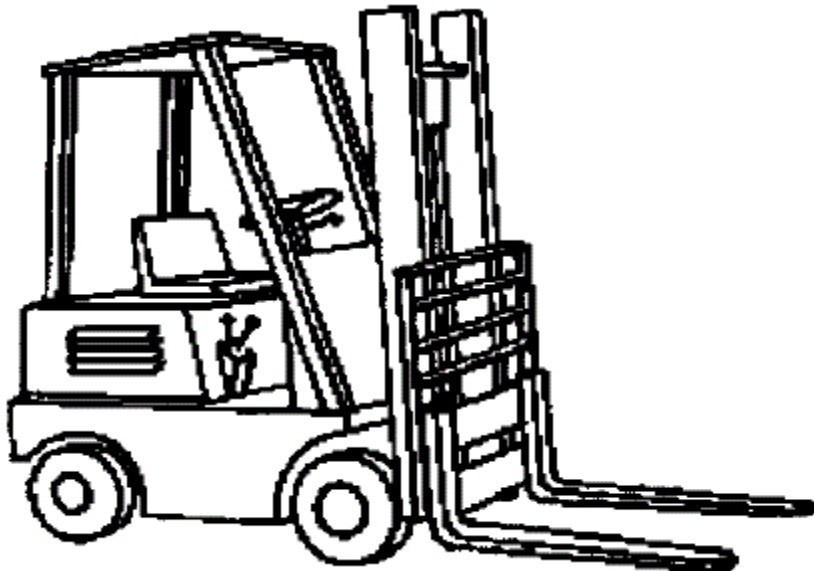
1. A 4-inch toeboard to prevent tools or small items from falling off.
2. An expanded metal backguard to protect personnel from moving parts of the forklift.
3. Mitered corners.
4. Handrail on backguard.
5. Safety chains with the top chain 42 inches from the pallet surface and a second chain approximately midway between the pallet surface and the top chain, to enclose the pallet area.
6. Chains for securing the pallet to the fork truck.
7. Checker plate flooring to prevent slippage of pallet.

**Figure 35.2. Extension Forks Used With The Safety Pallet.**



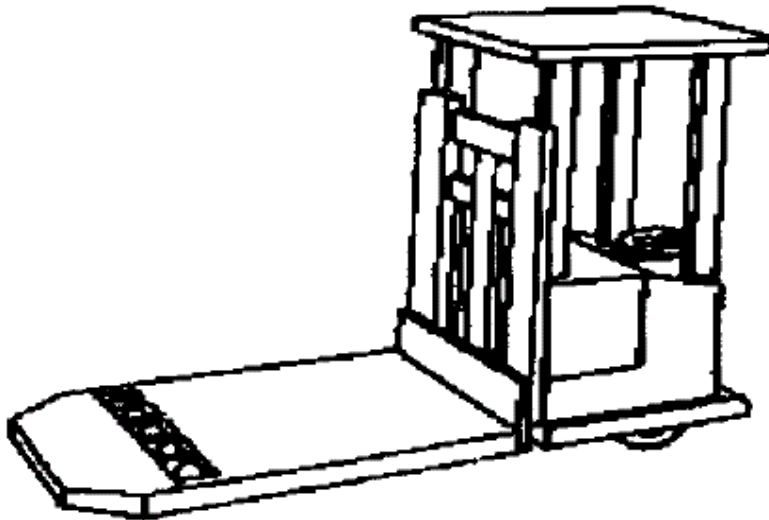
**Note:** Fork extensions may be needed to support larger type safety pallets. A notice to this effect shall be displayed prominently on the side of the pallet (“Use Fork Extensions”).

**Figure 35.3. High-Lift Truck.**



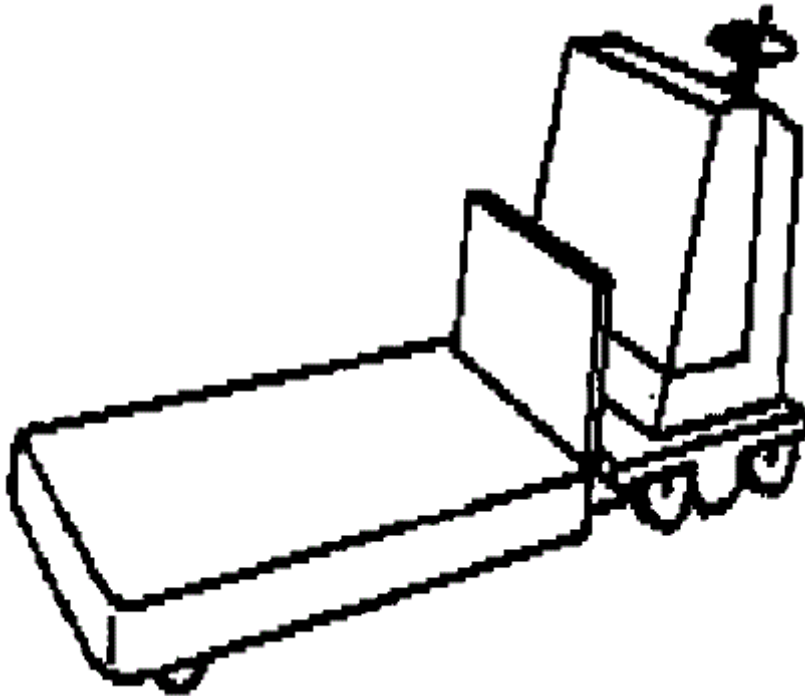
**Note:** Also known as Counterbalanced Truck, Cantilever Truck, Rider Truck, or Forklift Truck.

**Figure 35.4. High-Lift Truck.**



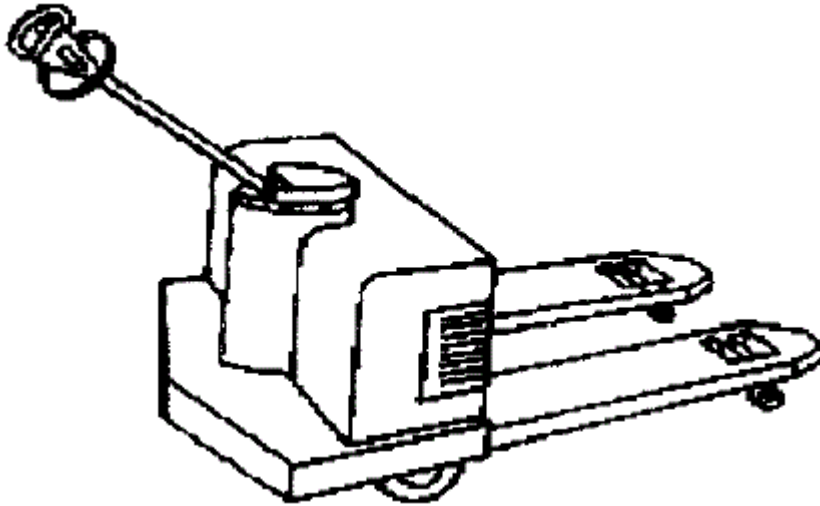
**Note:** Also known as a High-Lift Platform Truck.

**Figure 35.5. Low-Lift Truck.**



**Note:** Also known as a Low-Lift Platform Truck.

**Figure 35.6. Motorized Hand Truck.**



**Note:** Also known as a Pallet Truck.

**Figure 35.7. Industrial Tractor.**

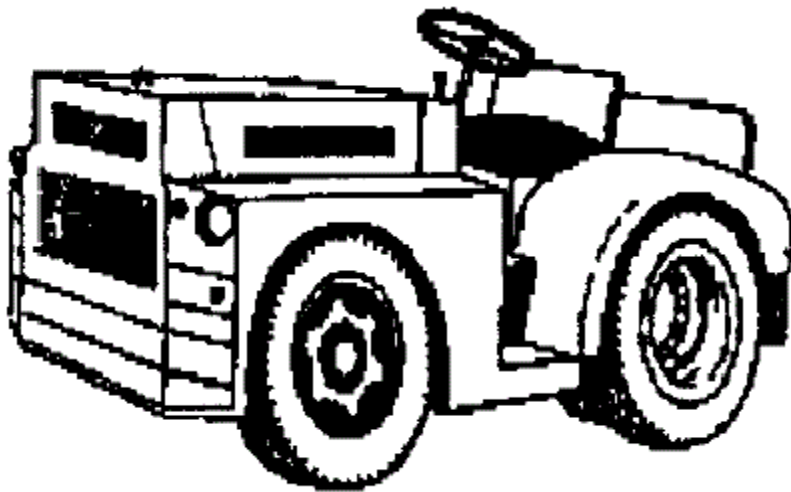


Figure 35.8. Motorized Hand or Rider Truck.

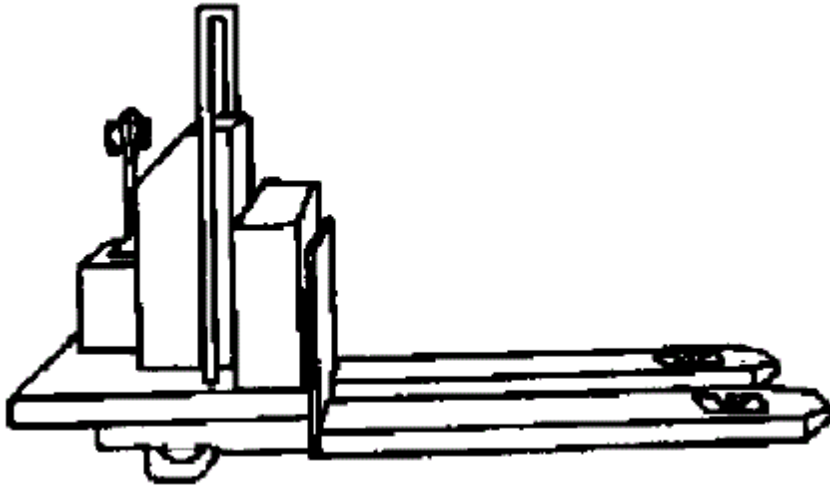


Figure 35.9. Reach Trucks.

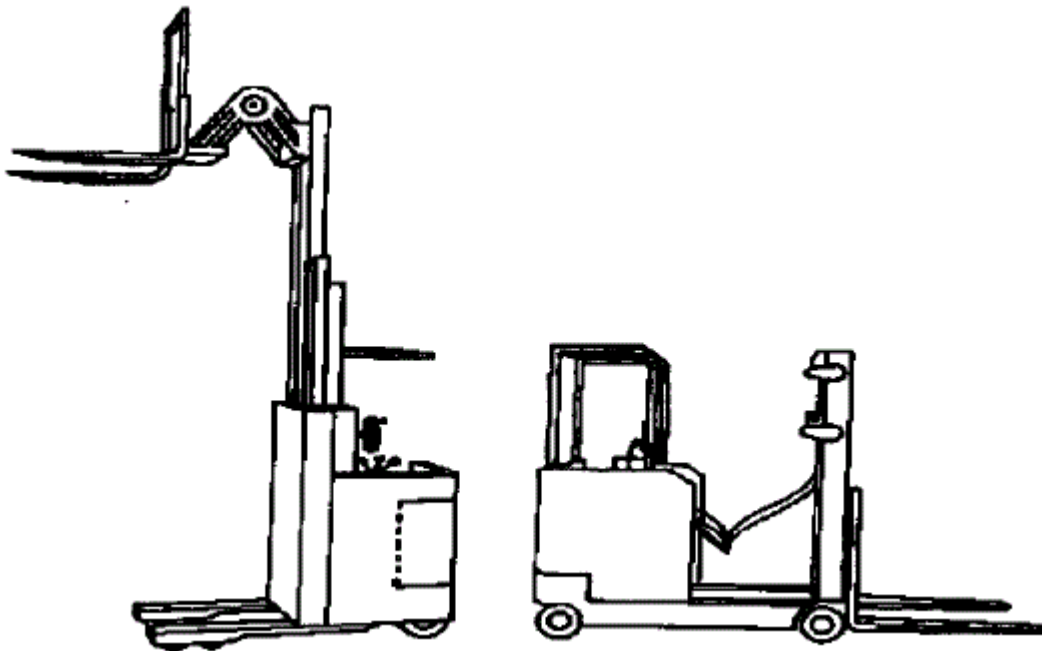


Figure 35.10. Side-Loader Truck.

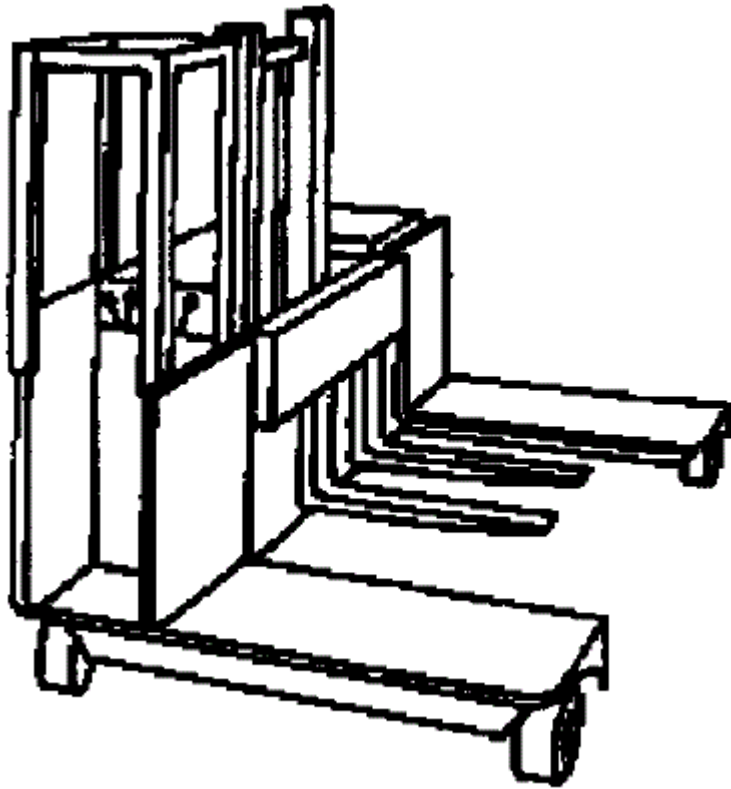
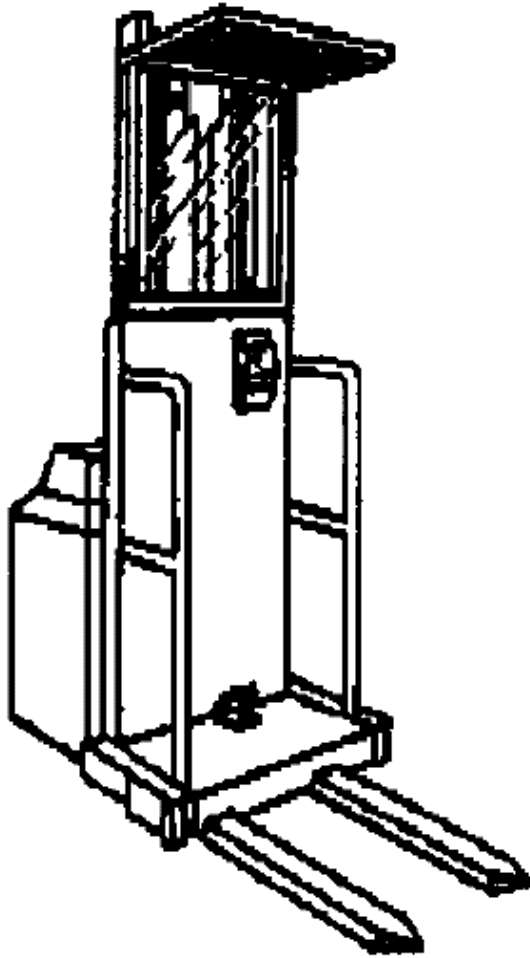


Figure 35.11. Order Picker Truck, High Lift.



**Note:** Guards required to prevent truck movement, when the operator extends beyond the truck, are not shown.

Figure 35.12. Narrow-Aisle Truck (Also known as a Straddle Truck).

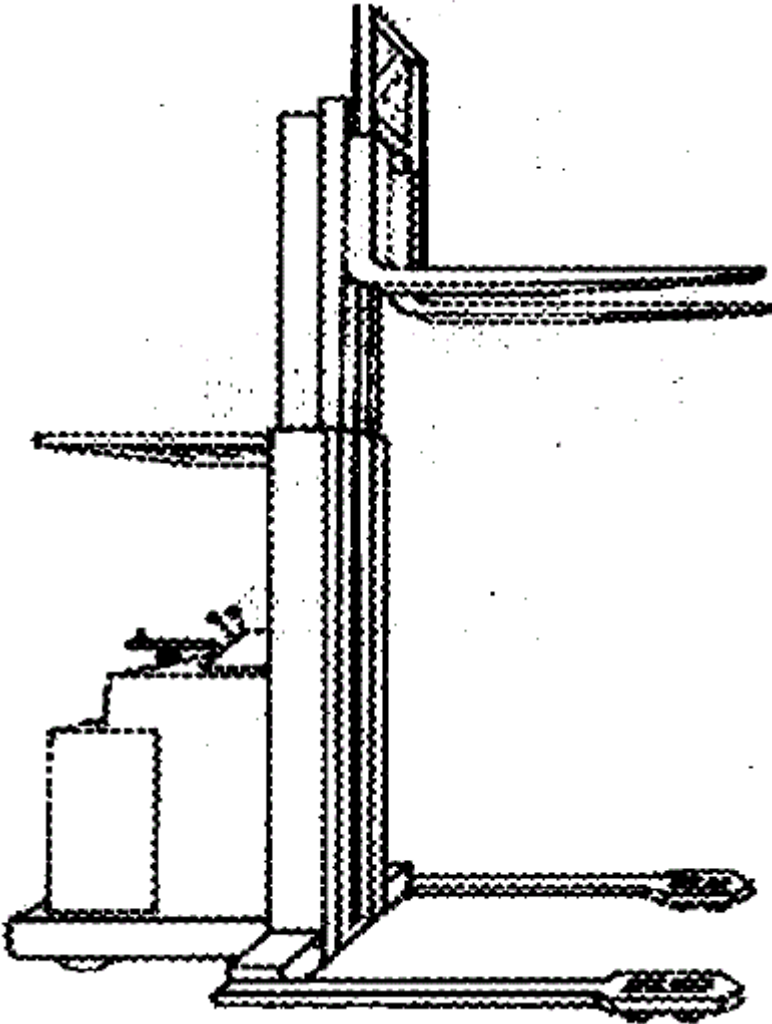




Figure 35.13. Truck, Straddle, Carry.

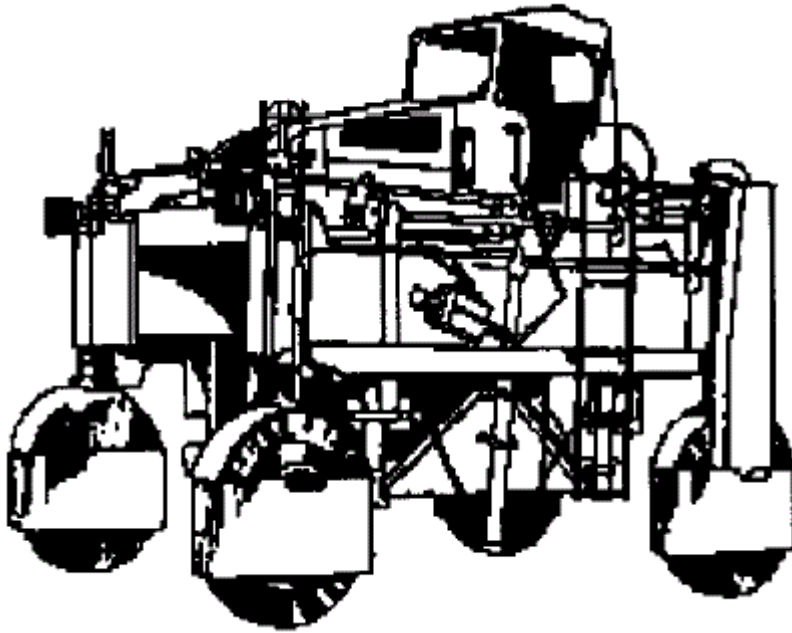


Figure 35.14. Truck, Warehouse, Double-Handle Type, 2-Wheel, Solid Rubber Tires.

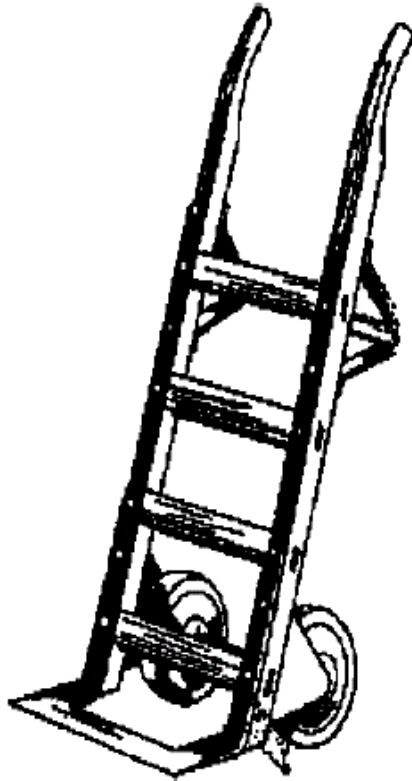


Figure 35.15. Truck, Hand, Platform, 4-Wheel.



Figure 35.16. Crane Truck, Warehouse, Electric.

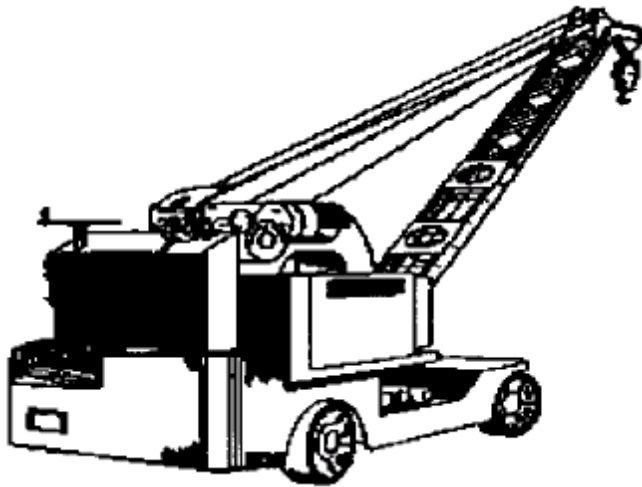


Figure 35.17. Crane Truck, Warehouse, Gasoline.

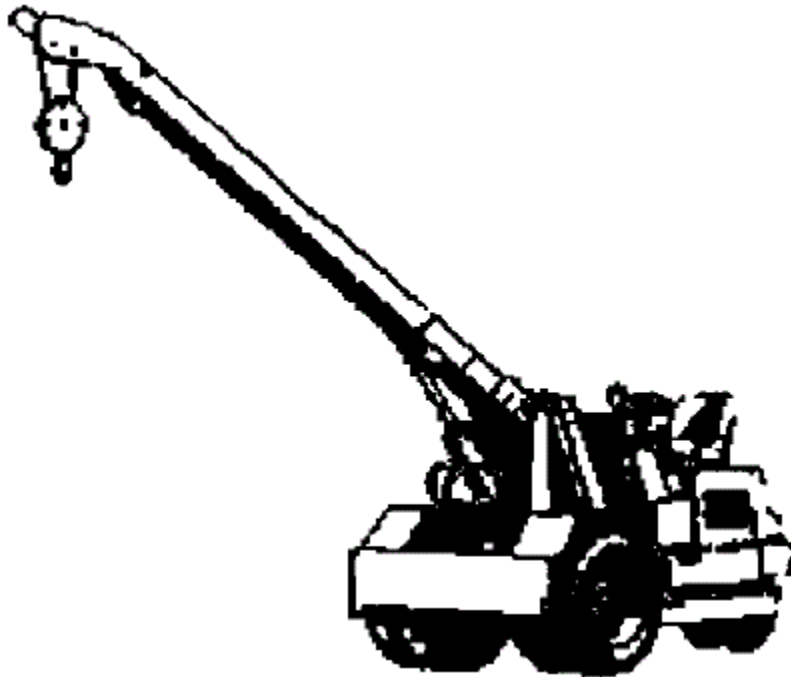
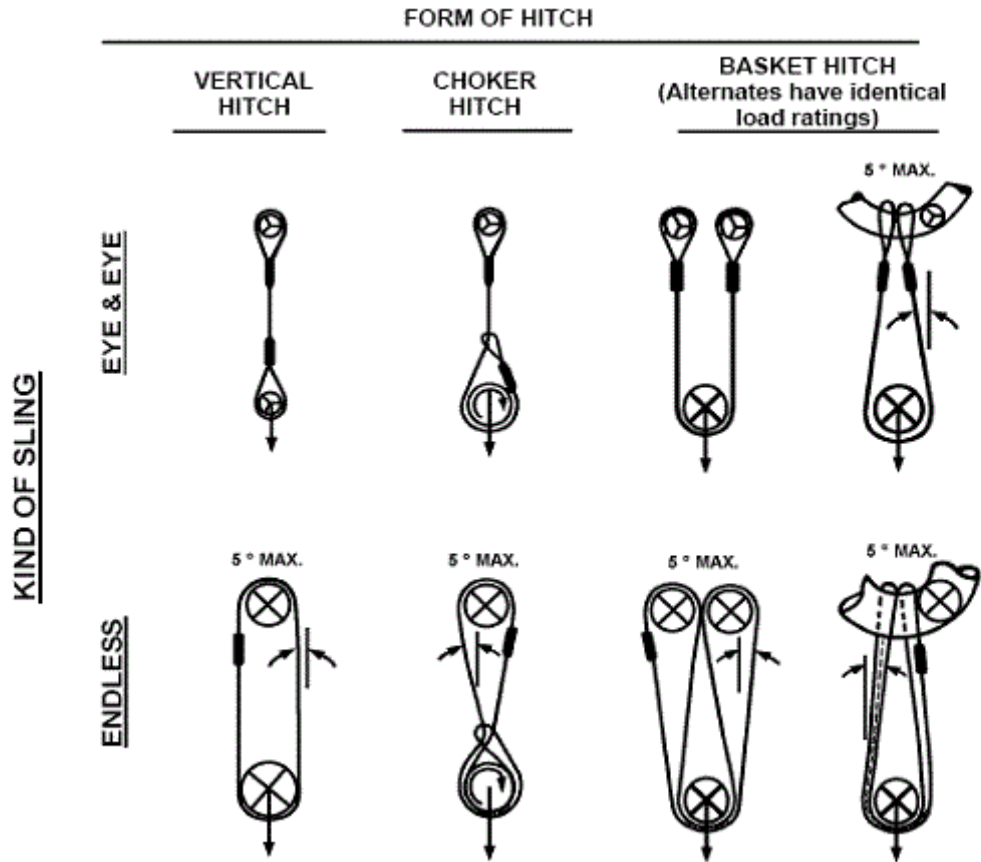


Figure 35.18. Basic Sling Configuration With Vertical Legs.



**Notes:**

1. Angles 5 degrees or less from the vertical may be considered vertical angles.
2. For slings with legs more than 5 degrees off vertical, the actual angle, as shown in **Figure 35.19.**, must be considered.

**Explanation of Symbols: Minimum Diameter of Curvature.**



REPRESENTS A CONTACT SURFACE WHICH SHALL HAVE A DIAMETER OF CURVATURE AT LEAST DOUBLE THE DIAMETER OF THE ROPE FROM WHICH THE SLING IS MADE

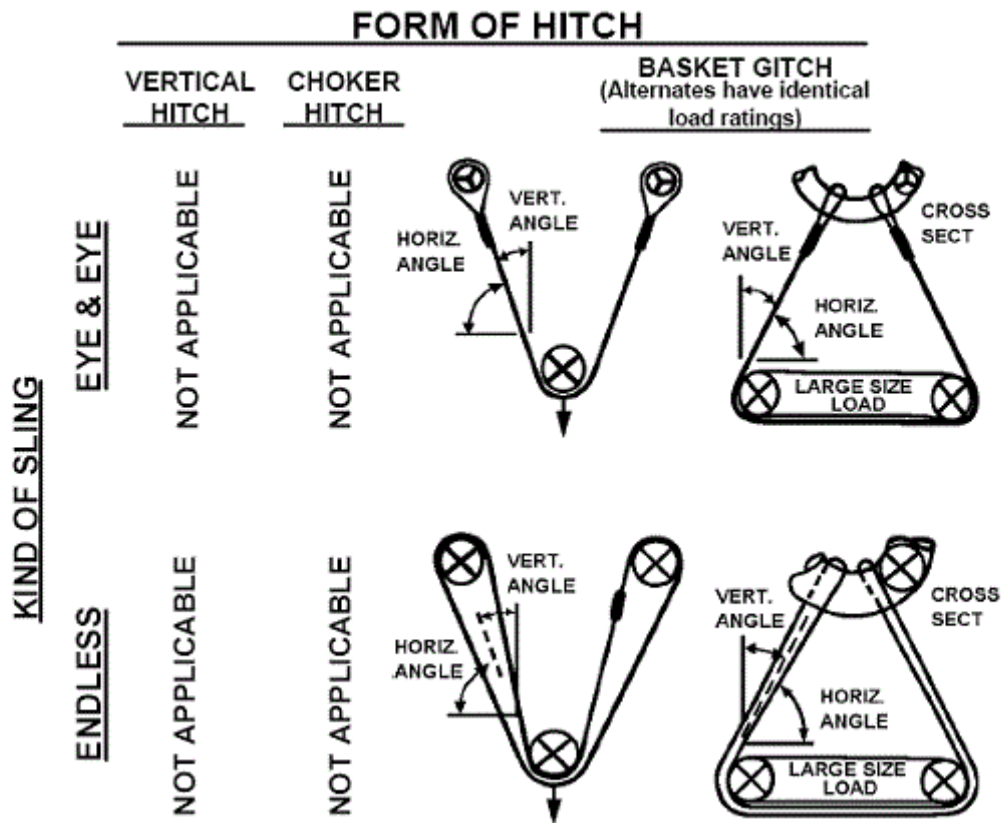


REPRESENTS A CONTACT SURFACE WHICH SHALL HAVE A DIAMETER OF CURVATURE AT LEAST 8 TIMES THE DIAMETER OF THE ROPE.



REPRESENTS A LOAD IN A CHOKER HITCH AND ILLUSTRATES THE ROTARY FORCE ON THE LOAD AND (OR) THE SLIPPAGE OF THE ROPE IN CONTACT WITH THE LOAD. DIAMETER OF CURVATURE OF LOAD SURFACE SHALL BE AT LEAST DOUBLE THE DIAMETER OF THE ROPE.

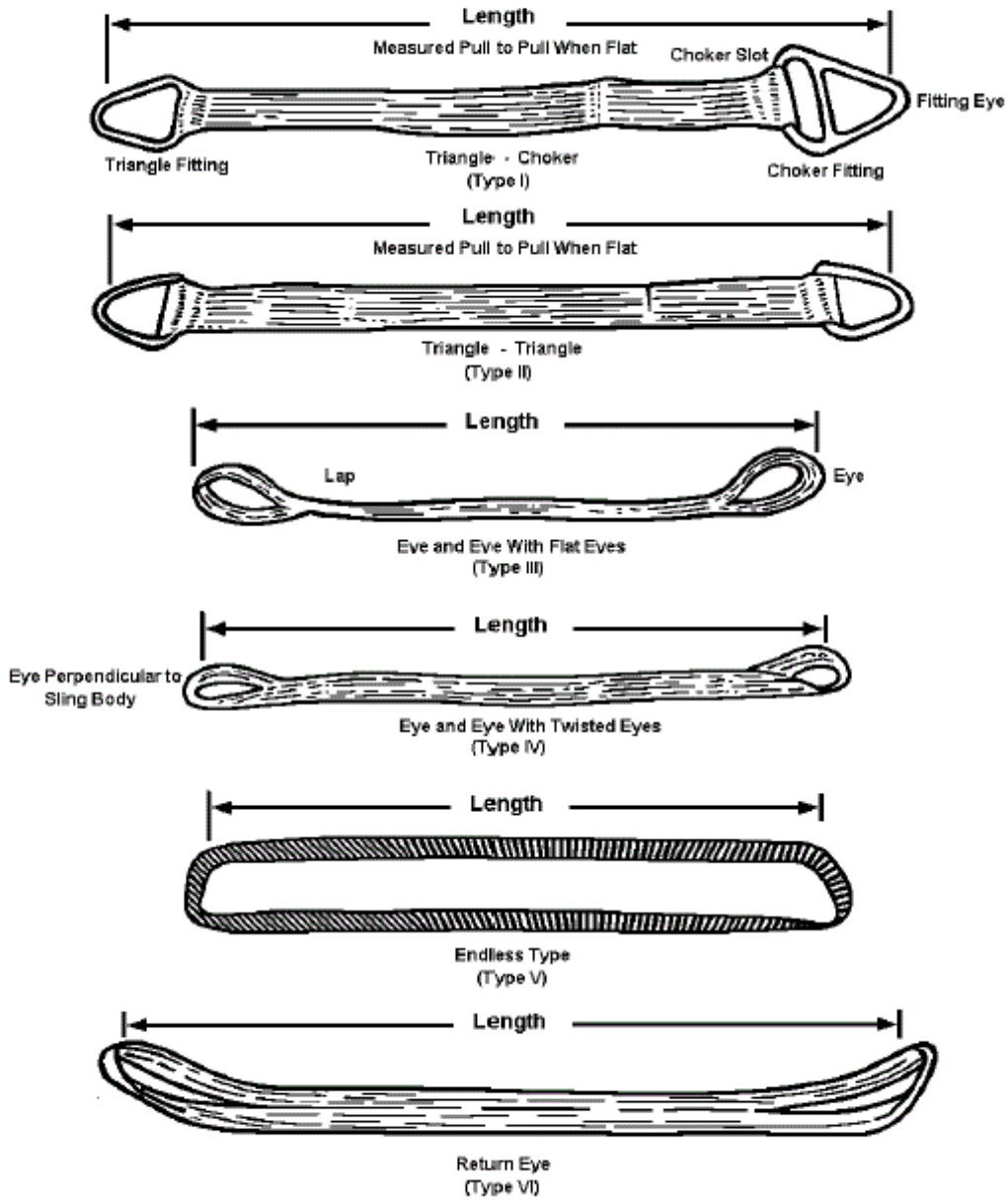
Figure 35.19. Sling Configuration With Angled Legs.



Notes:

1. For vertical angles of 5 degrees or less, refer to **Figure 35.18**.
2. Refer to **Figure 35.18**. for symbol explanation.

Figure 35.20. Basic Synthetic Web Sling Configuration.



**Figure 35.21. Hand Signals for Controlling Overhead and/or Gantry Crane Operations.**



**HOIST.** With forearm vertical, forefinger pointing up, move hand in small horizontal circle.



**LOWER.** With arm extended downward, forefinger pointing down, move hand in small horizontal circle.



**BRIDGE TRAVEL.** Arm extended forward, hand open and slightly raised. Make pushing motion in the direction of travel.



**TROLLEY TRAVEL.** Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.



**STOP.** Arm extended, palm down, move arm back and forth.



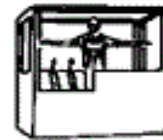
**EMERGENCY STOP.** Both arms extended, palms down, move arms back and forth.



**MULTIPLE TROLLEYS.** Hold up one finger for block marked "1" and two fingers for block marked "2". Regular signals follow.



**MOVE SLOWLY.** Use one hand to give any motion signal and place other hand motionless in front of Hand giving the motion signal. (Hoist slowly shows an example)



**MAGNET IS DISCONNECTED.** Crane operator spreads both hands apart palms up.

Figure 35.22. Hook Inspection Areas.

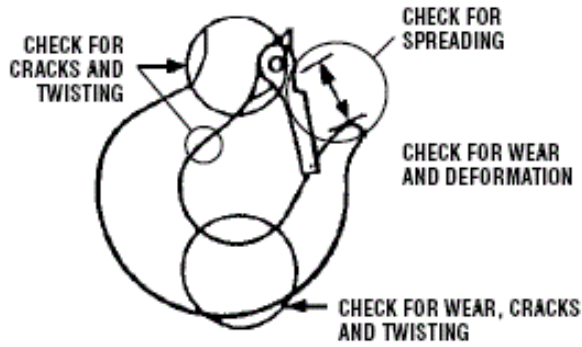
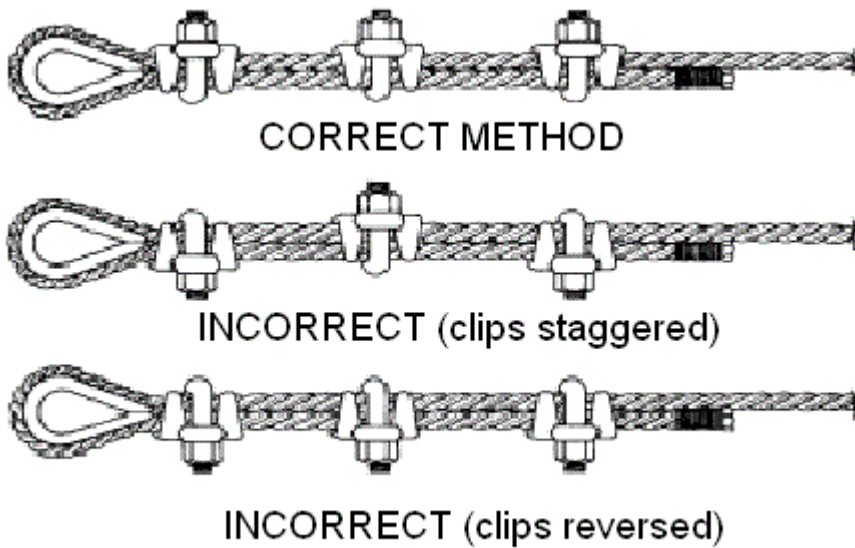
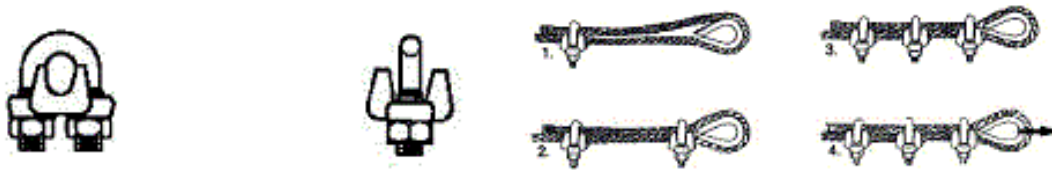


Figure 35.23. Right and Wrong Way of Using Cable Clips.





**Figure 35.24. Proper Method of Installing Cable Clips.**



**CORRECT METHOD OF INSTALLING U-BOLT WIRE ROPE CLIPS**

1. Turn back specified length of rope from thimble and apply first clip one saddle width from seized dead end. Tighten nuts evenly to specified torque.

Important: Seat "live end" of wire rope (load carrying part) in saddle and position U-bolt over "dead end".

2. Apply second clip close to the thimble without binding on it. Turn on nuts firmly but do not tighten yet to recommended torque.
3. Apply all other clips, equally spaced between first two clips.
4. Apply light tension and tighten all nuts evenly to specified torque.
5. Recheck and re-tighten nuts after initial load. This load should be at least equal to loads expected in general use. Wire rope will stretch slightly causing a reduction in diameter which will slacken the clips. Nuts must be checked at frequent intervals for tightness to assure efficiency of termination.

**Figure 35.25. Double Base Clamp.**

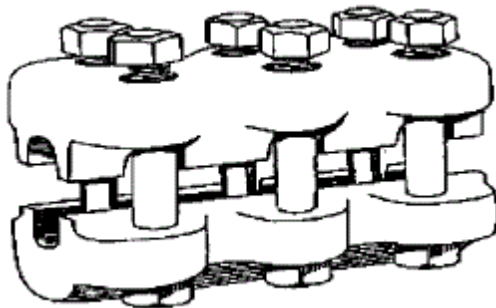


Figure 35.26. Joining Wire Ropes.



CORRECT



INCORRECT

Figure 35.27. Dead-Ending Rope in a Socket.



Loop back method

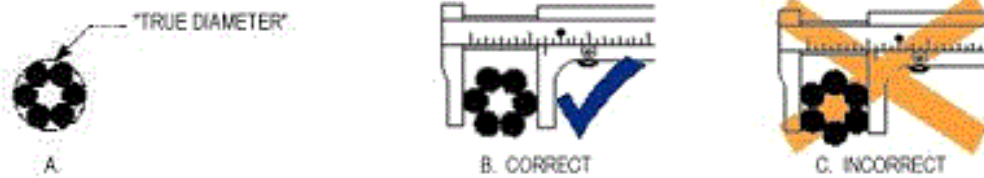


Extra piece of same size rope is clipped to main rope



Special clip method

Figure 35.28. Correct and Incorrect Way to Measure Wire Rope.



How to measure (or caliper) a wire rope correctly: Since the "true" diameter (A) lies within the circumscribed circle, always measure the larger dimension (B). Actual diameter can be 5% larger than nominal wire rope diameter

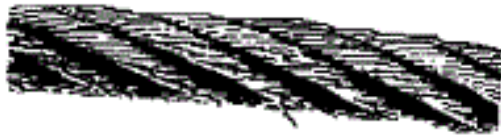
Figure 35.29. Wire Rope Wear and Damage.



A "bird cage" caused by sudden release of tension and resultant rebound of rope from overloaded condition. These strands and wires will not return to their original position.



A wire rope which has jumped a sheave. The rope is deformed into a "curl" as if bent around a round shaft. Close examination of the wires show two types of breaks - normal tensile "cup and cone" breaks and shear breaks which give the appearance of having been cut on an angle with a cold chisel.



A wire rope which has been subjected to repeated bending over sheaves under normal loads. This results in "fatigue" breaks in individual wires - these breaks are square and usually in the crowns of the strands.



A wire rope which has been linked. A link is caused by pulling down a loop in a slack line during improper handling, installation, or operation. Note the distortion of the strands and individual wires. Early rope failure will undoubtedly occur at this point.



An example of "fatigue" failure of a wire rope which has been subjected to heavy loads over small sheaves. The usual crown breaks are accompanied by breaks in the valleys of the strands - these breaks are caused by "strand nicking" resulting from heavy loads.



An example of a wire rope that has provided maximum service and is ready for replacement.



A close-up of a rope subjected to drum cranking. Note the distortion of the individual wires and displacement from their normal position. This is usually caused by the rope scrubbing on itself.



A fatigue break in a cable mol drill line caused by a tight link developed in the rope during operation.

Figure 35.30. Hook Showing Block Interface (Shank).

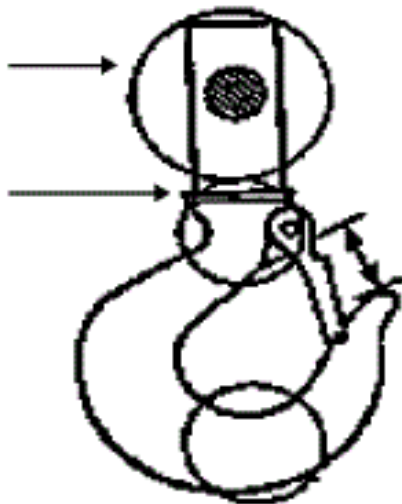


Table 35.1. Maximum Safe Working Load “A” Type Alloy Steel Chain Single Vertical Sling.

Maximum Safe Working Load “A” Type Alloy Steel Chain Single Vertical Sling							
Chain Size (inches)	Single Branch Sling 90 deg Loading	Double Sling			Triple and Quadruple Sling <sup>3</sup>		
		Vertical Angle <sup>1</sup>			Vertical Angle <sup>1</sup>		
		30 deg	45 deg	60 deg	30 deg	45 deg	60 deg
		Horizontal Angle <sup>2</sup>			Horizontal Angle <sup>2</sup>		
		(60 deg)	(45 deg)	(30 deg)	(60 deg)	(45 deg)	(30 deg)
1/4	3,250	5,650	4,550	3,250	8,400	6,800	4,900
3/8	6,600	11,400	9,300	6,600	17,000	14,000	9,900
1/2	11,250	19,500	15,900	11,250	29,000	24,000	17,000
5/8	16,500	28,500	23,300	16,500	43,000	35,000	24,500
3/4	23,000	39,800	32,500	23,000	59,500	48,500	34,500
7/8	28,750	49,800	40,600	28,750	74,500	61,000	43,000
1	38,750	67,100	54,800	38,750	101,000	82,000	58,000

Maximum Safe Working Load "A" Type Alloy Steel Chain Single Vertical Sling							
Chain Size (inches)	Single Branch Sling 90 deg Loading	Double Sling			Triple and Quadruple Sling <sup>3</sup>		
		Vertical Angle <sup>1</sup>			Vertical Angle <sup>1</sup>		
		30 deg	45 deg	60 deg	30 deg	45 deg	60 deg
		Horizontal Angle <sup>2</sup>			Horizontal Angle <sup>2</sup>		
		(60 deg)	(45 deg)	(30 deg)	(60 deg)	(45 deg)	(30 deg)
1-1/8	44,500	77,000	63,000	44,500	115,500	94,500	66,500
1-1/4	57,500	99,500	81,300	57,500	149,000	121,500	86,000
1-3/8	67,000	116,000	94,000	67,000	174,000	141,000	100,500
1-1/2	80,000	138,000	112,900	80,000	207,000	169,000	119,500
1-3/4	100,000	172,000	140,000	100,000	258,000	210,000	150,000

**Note 1:** Rating of multi-leg slings adjusted for angle of loading measured as the included angle between the inclined leg and the vertical as shown in [Figure 35.18](#).

**Note 2:** Rating of multi-leg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load as shown in [Figure 35.19](#).

**Note 3:** Quadruple sling rating is the same as triple sling because normal lifting practice may not distribute load uniformly to all four (4) legs.

**Table 35.2. Minimum Allowable Chain Size at Any Point of Link.**

Minimum Allowable Chain Size at Any Point of Link	
Chain Size (inches)	Minimum Allowable Chain Size (inches)
1/4	13/64
3/8	19/64
1/2	25/64
5/8	31/64
3/4	19/32
7/8	45/64
1	13/16
1-1/8	29/32
1-1/4	1
1-3/8	1-3/32
1-1/2	1-3/16
1-3/4	1-13/32

**Table 35.3. Rated Capacities for Single Leg Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC).**

Rated Capacities for Single Leg Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC)										
Rope		Rated Capacities, Tons (2,000 Lb)								
Diameter (inches)	Construction	Vertical			Choker			Vertical Basket <sup>1</sup>		
		HT	MS	S	HT	MS	S	HT	MS	S
1/4	6x19	0.49	0.51	0.55	0.37	0.38	0.41	0.99	1.0	1.1
5/16	6x19	0.76	0.79	0.85	0.57	0.59	0.64	1.5	1.6	1.7
3/8	6x19	1.1	1.1	1.2	0.80	0.85	0.91	2.1	2.2	2.4
7/16	6x19	1.4	1.5	1.6	1.1	1.1	1.2	2.9	3.0	3.3
1/2	6x19	1.8	2.0	2.1	1.4	1.5	1.6	3.7	3.9	4.3
9/16	6x19	2.3	2.5	2.7	1.7	1.9	2.0	4.6	5.0	5.4
5/8	6x19	2.8	3.1	3.3	2.1	2.3	2.5	5.6	6.2	6.7
3/4	6x19	3.9	4.4	4.8	2.9	3.3	3.6	7.8	8.8	9.5
7/8	6x19	5.1	5.9	6.4	3.9	4.5	4.8	10.0	12.0	13.0
1	6x19	6.7	7.7	8.4	5.0	5.8	6.3	13.0	15.0	17.0
1-1/8	6x19	8.4	9.5	10.0	6.3	7.1	7.9	17.0	19.0	21.0
1-1/4	6x37	9.8	11.0	12.0	7.4	8.3	9.2	20.0	22.0	25.0
1-3/8	6x37	12.0	13.0	15.0	8.9	10.0	11.0	24.0	27.0	30.0
1-1/2	6x37	14.0	16.0	15.0	10.0	12.0	13.0	28.0	32.0	35.0
1-5/8	6x37	16.0	18.0	21.0	12.0	14.0	15.0	33.0	36.0	41.0
1-3/4	6x37	19.0	21.0	24.0	14.0	16.0	18.0	38.0	43.0	48.0
2	6x37	25.0	28.0	31.0	18.0	21.0	23.0	49.0	55.0	62.0

**Notes:**

HT = Hand Tucked Splice and Hidden Tuck Splice.

For hidden tuck splice (IWRC) use values in HT column.

MS = Mechanical Splice.

S = Swaged or Zinc Poured Socket

<sup>1</sup> = These values only apply when the D/d ratio for HT slings is 10 or greater and for MS and S slings is 20 or greater where:

D = Diameter of curvature around which the body of the sling is bent;

d = Diameter of rope

**Table 35.4. Rated Capacities for Single Leg Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC).**

<b>Rated Capacities for Single Leg Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC)</b>										
<b>Rope</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>								
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>			<b>Choker</b>			<b>Vertical Basket<sup>1</sup></b>		
		<b>HT</b>	<b>MS</b>	<b>S</b>	<b>HT</b>	<b>MS</b>	<b>S</b>	<b>HT</b>	<b>MS</b>	<b>S</b>
1/4	6x19	0.53	0.56	0.59	0.40	0.42	0.44	1.0	1.1	1.2
5/16	6x19	0.81	0.87	0.92	0.61	0.65	0.69	1.6	1.7	1.8
3/8	6x19	1.1	1.2	1.3	0.86	0.93	0.98	2.3	2.5	2.6
7/16	6x19	1.5	1.7	1.8	1.2	1.3	1.3	3.1	3.4	3.5
1/2	6x19	2.0	2.2	2.3	1.5	1.6	1.7	3.9	4.4	4.6
9/16	6x19	2.5	2.7	2.9	1.8	2.1	2.2	4.9	5.5	5.8
5/8	6x19	3.0	3.4	3.6	2.2	2.5	2.7	6.0	6.8	7.2
3/4	6x19	4.2	4.9	5.1	3.1	3.6	3.8	8.4	9.7	10.0
7/8	6x19	5.5	6.6	6.9	4.1	4.9	5.2	11.0	13.0	14.0
1	6x19	7.2	8.5	9.0	5.4	6.4	6.7	14.0	17.0	18.0
1-1/8	6x19	9.0	10.0	11.0	6.8	7.8	8.5	18.0	21.0	23.0
1-1/4	6x37	10.0	12.0	13.0	7.9	9.2	9.9	21.0	24.0	26.0
1-3/8	6x37	13.0	15.0	16.0	9.6	11.0	12.0	25.0	29.0	32.0
1-1/2	6x37	15.0	17.0	19.0	11.0	13.0	14.0	30.0	35.0	38.0
1-5/8	6x37	18.0	20.0	22.0	13.0	15.0	17.0	35.0	41.0	44.0
1-3/4	6x37	20.0	24.0	26.0	15.0	18.0	19.0	41.0	47.0	51.0
2	6x37	26.0	30.0	33.0	20.0	23.0	25.0	53.0	61.0	66.0

**Notes:**  
HT = Hand Tucked Splice and Hidden Tuck Splice. For hidden tuck splice (IWRC) use values in HT column.  
MS = Mechanical Splice.  
S = Swaged or Zinc Poured Socket  
<sup>1</sup> = These values only apply when the D/d ratio for HT slings is 10 or greater and for MS and S slings is 20 or greater where:  
D = Diameter of curvature around which the body of the sling is bent;  
d = Diameter of rope

**Table 35.5. Rated Capacities for Single Leg Slings, Cable Laid Rope - Mechanical Splice Only, 7 x 7 x 7 and 7 x 19 Construction Galvanized Aircraft Grade Rope, 7 x 6 x 19 IWRC Construction Improved Plow Steel Grade Rope.**

<b>Rated Capacities for Single Leg Slings, Cable Laid Rope - Mechanical Splice Only, 7 x 7 x 7 and 7 x 19 Construction Galvanized Aircraft Grade Rope, 7 x 6 x 19 IWRC Construction Improved Plow Steel Grade Rope</b>				
<b>Rope</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket<sup>1</sup></b>
1/4	7x7x7	0.50	0.38	1.0
3/8	7x7x7	1.1	0.81	2.0
1/2	7x7x7	1.8	1.4	3.7
5/8	7x7x7	2.8	2.1	5.5
3/4	7x7x7	3.8	2.9	7.6
5/8	7x7x19	2.9	2.2	5.8
3/4	7x7x19	4.1	3.0	8.1
7/8	7x7x19	5.4	4.0	11.0
1	7x7x19	6.9	5.1	14.0
1-1/8	7x7x19	8.2	6.2	16.0
1-1/4	7x7x19	9.9	7.4	20.0
3/4	7x6x19 IWRC	3.8	2.8	7.6
7/8	7x6x19 IWRC	5.0	3.8	10.0
1	7x6x19 IWRC	6.4	4.8	13.0
1-1/8	7x6x19 IWRC	7.7	5.8	15.0
1-1/4	7x6x19 IWRC	9.2	6.9	18.0
1-15/16	7x6x19 IWRC	10.0	7.5	20.0
1-3/8	7x6x19 IWRC	11.0	8.2	22.0
1-1/2	7x6x19 IWRC	13.0	9.6	26.0

**Notes:**  
<sup>1</sup> = These values only apply when the D/d ratio is 10 or greater where:  
D = Diameter of curvature around which the body of the sling is bent;  
d = Diameter of rope



**Table 35.6. Rated Capacities for Single Leg Slings, 8-Part and 6-Part Braided Rope, 6 x 7 and 6 x 19 Construction Improved Plow Steel Grade Rope, 7 x 7 Construction Galvanized Aircraft Grade Rope.**

<b>Rated Capacities for Single Leg Slings, 8-Part and 6-Part Braided Rope, 6 x 7 and 6 x 19 Construction Improved Plow Steel Grade Rope, 7 x 7 Construction Galvanized Aircraft Grade Rope</b>							
<b>Rope</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>					
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>		<b>Choker</b>		<b>Basket, Vertical to 30 Degrees<sup>1</sup></b>	
		<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>
3/32	6x7	0.42	0.32	0.32	0.24	0.74	0.55
1/8	6x7	0.75	0.57	0.57	0.42	1.3	0.98
3/16	6x7	1.7	1.3	1.3	0.94	2.9	2.2
3/32	7x7	0.51	0.39	0.38	0.29	0.89	0.67
1/8	7x7	0.95	0.7	0.71	0.53	1.6	1.2
3/16	7x7	2.1	1.5	1.5	1.2	3.6	2.7
3/16	6x19	1.7	1.3	1.3	0.98	3.0	2.2
1.4	6x19	3.1	2.3	2.3	1.7	5.3	4.0
5/16	6x19	4.8	3.6	3.6	2.7	8.3	6.2
3/8	6x19	6.8	5.1	5.1	3.8	12.0	8.9
7/16	6x19	9.3	6.9	6.9	5.2	16.0	12.0
1/2	6x19	12.0	9.0	9.0	6.7	21.0	15.0
9/16	6x19	15.0	11.0	11.0	8.5	26.0	20.0
5/6	6x19	19.0	14.0	14.0	10.0	32.0	24.0
3/4	6x19	27.0	20.0	20.0	15.0	46.0	35.0
7/8	6x19	36.0	27.0	27.0	20.0	62.0	47.0
1	6x19	47.0	35.0	35.0	26.0	81.0	61.0

**Notes:**  
<sup>1</sup> = These values only apply when the D/d ratio is 20 or greater where:  
D = Diameter of curvature around which the body of the sling is bent;  
d = Diameter of component rope

**Table 35.7. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC).**

Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC)													
Rope		Rated Capacities, Tons (2,000 Lb)											
Diameter (inches)	Construction	2-Leg Bridle Slings						3-Leg Bridle Slings					
		30° (60°)		45° Angle		60° (30°)		30° (60°)		45° Angle		60° (30°)	
		HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
1/4	6x19	0.85	0.83	0.70	0.72	0.49	0.51	1.3	1.3	1.0	1.1	0.74	0.76
5/16	6x19	1.3	1.4	1.1	1.1	0.76	0.79	2.0	2.0	1.6	1.7	1.1	1.2
3/8	6x19	1.8	1.9	1.5	1.6	1.1	1.1	2.8	2.9	2.3	2.4	1.6	1.7
7/16	6x19	2.5	2.6	2.0	2.2	1.4	1.5	3.7	4.0	3.0	3.2	2.1	2.3
1/2	6x19	3.2	3.4	2.6	2.8	1.8	2.0	4.8	5.1	3.9	4.2	2.8	3.0
9/16	6x19	4.0	4.3	3.2	3.5	2.3	2.5	6.0	6.5	4.9	5.3	3.4	3.7
5/8	6x19	4.8	5.3	4.0	4.4	2.8	3.1	7.3	8.0	5.9	6.5	4.2	4.6
3/4	6x19	6.8	7.6	5.5	6.2	3.9	4.4	10.0	11.0	8.3	9.3	5.8	6.6
7/8	6x19	8.9	10.0	7.3	8.4	5.1	5.9	13.0	15.0	11.0	13.0	7.7	8.9
1	6x19	11.0	13.0	9.4	11.0	6.7	7.7	17.0	20.0	14.0	16.0	10.0	11.0
1-1/8	6x19	14.0	16.0	12.0	13.0	8.4	9.3	22.0	24.0	18.0	20.0	13.0	14.0
1-1/4	6x37	17.0	19.0	14.0	16.0	9.8	11.0	25.0	29.0	21.0	23.0	15.0	17.0
1-3/8	6x37	20.0	23.0	17.0	19.0	12.0	13.0	31.0	35.0	25.0	28.0	18.0	20.0
1-1/2	6x37	24.0	27.0	20.0	22.0	14.0	16.0	36.0	41.0	30.0	33.0	21.0	24.0
1-5/8	6x37	28.0	32.0	23.0	26.0	16.0	18.0	43.0	48.0	35.0	39.0	25.0	28.0
1-3/4	6x37	33.0	37.0	27.0	30.0	19.0	21.0	49.0	56.0	40.0	45.0	28.0	32.0
2	6x37	43.0	48.0	35.0	39.0	25.0	28.0	64.0	72.0	52.0	59.0	37.0	41.0

**Notes:**  
Horizontal angles shown in parentheses  
HT = Hand Tucked Splice  
MS = Mechanical Splice

**Table 35.8. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC).**

<b>Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 6 x 19 and 6 x 37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC)</b>													
<b>Rope</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>											
<b>Diameter (inches)</b>	<b>Construction</b>	<b>2-Leg Bridle Slings</b>						<b>3-Leg Bridle Slings</b>					
		<b>30° (60°)</b>		<b>45° Angle</b>		<b>60° (30°)</b>		<b>30° (60°)</b>		<b>45° Angle</b>		<b>60° (30°)</b>	
		<b>HT</b>	<b>MS</b>	<b>HT</b>	<b>MS</b>	<b>HT</b>	<b>MS</b>	<b>HT</b>	<b>MS</b>	<b>HT</b>	<b>MS</b>	<b>HT</b>	<b>MS</b>
1/4	6x19	0.92	0.97	0.75	0.79	0.53	0.56	1.4	1.4	1.1	1.2	0.79	0.84
5/16	6x19	1.4	1.5	1.1	1.2	0.81	0.87	2.1	2.3	1.7	1.8	1.2	1.3
3/8	6x19	2.0	2.1	1.6	1.8	1.1	1.2	3.0	3.2	2.4	2.6	1.7	1.9
7/16	6x19	2.7	2.9	2.2	2.4	1.5	1.7	4.0	4.4	3.3	3.6	2.3	2.5
1/2	6x19	3.4	3.8	2.8	3.1	2.0	2.2	5.1	5.7	4.2	4.6	3.0	3.3
9/16	6x19	4.3	4.8	3.5	3.9	2.5	2.7	6.4	7.1	5.2	5.8	3.7	4.1
5/8	6x19	5.2	5.9	4.2	4.8	3.0	3.4	7.8	8.8	6.4	7.2	4.5	5.1
3/4	6x19	7.3	8.4	5.9	6.9	4.2	4.9	11.0	13.0	8.9	10.0	6.3	7.3
7/8	6x19	9.6	11.0	7.8	9.3	5.5	6.6	14.0	17.0	12.0	14.0	8.3	9.9
1	6x19	12.0	15.0	10.0	12.0	7.2	8.5	19.0	22.0	15.0	18.0	11.0	13.0
1-1/8	6x19	16.0	18.0	13.0	15.0	9.0	10.0	23.0	27.0	19.0	22.0	13.0	16.0
1-1/4	6x37	18.0	21.0	15.0	17.0	10.0	12.0	27.0	32.0	22.0	26.0	16.0	18.0
1-3/8	6x37	22.0	25.0	18.0	21.0	13.0	15.0	33.0	38.0	27.0	31.0	19.0	22.0
1-1/2	6x37	26.0	30.0	21.0	25.0	15.0	17.0	39.0	45.0	32.0	37.0	23.0	26.0
1-5/8	6x37	31.0	35.0	25.0	29.0	18.0	20.0	46.0	53.0	38.0	43.0	27.0	31.0
1-3/4	6x37	35.0	41.0	29.0	33.0	20.0	24.0	53.0	61.0	43.0	50.0	31.0	35.0
2	6x37	46.0	53.0	37.0	43.0	26.0	30.0	68.0	79.0	56.0	65.0	40.0	46.0

**Notes:**  
Horizontal angles shown in parentheses  
HT = Hand Tucked Splice  
MS = Mechanical Splice

**Table 35.9. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, Cable Laid Rope-Mechanical Splice Only, 7 x 7 x 7 and 7 x 7 x 19 Constructions Galvanized Aircraft Grade Rope, 7x6x19 IWRC Construction Improved Plow Steel Grade Rope.**

Rope		Rated Capacities, Tons (2,000 Lb)					
Diameter (inches)	Construction	2-Leg Bridle Slings			3-Leg Bridle Slings		
		30° (60°)	45° Angle	60° (30°)	30° (60°)	45° Angle	60° (30°)
1/4	7x7x7	0.87	0.71	0.50	1.3	1.1	0.75
3/8	7x7x7	1.9	1.5	1.1	2.8	2.3	1.6
1/2	7x7x7	3.2	2.6	1.8	4.8	3.9	2.8
5/8	7x7x7	4.8	3.9	2.8	7.2	5.9	4.2
3/4	7x7x7	6.6	5.4	3.8	9.9	8.1	3.7
5/8	7x7x19	5.0	4.1	2.9	7.5	6.1	4.3
3/4	7x7x19	7.0	5.7	4.1	10.0	8.6	6.1
7/8	7x7x19	9.3	7.6	5.4	14.0	11.0	8.1
1	7x7x19	12.0	9.7	6.9	18.0	14.0	10.0
1-1/8	7x7x19	14.0	12.0	8.2	21.0	17.0	12.0
1-1/4	7x7x19	17.0	14.0	9.9	26.0	21.0	15.0
3/4	7x6x19 IWRC	6.6	5.4	3.8	9.9	8.0	5.7
7/8	7x6x19 IWRC	8.7	7.1	5.0	13.0	11.0	7.5
1	7x6x19 IWRC	11.0	9.0	6.4	17.0	13.0	9.6
1-1/8	7x6x19 IWRC	13.0	11.0	7.7	20.0	16.0	11.0
1-1/4	7x6x19 IWRC	16.0	13.0	9.2	24.0	20.0	14.0
1-5/16	7x6x19 IWRC	17.0	14.0	10.0	26.0	21.0	15.0
1-3/8	7x6x19 IWRC	19.0	15.0	11.0	28.0	23.0	16.0
1-1/2	7x6x19 IWRC	22.0	18.0	13.0	33.0	27.0	19.0

**Note:** Horizontal Angles shown in parentheses.

**Table 35.10. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 8-Part and 6-Part Braided Rope, 6 x 7 and 6 x 19 Construction Improved Plow Steel Grade Rope, 7 x 7 Construction Galvanized Aircraft Grade Rope.**

<b>Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 8-Part and 6-Part Braided Rope, 6 x 7 and 6 x 19 Construction Improved Plow Steel Grade Rope, 7 x 7 Construction Galvanized Aircraft Grade Rope</b>																					
<b>Rope</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>																			
<b>Diameter (inches)</b>	<b>Construction</b>	<b>2-Leg Bridle Slings</b>						<b>3-Leg Bridle Slings</b>													
		<b>30°</b>		<b>(60°)</b>		<b>45° Angle</b>		<b>60°</b>		<b>(30°)</b>		<b>30°</b>		<b>(60°)</b>		<b>45° Angle</b>		<b>60°</b>		<b>(30°)</b>	
		<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>
3/32	6x7	.074	.055	0.60	0.45	0.42	0.32	1.1	0.83	0.90	0.68	0.64	0.48								
1/8	6x7	1.3	0.98	1.1	0.80	0.76	0.57	2.0	1.5	1.6	1.2	1.1	0.85								
3/16	6x7	2.9	2.2	2.4	1.8	1.7	1.3	4.4	3.3	3.6	2.7	2.5	1.9								
3/32	7x7	0.89	0.67	0.72	0.55	0.51	0.39	1.3	1.0	1.1	0.82	0.77	0.58								
1/8	7x7	1.6	1.2	1.3	1.0	0.95	0.71	2.5	1.8	2.0	1.5	1.4	1.1								
3/16	7x7	3.6	2.7	2.9	2.2	2.1	1.5	5.4	4.0	4.4	3.3	3.1	2.3								
3/16	6x19	3.0	2.2	2.4	1.8	1.7	1.3	4.5	3.4	3.7	2.8	2.6	1.9								
1/4	6x19	5.3	4.0	4.3	3.2	3.1	2.3	8.0	6.0	6.5	4.9	4.6	3.4								
5/16	6x19	8.3	6.2	6.7	5.0	4.8	3.6	12.0	9.3	10.0	7.6	7.1	5.4								
3/8	6x19	12.0	8.9	9.7	7.2	6.8	5.1	18.0	13.0	14.0	11.0	10.0	7.7								
7/16	6x19	16.0	12.0	13.0	9.8	9.3	6.9	24.0	18.0	20.0	15.0	14.0	10.0								

<b>Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 8-Part and 6-Part Braided Rope, 6 x 7 and 6 x 19 Construction Improved Plow Steel Grade Rope, 7 x 7 Construction Galvanized Aircraft Grade Rope</b>																	
<b>Rope</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>															
<b>Diameter (inches)</b>	<b>Construction</b>	<b>2-Leg Bridle Slings</b>						<b>3-Leg Bridle Slings</b>									
		<b>30°</b>		<b>(60°)</b>		<b>45° Angle</b>		<b>60°</b>		<b>(30°)</b>		<b>45° Angle</b>		<b>60°</b>		<b>(30°)</b>	
		<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>	<b>8-Part</b>	<b>6-Part</b>		
1/2	6x19	21.0	15.0	17.0	13.0	12.0	9.0	31.0	23.0	25.0	19.0	18.0	13.0				
9/16	6x19	26.0	20.0	21.0	16.0	15.0	11.0	39.0	29.0	32.0	24.0	23.0	17.0				
5/8	6x19	32.0	24.0	26.0	20.0	20.0	14.0	48.0	36.0	40.0	30.0	28.0	21.0				
3/4	6x19	46.0	35.0	38.0	28.0	27.0	20.0	69.0	52.0	56.0	42.0	40.0	30.0				
7/8	6x19	62.0	47.0	51.0	38.0	36.0	27.0	94.0	70.0	76.0	57.0	54.0	40.0				
1	6x19	81.0	61.0	66.0	50.0	47.0	35.0	122.0	91.0	99.0	74.0	70.0	53.0				

**Note:** Horizontal Angles shown in Parentheses.

**Table 35.11. Rated Capacities for Strand Laid Grommet-Hand Tucked, Improved Plow Steel Grade Rope.**

<b>Rated Capacities for Strand Laid Grommet-Hand Tucked, Improved Plow Steel Grade Rope</b>				
<b>Rope Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket<sup>1</sup></b>
1/4	7x19	0.85	0.64	1.7
5/16	7x19	1.3	1.0	2.6
3/8	7x19	1.9	1.4	3.8
7/16	7x19	2.6	1.9	5.2
1/2	7x19	3.3	2.5	6.7
9/16	7x19	4.2	3.1	8.4
5/8	7x19	5.2	3.9	10.0
3/4	7x19	7.4	5.6	15.0
7/8	7x19	10.0	7.5	20.0
1	7x19	13.0	9.7	26.0
1-1/8	7x19	16.0	12.0	32.0
1-1/4	7x37	18.0	14.0	37.0
1-3/8	7x37	22.0	16.0	44.0
1-1/2	7x37	26.0	19.0	52.0

**Notes:**  
<sup>1</sup> = These values apply when the D/d ratio is 5 or greater where:  
D = Diameter of curvature around which rope is bent;  
d = Diameter of rope body

**Table 35.12. Rated Capacities for Cable Laid Grommet-Hand Tucked, 7 x 6 x 7 and 7 x 6 x 19 Constructions Improved Plow Steel Grade Rope, 7 x 7 x 7 Construction Galvanized Aircraft Grade Rope.**

<b>Rated Capacities for Cable Laid Grommet-Hand Tucked, 7 x 6 x 7 and 7 x 6 x 19 Constructions Improved Plow Steel Grade Rope, 7 x 7 x 7 Construction Galvanized Aircraft Grade Rope</b>				
<b>Cable Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket<sup>1</sup></b>
3/8	7x6x7	1.3	0.95	2.5

<b>Rated Capacities for Cable Laid Grommet-Hand Tucked, 7 x 6 x 7 and 7 x 6 x 19 Constructions Improved Plow Steel Grade Rope, 7 x 7 x 7 Construction Galvanized Aircraft Grade Rope</b>				
<b>Cable Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket<sup>1</sup></b>
9/16	7x6x7	2.8	2.1	5.6
5/8	7x6x7	3.8	2.8	7.6
3/8	7x7x7	1.6	1.2	3.2
9/16	7x7x7	3.5	2.6	6.9
5/8	7x7x7	4.5	3.4	9.0
5/8	7x6x19	3.9	3.0	7.9
3/4	7x6x19	5.1	3.8	10.0
15/16	7x6x19	7.9	5.9	16.0
1-1/8	7x6x19	11.0	8.4	22.0
1-15/16	7x6x19	15.0	11.0	30.0
1-1/2	7x6x19	19.0	14.0	39.0
1-11/16	7x6x19	24.0	18.0	49.0
1-7/8	7x6x19	30.0	22.0	60.0
2-1/4	7x6x19	42.0	31.0	84.0
2-5/8	7x6x19	56.0	42.0	112.0

**Notes:**  
<sup>1</sup> = These values apply when the D/d ratio is 5 or greater where:  
D = Diameter of curvature around which cable body is bent;  
d = Diameter of cable body

**Table 35.13. Rated Capacities for Strand Laid Endless Slings-Mechanical Joint, Improved Plow Steel Grade Rope.**

<b>Rated Capacities for Strand Laid Endless Slings-Mechanical Joint, Improved Plow Steel Grade Rope</b>				
<b>Rope Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket<sup>1</sup></b>
1/4	6x19 IWRC	0.92	0.69	1.8



<b>Rated Capacities for Strand Laid Endless Slings-Mechanical Joint, Improved Plow Steel Grade Rope</b>				
<b>Rope Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket<sup>1</sup></b>
3/8	6x19 IWRC	2.0	1.5	4.1
1/2	6x19 IWRC	3.6	2.7	7.2
5/8	6x19 IWRC	5.6	4.2	11.0
3/4	6x19 IWRC	8.0	6.0	16.0
7/8	6x19 IWRC	11.0	8.1	21.0
1	6x19 IWRC	14.0	10.0	28.0
1-1/8	6x19 IWRC	18.0	13.0	35.0
1-1/4	6x37 IWRC	21.0	15.0	41.0
1-3/8	6x37 IWRC	25.0	19.0	50.0
1-1/2	6x37 IWRC	29.0	22.0	59.0

**Notes:**  
<sup>1</sup> = These values apply when the D/d ratio is 5 or greater where:  
D = Diameter of curvature around which rope is bent;  
d = Diameter of rope body

**Table 35.14. Rated Capacities for Cable Laid Endless Slings-Mechanical Joint, 7 x 7 x 7 and 7 x 7 x 19 Construction Galvanized Aircraft Grade Rope, 7 x 6 x 19 IWRC Construction Improved Plow Steel Grade Rope.**

<b>Rated Capacities for Cable Laid Endless Slings-Mechanical Joint, 7 x 7 x 7 and 7 x 7 x 19 Construction Galvanized Aircraft Grade Rope, 7 x 6 x 19 IWRC Construction Improved Plow Steel Grade Rope</b>				
<b>Cable Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Basket<sup>1</sup></b>
1/4	7x7x7	0.83	0.62	1.6
3/8	7x7x7	1.8	1.3	3.5
1/2	7x7x7	3.0	2.3	6.1
5/8	7x7x7	4.5	3.4	9.1
3/4	7x7x7	6.3	4.7	12.0
5/8	7x7x19	4.7	3.5	9.5
3/4	7x7x19	6.7	5.0	13.0

<b>Rated Capacities for Cable Laid Endless Slings-Mechanical Joint, 7 x 7 x 7 and 7 x 7 x 19 Construction Galvanized Aircraft Grade Rope, 7 x 6 x 19 IWRC Construction Improved Plow Steel Grade Rope</b>				
<b>Cable Body</b>		<b>Rated Capacities, Tons (2,000 Lb)</b>		
<b>Diameter (inches)</b>	<b>Construction</b>	<b>Vertical</b>	<b>Choker</b>	<b>Basket<sup>1</sup></b>
7/8	7x7x19	8.9	6.6	18.0
1	7x7x19	11.0	8.5	22.0
1-1/8	7x7x19	14.0	10.0	28.0
1-1/4	7x7x19	17.0	12.0	33.0
3/4	7x6x19 IWRC	6.2	4.7	12.0
7/8	7x6x19 IWRC	8.3	6.2	16.0
1	7x6x19 IWRC	10.0	7.9	21.0
1-1/8	7x6x19 IWRC	13.0	9.7	26.0
1-1/4	7x6x19 IWRC	16.0	12.0	31.0
1-3/8	7x6x19 IWRC	18.0	14.0	37.0
1-1/2	7x6x19 IWRC	22.0	16.0	43.0

**Notes:**  
<sup>1</sup> = These values apply when the D/d ratio is 5 or greater where:  
D = Diameter of curvature around which cable body is bent;  
d = Diameter of cable body

**Table 35.15. Rated Capacities Carbon Steel and Stainless Steel Metal Mesh Slings.**

<b>Rated Capacities Carbon Steel and Stainless Steel Metal Mesh Slings</b>					
<b>Sling Width (inches)</b>	<b>Vertical or Choker</b>	<b>Vertical Basket</b>	<b>Effect of Angle on Rated Capacities in Basket Hitch</b>		
			<b>30° (60°)</b>	<b>45° (45°)</b>	<b>60° (30°)</b>
<b>Heavy Duty – 10 Gauge 35 Spirals/Ft of Sling Width</b>					
2	1,500	3,000	2,600	2,100	1,500
3	2,700	5,400	4,700	3,800	2,700
4	4,000	8,000	6,900	5,600	4,000
6	6,000	12,000	10,400	8,400	6,000
8	8,000	16,000	13,800	11,300	8,000
10	10,000	20,000	17,000	14,100	10,000
12	12,000	24,000	20,700	16,900	12,000
14	14,000	28,000	24,200	19,700	14,000
16	16,000	32,000	27,700	22,600	16,000
18	18,000	36,000	31,100	25,400	18,000

<b>Rated Capacities Carbon Steel and Stainless Steel Metal Mesh Slings</b>					
<b>Sling Width (inches)</b>	<b>Vertical or Choker</b>	<b>Vertical Basket</b>	<b>Effect of Angle on Rated Capacities in Basket Hitch</b>		
			<b>30° (60°)</b>	<b>45° (45°)</b>	<b>60° (30°)</b>
<b>Heavy Duty – 10 Gauge 35 Spirals/Ft of Sling Width</b>					
20	20,000	40,000	34,600	28,200	20,000
<b>Medium Duty – 12 Gauge 43 Spirals/Ft of Sling Width</b>					
2	1,350	2,700	2,300	1,900	1,400
3	2,000	4,000	3,500	2,800	2,000
4	2,700	5,400	4,700	3,800	2,700
6	4,500	9,000	7,800	6,400	4,500
8	6,000	12,000	10,400	8,500	6,000
10	7,500	15,000	13,000	10,600	7,500
12	9,000	18,000	15,600	12,700	9,000
14	10,500	21,000	18,200	14,800	10,500
16	12,000	24,000	20,800	17,000	12,000
18	13,500	27,000	23,400	19,100	13,500
20	15,000	30,000	26,000	21,200	15,000
<b>Light Duty – 14 Gauge 59 Spirals/Ft of Sling Width</b>					
2	900	1,800	1,600	1,300	900
3	1,400	2,800	2,400	2,000	1,400
4	2,000	4,000	3,500	2,800	2,000
6	3,000	6,000	5,200	4,200	3,000
8	4,000	8,000	6,900	5,700	4,000
10	5,000	10,000	8,600	7,100	5,000
12	6,000	12,000	10,400	8,500	6,000
14	7,000	14,000	12,100	9,900	7,000
16	8,000	16,000	13,900	11,300	8,000
18	9,000	18,000	15,600	12,700	9,000
20	10,000	20,000	17,300	14,100	10,000
<b>Note:</b> Horizontal Angles shown in Parentheses.					

Table 35.16. Manila Rope Slings (Rated Capacity in Pounds).

Manila Rope Slings (Rated Capacity in Pounds)													
Rope Diameter Nominal (inches)	Nominal Weight per 100 ft in pounds	Eye and Eye Slings						Endless Slings					
		Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal				Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	7.5	480	240	960	830	680	480	865	430	1,730	1,500	1,220	865
9/16	10.4	620	310	1,240	1,070	875	620	1,120	560	2,230	1,930	1,580	1,120
5/8	13.3	790	395	1,580	1,370	1,120	790	1,420	710	2,840	2,460	2,010	1,420
3/4	16.7	970	485	1,940	1,680	1,370	970	1,750	875	3,490	3,020	2,470	1,750
13/16	19.5	1,170	585	2,340	2,030	1,650	1,170	2,110	1,050	4,210	3,650	2,980	2,110
7/8	22.5	1,390	695	2,780	2,410	1,970	1,390	2,500	1,250	5,000	4,330	3,540	2,500
1	27.0	1,620	810	3,240	2,810	2,290	1,620	2,920	1,460	5,830	5,050	4,120	2,920
1-1/16	31.3	1,890	945	3,780	3,270	2,670	1,890	3,400	1,700	6,800	5,890	4,810	3,400
1-1/8	36.0	2,160	1,080	4,320	3,740	3,050	2,160	3,890	1,940	7,780	6,730	5,500	3,890
1-1/4	41.7	2,430	1,220	4,860	4,210	3,440	2,430	4,370	2,190	8,750	7,580	6,190	4,370
1-5/16	47.9	2,700	1,350	5,400	4,680	3,820	2,700	4,860	2,430	9,720	8,420	6,870	4,860
1-1/2	59.9	3,330	1,670	6,660	5,770	4,710	3,330	5,990	3,000	12,000	10,400	8,480	5,990
1-5/8	74.6	4,050	2,030	8,100	7,010	5,730	4,050	7,290	3,650	14,600	12,600	10,300	7,290
1-3/4	89.3	4,770	2,390	9,540	8,260	6,740	4,770	8,590	4,290	17,200	14,900	12,100	8,590
2	107.5	5,580	2,790	11,200	9,660	7,890	5,580	10,000	5,020	20,100	17,400	14,200	10,000

Manila Rope Slings (Rated Capacity in Pounds)													
Rope Diameter Nominal (inches)	Nominal Weight per 100 ft in pounds	Eye and Eye Slings						Endless Slings					
		Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal				Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
2-1/8	125.0	6,480	3,240	13,000	11,200	9,160	6,480	11,700	5,830	23,300	20,200	16,500	11,700
2-1/4	146.0	7,380	3,690	14,800	12,800	10,400	7,380	13,300	6,640	26,600	23,000	18,800	13,300
2-1/2	166.7	8,370	4,190	16,700	14,500	11,800	8,370	15,100	7,530	30,100	26,100	21,300	15,100
2-5/8	190.8	9,360	4,680	18,700	16,200	13,200	9,360	16,800	8,420	33,700	29,200	23,800	16,800
<p><b>Note 1:</b> Angle of Rope to Vertical shown in parentheses</p> <p><b>Note 2:</b> Refer to <b>Figures 35.18.</b> and <b>35.19.</b> for sling configuration descriptions.</p>													

**Table 35.17. Nylon Rope Slings (Rated Capacity in Pounds).**

Nylon Rope Slings (Rated Capacity in Pounds)													
Rope Dia in Inches	Nomi-nal Weight per 100 Ft. in Pounds	Eye and Eye Slings						Endless Slings					
		Vertical Hitch	Choker Hitch	Basket Hitch, Angle of Rope to Horizontal				Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	6.5	635	320	1,270	1,100	900	635	1,140	570	2,290	1,980	1,620	1,140
9/16	8.3	790	395	1,580	1,370	1,120	790	1,420	710	2,840	2,460	2,010	1,420
5/8	10.5	1,030	515	2,060	1,780	1,460	1,030	1,850	925	3,710	3,210	2,620	1,850
3/4	14.5	1,410	705	2,820	2,440	1,990	1,410	2,540	1,270	5,080	4,400	3,590	2,540
13/16	17.0	1,680	840	3,360	2,910	2,380	1,680	3,020	1,510	6,050	5,240	4,280	3,020
7/8	20.0	1,980	990	3,960	3,430	2,800	1,980	3,560	1,780	7,130	6,170	5,040	3,560
1	26.0	2,480	1,240	4,960	4,300	3,510	2,480	4,460	2,230	8,930	7,730	6,310	4,460
1-1/16	29.0	2,850	1,430	5,700	4,940	4,030	2,850	5,130	2,570	10,300	8,890	7,260	5,130
1-1/8	34.0	3,270	1,640	6,540	5,660	4,620	3,270	5,890	2,940	11,800	10,200	8,330	5,890
1-1/4	40.0	3,710	1,860	7,420	6,430	5,250	3,710	6,680	3,340	13,400	11,600	9,450	6,680
1-5/16	45.0	4,260	2,130	8,520	7,380	6,020	4,260	7,670	3,830	15,300	13,300	10,800	7,670
1-1/2	55.0	5,250	2,630	10,500	9,090	7,420	5,250	9,450	4,730	18,900	16,400	13,400	9,450
1-5/8	68.0	6,440	3,220	12,900	11,200	9,110	6,440	11,600	5,800	23,200	20,100	16,400	11,600
1-3/4	83.0	7,720	3,860	15,400	13,400	10,900	7,720	13,900	6,950	27,800	24,100	19,700	13,900
2	95.0	9,110	4,560	18,200	15,800	12,900	9,110	16,400	8,200	32,800	28,400	23,200	16,400
2-1/8	109.0	10,500	5,250	21,000	18,200	14,800	10,500	18,900	9,450	37,800	32,700	26,700	18,900
2-1/4	129.0	12,400	6,200	24,800	21,500	17,500	12,400	22,300	11,200	44,600	38,700	31,600	22,300
2-1/2	149.0	13,900	6,950	27,800	24,100	19,700	13,900	25,000	12,500	50,000	43,300	35,400	25,000
2-5/8	168.0	16,000	8,000	32,000	27,700	22,600	16,000	28,800	14,400	57,600	48,900	40,700	28,800

**Note 1:** Angle of Rope to Vertical Shown in Parentheses.  
**Note 2:** Refer to **Figures 35.18.** and **35.19.** for sling configuration descriptions.

Table 35.18. Polyester Rope Slings (Rated Capacity in Pounds).

Polyester Rope Slings (Rated Capacity in Pounds)													
Rope Dia Nominal in Inches	Nominal Weight per 100 Ft. in Pounds	Eye and Eye Slings						Endless Slings					
		Vertical Hitch	Choker Hitch	Basket Hitch, Angle of Rope to Horizontal				Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	8.0	635	320	1,270	1,100	900	635	1,140	570	2,290	1,980	1,620	1,140
9/16	10.2	790	395	1,580	1,370	1,120	790	1,420	710	2,840	2,460	2,010	1,420
5/8	13.0	990	495	1,980	1,710	1,400	990	1,780	890	3,570	3,090	2,520	1,780
3/4	17.5	1,240	620	2,480	2,150	1,750	1,240	2,230	1,120	4,470	3,870	3,160	2,230
13/16	21.0	1,540	770	3,080	2,670	2,180	1,540	2,770	1,390	5,540	4,800	3,920	2,770
7/8	25.0	1,780	890	3,560	3,080	2,520	1,780	3,200	1,600	6,410	5,550	4,530	3,200
1	30.5	2,180	1,090	4,360	3,780	3,080	2,180	3,920	2,960	7,850	6,800	5,550	3,920
1-1/16	34.5	2,530	1,270	5,060	4,380	3,580	2,530	4,550	2,280	9,110	7,990	6,440	4,550
1-1/8	40.0	2,920	1,460	5,840	5,060	4,130	2,920	5,260	2,630	10,500	9,100	7,440	5,260
1-1/4	46.3	3,290	1,650	6,580	5,700	4,650	3,290	5,920	2,960	11,800	10,300	8,380	5,920
1-5/16	52.5	3,710	1,860	7,420	6,430	5,250	3,710	6,680	3,340	13,400	11,600	9,450	6,680
1-1/2	66.8	4,630	2,320	9,260	8,020	6,550	4,630	8,330	4,170	16,700	14,400	11,800	8,330
1-5/8	82.0	5,640	2,820	11,300	9,770	7,980	5,640	10,200	5,080	20,300	17,600	14,400	10,200
1-3/4	98.0	6,710	3,360	13,400	11,600	9,490	6,710	12,100	6,040	24,200	20,900	17,100	12,100
2	118.0	7,920	3,960	15,800	13,700	11,200	7,920	14,300	7,130	28,500	24,700	20,200	14,300
2-1/8	135.0	9,110	4,460	18,200	15,800	12,900	9,110	16,400	8,200	32,800	28,400	23,200	16,400
2-1/4	157.0	10,600	5,300	21,200	18,400	15,000	10,600	19,100	9,540	38,200	33,100	27,000	19,100
2-1/2	181.0	12,100	6,050	24,200	21,000	17,100	12,100	21,800	10,900	43,600	37,700	30,800	21,800
2-5/8	205.0	13,600	6,800	27,200	23,600	19,200	13,600	24,500	12,200	49,000	42,400	34,600	24,500

**Note 1:** Angle of Rope to Vertical shown in Parentheses  
**Note 2:** Refer to **Figures 35.18.** and **35.19.** for sling configuration descriptions.

**Table 35.19. Polypropylene Rope Slings (Rated Capacity in Pounds).**

Polypropylene Rope Slings (Rated Capacity in Pounds)													
Rope Dia Nominal (inches)	Nominal Weight per 100 Ft. in Pounds	Eye and Eye Slings						Endless Slings					
		Vertical Hitch	Choker Hitch	Basket Hitch, Angle of Rope to Horizontal				Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	4.7	645	325	1,290	1,120	910	645	1,160	580	2,320	2,010	1,640	1,160
9/16	6.1	780	390	1,560	1,350	1,100	780	1,400	700	2,810	2,430	1,990	1,400
5/8	7.5	950	475	1,900	1,650	1,340	950	1,710	855	3,420	2,960	2,420	1,710
3/4	10.7	1,300	650	2,600	2,250	1,840	1,300	2,340	1,170	4,680	4,050	3,310	2,340
13/16	12.7	1,520	760	3,040	2,630	2,150	1,520	2,740	1,370	5,470	4,740	3,870	2,740
7/8	15.0	1,760	880	3,520	3,050	2,490	1,760	3,170	1,580	6,340	5,490	4,480	3,170
1	18.0	2,140	1,070	4,280	3,700	3,030	2,140	3,850	1,930	7,700	6,670	5,450	3,860
1-1/16	20.4	2,450	1,230	4,900	4,240	3,460	2,450	4,410	2,210	8,820	7,640	6,240	4,410
1-1/8	23.7	2,800	1,400	5,600	4,850	3,960	2,800	5,040	2,520	10,100	8,730	7,130	5,040
1-1/4	27.0	3,210	1,610	6,420	5,560	4,540	3,210	5,780	2,890	11,600	10,000	8,170	5,780
1-5/16	30.5	3,600	1,800	7,200	6,240	5,090	3,600	6,480	3,240	13,000	11,200	9,170	6,480
1-1/2	38.5	4,540	2,270	9,080	7,860	6,420	4,540	8,170	4,090	16,300	14,200	11,600	8,170
1-5/8	47.5	5,510	2,760	11,000	9,540	7,790	5,510	9,920	4,960	19,800	17,200	14,000	9,920
1-3/4	57.0	6,580	3,290	13,200	11,400	9,300	6,580	11,800	5,920	23,700	20,500	16,800	11,800
2	69.0	7,960	3,980	15,900	13,800	11,300	7,960	14,300	7,160	28,700	24,800	20,300	14,300
2-1/8	80.0	9,330	4,670	18,700	16,200	13,200	9,330	16,800	8,400	33,600	29,100	23,800	16,800



Polypropylene Rope Slings (Rated Capacity in Pounds)													
Rope Dia Nominal (inches)	Nominal Weight per 100 Ft. in Pounds	Eye and Eye Slings						Endless Slings					
		Vertical Hitch	Choker Hitch	Basket Hitch, Angle of Rope to Horizontal				Vertical Hitch	Choker Hitch	Basket Hitch; Angle of Rope to Horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
2-1/4	92.0	10,600	5,300	21,200	18,400	15,000	10,600	19,100	9,540	38,200	33,100	27,000	19,100
2-1/2	107.0	12,200	6,100	24,400	21,100	17,300	12,200	22,000	11,000	43,900	38,000	31,100	22,000
2-5/8	120.0	13,800	6,900	27,600	23,900	19,600	13,800	24,800	12,400	49,700	43,000	35,100	24,800

**Note 1:** Angle of Rope to Vertical shown in Parentheses.  
**Note 2:** Refer to **Figures 35.18. and 35.19.** for sling configuration descriptions.

Table 35.20. Synthetic Web Slings.

Synthetic Web Slings. 1,000 Pounds per Inch of Width – Single Ply (Rated capacity in pounds)						
Sling Body Width (inches)	Triangle -- Choker slings, type I Triangle -- Triangle slings, type II Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV					
	Vertical	Choker	Vertical Basket	30° Basket	45° Basket	60° Basket
1	1,000	750	2,000	1,700	1,400	1,000
2	2,000	1,500	4,000	3,500	2,800	2,000
3	3,000	2,200	6,000	5,200	4,200	3,000
4	4,000	3,000	8,000	6,900	5,700	4,000
5	5,000	3,700	10,000	8,700	7,100	5,000
6	6,000	4,500	12,000	10,400	8,500	6,000
Sling Body Width (inches)	Endless Slings, type V					
	Vertical	Choker	Vertical Basket	30° Basket	45° Basket	60° Basket
1	1,600	1,300	3,200	2,800	2,300	1,600
2	3,200	2,600	6,400	5,500	4,500	3,200
3	4,800	3,800	9,600	8,300	6,800	4,800
4	6,400	5,100	12,800	11,100	9,000	6,400
5	8,000	6,400	16,000	13,900	11,300	8,000
6	9,600	7,700	19,200	16,600	13,600	9,600
Sling Body Width (inches)	Return Eye Slings, type VI					
	Vertical	Choker	Vertical Basket	30° Basket	45° Basket	60° Basket
1	800	650	1,600	1,400	1,150	800
2	1,600	1,300	3,200	2,800	2,300	1,600
3	2,400	1,950	4,800	4,150	3,400	2,400
4	3,200	2,600	6,400	5,500	4,500	3,200
5	4,000	3,250	8,000	6,900	5,650	4,000
6	4,800	3,800	9,600	8,300	6,800	4,800
<b>Note 1:</b> All angles shown are measured from the vertical.						
<b>Note 2:</b> Capacities for intermediate widths not shown may be obtained by interpolation.						

Table 35.21. Synthetic Web Slings.

Synthetic Web Slings. 1,200 Pounds per Inch of Width -- Single-Ply (Rated capacity in pounds)	
Sling Body Width (inches)	Triangle -- Choker slings, type I Triangle -- Triangle slings, type II Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV

<b>Synthetic Web Slings. 1,200 Pounds per Inch of Width -- Single-Ply (Rated capacity in pounds)</b>						
	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket</b>	<b>30° Basket</b>	<b>45° Basket</b>	<b>60° Basket</b>
1	1,200	900	2,400	2,100	1,700	1,200
2	2,400	1,800	4,800	4,200	3,400	2,400
3	3,600	2,700	7,200	6,200	5,100	3,600
4	4,800	3,600	9,600	8,300	6,800	4,800
5	6,000	4,500	12,000	10,400	8,500	6,000
6	7,200	5,400	14,400	12,500	10,200	7,200
<b>Sling Body Width (inches)</b>	<b>Endless Slings, type V</b>					
	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket</b>	<b>30° Basket</b>	<b>45° Basket</b>	<b>60° Basket</b>
1	1,900	1,500	3,800	3,300	2,700	1,900
2	3,800	3,000	7,600	6,600	5,400	3,800
3	5,800	4,600	11,600	10,000	8,200	5,800
4	7,700	6,200	15,400	13,300	10,900	7,700
5	9,600	7,700	19,200	16,600	13,600	9,600
6	11,500	9,200	23,000	19,900	16,300	11,500
<b>Sling Body Width (inches)</b>	<b>Return Eye Slings, type VI</b>					
	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket</b>	<b>30° Basket</b>	<b>45° Basket</b>	<b>60° Basket</b>
1	950	750	1,900	1,650	1,350	950
2	1,900	1,500	3,800	3,300	2,700	1,900
3	2,850	2,250	5,700	4,950	4,050	2,850
4	3,800	3,000	7,600	6,600	5,400	3,800
5	4,750	3,750	9,500	8,250	6,750	4,750
6	5,800	4,600	11,600	10,000	8,200	5,800
<b>Note 1:</b> All angles shown are measured from the vertical.						
<b>Note 2:</b> Capacities for intermediate widths not shown may be obtained by interpolation.						

**Table 35.22. Synthetic Web Slings.**

<b>Synthetic Web Slings. 1,600 Pounds per Inch of Width -- Single-Ply (Rated capacity in pounds)</b>						
<b>Sling Body Width (inches)</b>	<b>Triangle -- Choker slings, type I Triangle -- Triangle slings, type II Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV</b>					
	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket</b>	<b>30° Basket</b>	<b>45° Basket</b>	<b>60° Basket</b>
1	1,600	1,200	3,200	2,800	2,300	1,600
2	3,200	2,400	6,400	5,500	4,500	3,200
3	4,800	3,600	9,600	8,300	6,800	4,800
4	6,400	4,800	12,800	11,100	9,000	6,400

<b>Synthetic Web Slings. 1,600 Pounds per Inch of Width -- Single-Ply (Rated capacity in pounds)</b>						
5	8,000	6,000	16,000	13,800	11,300	8,000
6	9,600	7,200	19,200	16,600	13,600	9,600
<b>Sling Body Width (inches)</b>	<b>Endless Slings, type V</b>					
	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket</b>	<b>30° Basket</b>	<b>45° Basket</b>	<b>60° Basket</b>
1	2,600	2,100	5,200	4,500	3,700	2,600
2	5,100	4,100	10,200	8,800	7,200	5,100
3	7,700	6,200	15,400	13,300	10,900	7,700
4	10,100	8,200	20,400	17,700	14,400	10,200
5	12,800	10,200	25,600	22,200	18,100	12,800
6	15,400	12,300	30,800	26,700	21,800	15,400
<b>Sling Body Width (inches)</b>	<b>Return Eye Slings, type VI</b>					
	<b>Vertical</b>	<b>Choker</b>	<b>Vertical Basket</b>	<b>30° Basket</b>	<b>45° Basket</b>	<b>60° Basket</b>
1	1,050	1,050	2,600	2,250	1,850	1,300
2	2,600	2,100	5,200	4,500	3,700	2,600
3	3,900	3,150	7,800	6,750	5,500	3,900
4	5,100	4,100	10,200	8,800	7,200	5,100
5	6,400	5,150	12,800	11,050	9,050	6,400
6	7,700	6,200	15,400	13,300	10,900	7,700
<b>Note 1:</b> All angles shown are measured from the vertical.						
<b>Note 2:</b> Capacities for intermediate widths not shown may be obtained by interpolation.						

**Table 35.23. Number of Spacing of Clips for Ropes of Various Sizes.**

<b>Number of Spacing of Clips for Ropes of Various Sizes (If manufacturer's recommendations are not available)</b>				
<b>Rope Diameter (inches)</b>	<b>Minimum Number Of Drop Forged Clips</b>	<b>Amount of Rope to Turn Back (inches)</b>	<b>Torque in Ft. Lbs</b>	<b>Minimum Spacing (inches)</b>
1/8	3	3-1/4	4.5	3
1/4	3	4-3/4	15	3
1/2	3	11-1/2	65	3
5/8	3	12	95	3-3/4
3/4	4	18	130	4-1/2
7/8	4	19	225	5-1/4
1	5	26	225	6
1-1/8	6	34	225	6-3/4
1-1/4	6	44	360	7-1/2
1-3/8	7	44	360	8-1/4

Number of Spacing of Clips for Ropes of Various Sizes (If manufacturer's recommendations are not available)				
Rope Diameter (inches)	Minimum Number Of Drop Forged Clips	Amount of Rope to Turn Back (inches)	Torque in Ft. Lbs	Minimum Spacing (inches)
1-1/2	7	54	360	9
1-5/8	8	58	430	
1-3/4	8	61	590	
2	8	71	750	
2-1/4	8	73	750	

**Note 1:** Apply the initial load and retighten nuts to the recommended torque. The rope will stretch and shrink in diameter when loads are applied inspect periodically and retighten.

**Note 2:** The efficiency rating of a properly prepared termination for clip sizes 1/8 to 7/8 in. is approximately 80 percent and for sizes 1 to 3 in. is approximately 90 percent. This rating is based on the catalog breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

**Note 3:** 1 in. = 2.54 cm. / 1 ft-lb = 1.36 Newton-meter.

**Note 4:** The number of clips shown is based upon using right regular or Lang lay wire rope, 6 x 19 class or 6 x 37 class, fiber core or Independent Wire Rope Core (IWRC), Improved Plow Steel (IPS) or Extra Improved Plow Steel (XIPS). If Seale construction or similar large outer wire type construction in the 6 x 19 class is used for sizes 1 in. (2.5 cm) and larger, add one additional clip.

**Note 5:** The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fiber core, IPS, nominal sizes 1-1/2 in. and smaller; and right regular lay wire rope, 18 x 7 class, fiber core, IPS or XIPS, nominal sizes 1-3/4 in. and smaller.

**Note 6:** For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

**Note 7:** Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end — live end rests in clip saddle). Tighten nuts evenly to recommended torque.

**Note 8:** Apply the next clip as near the loop as possible. Turn on nuts firm but do not tighten. Space additional clips, if required, equally between the first two. Turn on nuts — take up rope slack — tighten all nuts evenly on all clips to recommended torque.

**Table 35.24. Testing and Inspection Requirements for Materials Handling and Storage Equipment.**

Testing and Inspection Requirements for Materials Handling and Storage Equipment					
<b>Note:</b> This table provides a general overview of requirements outlined in this standard. Refer to specific paragraphs identified in parenthesis for more detailed information. See <b>Table 35.25.</b> for additional testing and inspection requirements for hoisting equipment used for critical and nuclear loads.					
Type of Equipment	Load Tests		Inspections		Specialized Operator Qualifications
	Initial (Generally Manufacturer)	Following Repair, Modifications, etc.	Daily or Prior to Use	Periodic	

Manual Hoisting Devices	Yes 100% – 125% (35.5.2.5.2.1.)	Yes 100% – 125% (35.5.2.5.2.2.)	Yes (35.5.2.3.1.)	Annually (35.5.2.3.2.)	No
Powered Industrial Trucks	No	No	Yes (35.5.2.5.)	No	Yes (35.5.2.2.)
Conveyors	No	No	Yes (35.6.3.4.)	No	Yes (35.6.3.2.)
Hoists	Yes 100% – 125% (35.6.3.7.2.)	Yes 100% – 125% (35.6.3.7.2.)	Yes (35.6.3.5.1.)	Yes (35.6.3.5.2.) Other (35.6.3.5.3.)	Yes (35.6.3.3.)
Slings	Yes 100% – 200% (35.9.3.1.1., 35.9.3.2.1., 35.9.3.2.6., 35.9.3.3.1., 35.9.3.4.1., 35.9.3.5.1.)	Yes 100% – 200% (35.9.3.1.1., 35.9.3.3.1., 35.9.3.5.1.)	Yes (35.9.2.3.1.)	Yes (35.9.2.3.2.)	No
Overhead and Locomotive Cranes	Yes 100% – 125% (35.10.2.7.2.)	Yes 100% – 125% (35.10.2.7.2.)	Yes (35.10.2.5.1.)	Yes (35.10.2.5.2.) Other (35.10.2.5.3.)	Yes (35.10.2.3.)
Mobile Cranes	No	Yes 100% – 110% (35.11.2.6.2.1.)	Yes (35.11.2.4.1., 35.11.2.4.2.)	Monthly (35.11.2.4.3.) Annually (35.11.2.4.4.) Other (35.11.2.4.5.)	Yes (35.11.2.2.)
Related Hoisting Equipment (Chain, Wire, Rope, Hook, Personnel Platforms)	Yes (35.13.2.1.1., 35.13.2.2.1., 35.13.6.6.2.)	Yes 100% – 110% (35.13.4.1.1., 35.13.6.6.2.)	Yes (35.13.1.2.1., 35.13.2.1.4., 35.13.4.1.3.)	Yes (35.13.1.2.1.) Monthly (35.13.1.2.1., 35.13.2.1.4., 35.13.4.1.3.) Other (35.13.1.2.2., 35.13.1.4.3.)	No
Derricks	Yes (35.10.2.1.)	No	Yes (35.10.1.1.1., 35.10.1.2.)	Yes (35.10.1.3.) Other (35.10.1.4.)	No

**Table 35.25. Additional Testing and Inspection Requirements for Materials Handling Equipment Used for Critical and Nuclear Loads.**

Additional Testing and Inspection Requirements for Materials Handling Equipment Used for Critical and Nuclear Loads		
<p><b>Note:</b> This table provides a general overview of requirements outlined in this standard. Refer to specific paragraphs identified in parenthesis for more detailed information. Requirements outlined in this table are additional requirements to those outlined in <b>Table 35.24.</b></p>		
Type of Equipment	Annual Load Test	Periodic Inspection
Hoists		

<b>Nuclear Load</b>	<b>Yes</b> <b>Not less than 100% or more than 125% of the rated capacity</b> <b>(35.6.3.7.3.)</b>	<b>Semiannually</b> <b>(35.6.3.5.2.)</b>
<b>Critical Load</b>	<b>Yes</b> <b>Not less than 100% or more than 125% of the rated capacity</b> <b>(35.6.3.7.4.)</b>	
<b>Slings</b>		
<b>Nuclear Load</b>	<b>Yes</b> <b>Per 11N Series TOs</b> <b>(35.9.2.4.)</b>	<b>Yes</b> <b>Per 11N Series TOs</b> <b>(35.9.2.3.)</b>
<b>Overhead Cranes</b>		
<b>Nuclear Load</b>	<b>Yes</b> <b>Not less than 100% or more than 110%</b> <b>(35.10.2.7.3.)</b>	<b>Semiannually</b> <b>(35.10.2.5.2.)</b>
<b>Mobile and Locomotive Cranes</b>		
<b>Nuclear Load</b>	<b>Yes</b> <b>Not less than 100% or more than 110%</b> <b>(35.11.2.6.2.2.)</b>	
<b>Related Hoisting</b>		
<b>Equipment</b> <b>Critical and Nuclear Load</b>	<b>NDI Hook Annually</b> <b>(35.13.4.1.4.)</b>	

**35.12. Materials Handling Equipment Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

- 35.12.1. Have qualified personnel been identified as training instructors? Reference [35.3.3.1](#)
- 35.12.2. Have training outlines been developed for all material handling equipment? Reference [35.3.3.2](#)
- 35.12.3. Does the instructor provide written certification of training completion to the OR&L? Reference [35.3.3.3](#)
- 35.12.4. Do instructors evaluate each operator at least once every three (3) years and provide refresher training in relevant topics when there is reason to believe there is a need? Reference [35.3.3.7](#)
- 35.12.5. Are safety pallets used to lift personnel designed correctly? Reference [35.3.4.6](#)
- 35.12.6. Do operators follow all applicable requirements for safe operation of powered industrial trucks? Reference [35.3.5](#)
- 35.12.7. Do materials handling and lifting equipment operators conduct daily or prior-to-use inspections and document them on AF Form 1800 per requirements of paragraph [35.1.1](#)? Reference [35.3.6](#).
- 35.12.8. Is materials handling and lifting equipment cleaned in designated locations and only with cleaning agents approved by the FES Flight and BE? Reference [35.3.7.2](#)

- 35.12.9. Do conveyors meet all required design and safety features? Reference [35.4.2](#)
- 35.12.10. Are all personnel trained on procedures for operating conveyors? Reference [35.4.2.2](#)
- 35.12.11. Are inspections of manual hoisting and pulling devices conducted annually? Reference [35.5.2.3.2](#)
- 35.12.12. Do identification tags attached to hoists include date of annual inspection, date of load test, capacity of hoist and identification number of hoist? Reference [35.5.2.3.3](#)
- 35.12.13. Are hoists operated only by personnel who are trained and qualified to use the equipment? Reference [35.6.3.3](#)
- 35.12.14. Are inspections of hoists and related equipment performed periodically and documented per requirements of paragraph [35.1.1](#)? Reference [35.6.3.5.2](#).
- 35.12.15. Do maintenance activities use lockout/tagout procedures IAW [Chapter 21](#)? Reference [35.6.3.6.5.1](#)
- 35.12.16. Have operational (no load) and load tests been performed on all new hoists and those which have had load-suspension parts altered, replaced or repaired? Reference [35.6.3.7.1](#)
- 35.12.17. Are annual load tests performed on nuclear-certified hoists? Reference [35.6.3.7.3](#)
- 35.12.18. Are annual load tests performed on hoists required to lift critical loads? Reference [35.6.3.7.4](#)
- 35.12.19. Are records of periodic inspections, repairs and tests of hoists maintained indefinitely? Reference [35.6.3.8](#)
- 35.12.20. Do all slings comply with the design and manufacturing requirements of 29 CFR 1910.184 and ANSI B30.9? Reference [35.7.2.1](#)
- 35.12.21. Are slings marked or identified with all required information on the sling or a durable and legible tag or label? Reference [35.7.2.2](#)
- 35.12.22. Are documented sling inspections conducted by a qualified person? Reference [35.7.2.3.2](#)
- 35.12.23. Are all repaired or reconditioned slings appropriately load tested? Reference [35.7.2.4.2](#)
- 35.12.24. Is a record of each sling's most recent load test maintained on file? Reference [35.7.2.4.2](#)
- 35.12.25. Is the rated capacity plainly marked on each side of a crane, and if the crane has more than one hoisting unit, is the rated capacity marked on each unit? Reference [35.8.2.2.2](#)
- 35.12.26. Do pendant and cab hoist controls for trolley and bridge movement use compass points as the preferred identification wherever possible? Reference [35.8.2.2.6](#)
- 35.12.27. Is access to the cab or bridge walkway gained by a conveniently placed fixed ladder, stairs or platform requiring no step over any gap in excess of 12 inches? Reference [35.8.2.2.8](#)



- 35.12.28. Is a fire extinguisher, rated at least 10 BC, located in the cab of the crane? Reference [35.8.2.2.9](#)
- 35.12.29. Are only properly trained and qualified personnel permitted to operate cranes? Reference [35.8.2.3](#)
- 35.12.30. Do cab-operated and pulpit-operated equipment operators meet the minimum physical qualifications? Reference [35.8.2.3.1.2](#)
- 35.12.31. Are the standard hand signals posted on or near all cranes? Reference [35.8.2.4.6](#)
- 35.12.32. Do personnel involved in materials handling wear all appropriate personal protective equipment? Reference [35.8.2.4.7](#)
- 35.12.33. Is a preventive maintenance program established and records maintained and readily available? Reference [35.8.2.6.1.1](#)
- 35.12.34. Are hazardous energy control (lockout/tagout) procedures developed and used during powered crane maintenance activities? Reference [35.8.2.6.2.1.3](#)
- 35.12.35. Have all cranes received the required operational (no load) test? Reference [35.8.2.7.1.1](#)
- 35.12.36. Is a clearly legible rating chart located in view of the operator in the crane cab? Reference [35.9.2.1.2.1](#)
- 35.12.37. Are those portions of crane cabs that extend beyond the main chassis when rotated color coded on the lower areas to denote a strike hazard to personnel on the ground? Reference [35.9.2.1.2.5](#)
- 35.12.38. Is an audible warning device provided when hoisting operations or moving equipment might endanger personnel in the work area, and is the device control within easy reach of the operator? Reference [35.9.2.1.2.10](#)
- 35.12.39. Is a warning permanently posted in the cab of the crane which states: “*DANGER HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines*”? Reference [35.9.2.1.2.11](#)
- 35.12.40. Have man-rated cranes been approved prior to acquisition or use? Reference [35.9.2.1.2.13](#)
- 35.12.41. Are all crawler, locomotive, truck and mobile hydraulic crane operators licensed to operate cranes? Reference [35.9.2.2](#)
- 35.12.42. Is a list of qualified operators maintained by the using organization? Reference [35.9.2.2](#)
- 35.12.43. Do all operators meet the minimum physical qualifications? Reference [35.9.2.2.1.2](#)
- 35.12.44. Do operators follow correct procedures prior to leaving a crane unattended? Reference [35.9.2.3.5](#)
- 35.12.45. During periods of non-use, high winds or weather alerts, do operators lower the boom to ground level or a resting platform or otherwise ensure the boom is secure against movement from wind or other forces? Reference [35.9.2.3.6](#)

- 35.12.46. Are outriggers used when required and is blocking to support the outriggers of sufficient size and strength to prevent shifting or toppling of the crane under load? Reference [35.9.2.3.24](#)
- 35.12.47. When rotating the crane, is a tag line used when necessary to control rotation of the load? Reference [35.9.2.3.30](#)
- 35.12.48. Are procedures in place to ensure safe operations in the vicinity of electrical power lines? Reference [35.9.2.3.39](#)
- 35.12.49. Is appropriate personal protective equipment worn by crane crew personnel and construction personnel involved in crane operations? Reference [35.9.2.3.41](#)
- 35.12.50. If an approved crane is used to lift personnel, is the platform used to suspend personnel designed correctly? Reference [35.11.6](#)
- 35.12.51. Are all required load tests of mobile and locomotive cranes conducted and records maintained? (Reference [35.9.2.6](#))
- 35.12.52. Are energy control (lockout/tagout) procedures used during crane maintenance activities? Reference [35.9.2.5.1.1.2](#)
- 35.12.53. Are frequent and periodic inspections of derricks performed as required and documented? Reference [35.10.1](#)
- 35.12.54. Have all required load tests of derricks been performed? Reference [35.10.2.1](#)
- 35.12.55. Is a preventive maintenance program established for derricks, and are these maintenance activities documented? Reference [35.10.3.1.1](#)
- 35.12.56. Are running ropes visually inspected daily or prior to use and are those inspections documented? Reference [35.11.2.2.1](#)
- 35.12.57. Is a full, written, dated and signed report of wire rope condition kept on file for a minimum of one year and readily available? Reference [35.11.2.2.1](#)
- 35.12.58. Are hoist chains inspected before use and monthly, and are these inspections documented? Reference [35.11.3.1.4](#)
- 35.12.59. Are hooks with more than 5% of normal throat opening or any apparent bend or twist from the plane from the original baseline measurements removed from service and replaced? Reference [35.11.5.1.1](#)
- 35.12.60. Are all hooks visually inspected daily or prior to use and thoroughly inspected each month? Reference [35.11.5.1.3](#)
- 35.12.61. If operations require removal or replacement of hooks and/or lifting fixtures, is the lifting capacity of the hooks/lifting fixtures readily identifiable to the hoist/crane operator? Reference [35.11.5.3](#)

## Chapter 36

### HYDROCARBON FUELS

#### 36.1. Specific Hazards.

36.1.1. Hydrocarbon fuels range in color from clear to straw-yellow or a very pale blue. Certain gasoline, particularly aviation gasoline containing tetraethyl lead, have dyes added to identify the type of the fuel. TO 42B-1-1, *Quality Control Fuels and Lubricants*, provides the military specifications for fuels. Hydrocarbon fuels are a fat solvent, which can irritate skin. Fuels such as gasoline, kerosene, diesel and fuel oils have similar characteristics and warrant the same degree of safety as aviation fuels.

36.1.2. TO 42B-1-1-14, Fuels for USAF Aircraft, provides a complete description of aircraft fuel classifications, characteristics and use, and is summarized below:

36.1.2.1. General. There are four types of aircraft fuels: Wide-cut type (JP-4 and Jet B), kerosene type (JP-8, Jet A-1 and Jet A), high flashpoint kerosene (JP-5) and aviation gasoline. With certain restrictions, all four types are used in turbojet and turboprop engines. Aviation gasoline is used only in reciprocating engines. Gasoline-type fuels are not used in aircraft turbojet and turboprop engines because of poorer lubricating properties than kerosene-type fuels and because lead additives may adversely affect turbine engines.

36.1.2.2. Wide-Cut Type (JP-4 and Jet B). Wide-cut fuels are mixtures of gasoline and kerosene distillate fractions with an approximate boiling range of 35 degrees centigrade (C) to 315 degrees C (95 degrees F to 600 degrees F).

36.1.2.3. Kerosene Type (JP-8, Jet A-1 and Jet A). Kerosene type fuels are petroleum distillates with an approximate boiling range of 165 degrees C to 290 degrees C (330 degrees F to 550 degrees F).

36.1.2.4. High-Flashpoint Kerosene (JP-5). High-flashpoint kerosene fuel has essentially the same characteristics as the kerosene fuels, but with a minimum flashpoint of 60 degrees C (140 degrees F).

36.1.2.5. Aviation Gasoline. Gasoline is a petroleum distillate with an approximate boiling range of 35 degrees C to 165 degrees C (95 degrees F to 330 degrees F).

36.1.2.6. North Atlantic Treaty Organization (NATO) Turbine Engine Fuels. In overseas areas, turbine engine fuels may be identified by a NATO symbol. **Note:** NATO fuels have similar qualities to the fuels above.

36.1.3. Chemical Properties. Hydrocarbon fuels are insoluble in water, are soluble in many organic components and are excellent solvents for many organic materials. These fuels are chemically stable and insensitive to shock. Some dyes used in gasoline products are light sensitive and must be handled with minimum exposure to light to prevent change of color. Air Force fuels demonstrate good thermal stability over a wide range of ambient storage temperatures, but extreme temperature or prolonged storage will accelerate oxidation, gum and sediment formation. Hydrocarbon fuels react with strong oxidizers, and this reaction is accelerated at higher pressures and/or temperatures.

36.1.4. Ignition Hazard. Oxygen comprises approximately 21 percent by volume of the total atmospheric air. Leaks in oxygen gas storage cylinders or cryogenic generators can raise the oxygen level of air. Oxygen at concentrations of 16percent or less will not support combustion. Hydrocarbon fuel vapors can create an explosive atmosphere (lower explosive limit 1 percent, upper explosive limit 7 percent, by volume). The ignition susceptibility of the fuel, **Table 22.10**, varies with flashpoint, pressure and the specific type of fuel. Hydrocarbon fuel fires may be both air-supported and other-oxidizer-supported. The rate of fuel evaporation increases with a rise in temperature. A mixture below lower explosive limits is too “lean” to burn and a mixture above the upper flammable and/or explosive range is too “rich” to burn.

#### 36.1.5. Sources of Ignition.

36.1.5.1. General. Unexpected and unwanted ignition of fuels can cause fires and explosions which may result in property damage, injury and/or loss of life. Ignition sources include open flames such as matches and cigarette lighters, cutting and welding sparks, static electricity, electrical arcing and lightning. Support equipment being operated in any fuels area shall meet the requirements of AFMAN 24-306 (IP), *Manual for the Wheeled Operator*, and TO 36-1-191, Chapter 3, *Motor Vehicle and Base Support Equipment Inspection*.

36.1.5.2. Static Electricity. Static electricity can occur when fuel is stable (not flowing) or flowing. Static electricity can build up by the slightest movement in a stable environment, i.e., in a fuel tank or cell, container, etc. Fuel flowing through hoses or pipe systems can generate an electrostatic charge over 20,000 volts, sufficient to cause an arc or spark when touched. A conductivity additive in JP-4 and JP-8 minimizes static buildup during fuel flow. **Warning:** The additive reduces, but does not eliminate, static electricity in fuel flowing through hoses or pipes.

36.1.5.3. Clothing containing more than 65 percent nylon, rayon, wool or polyester shall not be worn as outer garments when working with/around low flash point fuels. Flak vests shall not be worn during aircraft fuel servicing operations or during fuel operations where low flashpoint vapors may be present. In all cases (i.e., servicing with any fuel), a worker wearing a flak vest will always ground or bond him- or herself when approaching an aircraft and prior to beginning work. If no spark occurs during bonding or grounding, normal work may begin. However, if a spark does occur during bonding or grounding, the worker will ground or bond him or herself frequently during all work phases. **Note:** Commanders may authorize wear of body armor/flak vests and Gortex-type clothing in combat areas. Outer garments shall not be removed or put on in the work area. Matches or lighters shall not be handled or removed from pockets.

#### 36.1.6. Sources of Static Electricity.

36.1.6.1. The filter-separator unit generates static electricity when fuel flows through tiny filter openings (filtration). Workers should wait at least 30 seconds after flow stops so the static charge can dissipate from the filter before removing bonding connections, etc.

36.1.6.2. Aircraft refuelers and petroleum transport vehicles. The filter separator installed on bottom and/or top loading fillstands and wire screens or line strainers, which have small openings, generate static charges. Screens with a pore size less than 300 micron with 50 mesh per inch can create static charges. Movement of fuel through piping or hose also generates static charges. Proper grounding and bonding are required to control static buildup and hazards.

36.1.6.3. Avoid top loading refuelers from an overhead spout whenever possible. An approved waiver will be obtained from the MAJCOM Ground Safety and Fuels offices prior to performing top loading operations. This method increases electrostatic charges when fuel freefalls through air and agitates fuel in the tank. If top loading is necessary, extend the filling spout to the bottom of the tank and keep submerged during the entire operation to reduce the static generation.

36.1.6.3.1. Bottom loading of refuelers minimizes fuel turbulence. For this reason, ensure permanent fuel storage tanks systems are designed for bottom loading.

36.1.6.3.2. Regardless of the filling method used, danger signals such as crackling and hissing sounds indicate the presence of dangerous levels of static electricity. If this occurs, immediately stop filling operations and evacuate personnel until the static charge has dissipated. Identify and eliminate the cause of the static buildup before resuming operations.

36.1.6.4. Support equipment can develop a static charge while parked due to movement of dust particles and air currents or during periods of thunderstorm activity.

36.1.6.5. Grounding and/or bonding requirements in UFC 3-460-03, *O&M: Maintenance of Petroleum Systems*, TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, TO 42B-1-1, and TO 37-1-1, *Operation, Inspection, and Maintenance of Permanently Installed Fuel Storage and Dispensing Systems*, shall be followed. Remove or replace all static grounds with resistances of more than 10,000 ohms, and repair and retest damaged static grounds. Static grounds do not require periodic retest.

36.1.7. Toxicity. Hydrocarbon fuels can irritate skin. Repeated contact can cause scaling, defatting, fissuring and blistering of the skin. Inhalation of vapor can irritate the upper respiratory tract and depress the central nervous system, resulting in depression, dizziness, headaches, anesthesia, coma or death. Aspiration causes severe lung irritation with coughing, gagging and rapidly developing pulmonary edema, which can progress to bronchopneumonia and death. Ingestion causes irritation of mucous membranes of throat, esophagus and stomach, followed by depression of the central nervous system.

36.1.8. Exposure to Fuel Additives. Air Force fuels may contain benzene. Benzene is present in both gasoline-based and kerosene-based fuels. **Note:** JP series fuels do not contain tetraethyl lead. All fuels contain benzene to some degree (0.1 to 5 percent by volume). Aviation gasoline usually contains higher concentrations of benzene than does heavier distillate fuels. However, benzene is toxic even in low concentrations. This is particularly true in confined spaces such as petroleum storage tanks. Fuels laboratories, listed in TO 42B-1-1, can analyze fuel for benzene content.

36.1.9. Asphyxiation and Confined Space. Hydrocarbon fuel vapors will displace oxygen in enclosed spaces and pits and may cause death due to asphyxiation. Refer to **Chapter 23**, *Confined Spaces*, for additional guidance.

## 36.2. Specific Requirements.

36.2.1. Fuel Spill Classifications. Fuel spill classification and emergency procedures are described in TO 00-25-172. Cleanup procedures shall be established IAW the installation environmental management office guidance.

### 36.2.2. Training.

36.2.2.1. AFI 90-821, *Hazard Communication*, provides specific training requirements for personnel engaged in handling or use of hazardous materials. Employees working with fuels shall be trained IAW AFI 90-821.

36.2.2.2. Ensure individuals exposed to petroleum products understand the hazards of static electricity.

36.2.2.3. Ensure fuels handling personnel are trained in fire prevention and protection as it relates to their particular duties. Refer to **Chapter 6**, *Fire Protection and Prevention*, for additional guidance and information.

36.2.2.4. Operations involving the handling, transfer or storage of hydrocarbon fuels normally require a minimum of two persons who are knowledgeable of fuel safety and operational procedures. Refer to AFI 23-201, *Fuels Management*, for guidance on the two-person policy.

36.2.2.5. Ensure personnel are trained to prevent hydrocarbon fuels and propellant oxidizers being spilled in the same area. If such a spill does occur and if the oxidizer is water soluble, flood the oxidizer with water to dilute it and help reduce the risk of an explosion or fire. Notify the installation Fire Emergency Services (FES) Flight when a fuel spill or oxidizer spill occurs.

36.2.3. Petroleum Storage Tank Entry. UFC 3-460-03 covers this subject in detail and shall be used as definitive guidance on all tank entry tasks. **Chapter 23** also provides confined space guidance.

36.2.4. Work Areas and Storage Rooms. The following design safety features shall be included where petroleum products are handled or stored:

36.2.4.1. Refer to **Chapter 19**, *Emergency Shower and Eyewash Units*, for requirements for emergency showers and/or face and eyewash units for fuels handling.

36.2.4.2. Consult **Chapter 14**, *Personal Protective Equipment (PPE)*, for guidance on rescue harnesses, lifelines and PPE, and AFOSH Standard 48-137, *Respiratory Protection Program*, for respirator requirements.

36.2.4.3. Refer to **Chapter 6** and consult the installation FES Flight for guidance on fire suppression systems.

36.2.5. Adverse Weather Conditions. Refer to **Chapter 11**, *Weather Safety*, for guidance.

36.2.6. First Aid. Personnel shall take the following steps if hydrocarbon fuels are splashed or spilled onto them:

36.2.6.1. Remove contaminated clothing as soon as possible and wash affected skin areas with soap and water. Thoroughly air and launder contaminated clothing before it is worn again. Do not place contaminated clothing in lockers or other confined spaces. Hang clothing in a safe area away from fire and heat, and allow it to air dry.

36.2.6.2. If fuel is splashed into the eyes, immediately flush the eyes with water continuously for at least 15 minutes; then seek medical attention. Refer to [Chapter 19](#) for guidance on emergency shower and eyewash units.

36.2.6.3. If fuel is swallowed, do not induce vomiting. Seek medical assistance as soon as possible.

36.2.7. Finger Rings and Jewelry. Refer to [Chapter 9](#), *Jewelry*.

### 36.3. Fuel Storage Systems.

36.3.1. Safety Features. New construction, alteration and/or modification of petroleum facilities shall conform to UFC 3-460-01, *Design, Petroleum Fuel Facilities*, as well as all other applicable Air Force specifications and directives. Existing facilities, unless hazards are present, are not required to meet current Air Force specifications or directives until a modification or alteration is planned.

36.3.1.1. Access. Where necessary, pit covers shall be altered or replaced to provide free and unobstructed access. Fuels Management in conjunction with Water Fuel Management personnel shall determine which pits are essential to the operation and control of the system. Nonessential pits, or pits that can be made nonessential, shall be filled with sand to eliminate vapor hazards. Essential pits shall be kept clean, dry and vapor-free. Pit covers shall be closed except when in use or work is being done in the pit.

36.3.1.2. Ventilation.

36.3.1.2.1. Adequate ventilation shall be provided for below-grade pump houses and deep pits to prevent accumulation of explosive vapor hazards. Opening pit covers normally provides sufficient ventilation only for shallow pits and hand holes, but this must be consistent with BE's OEH risk assessment. Refer to paragraph [2.3](#) for additional guidance.

36.3.1.2.2. Entry into confined spaces and pits where oxygen may be displaced by fuel vapors shall be according to master entry plans and permits issued in compliance with [Chapter 23](#). Contact BE for specific ventilation requirements.

36.3.1.3. Drainage. Gravity drains or pumps shall be provided to control water in pits. Drains from pits and/or pump house floors will not be connected to sanitary or storm sewer systems, unless permitted by the installation Environmental Management office. Contact BE for an OEH risk assessment.

36.3.1.4. Piping System Identification. Piping systems shall be color coded to aid in identifying the contents of piping in fuel storage areas. Yellow shall be used as a primary warning for all flammable gases and liquids, and black and white shall be used for identification of contents. Refer to MIL-STD-161G, *Identification Methods for Bulk*

*Petroleum Products Systems Including Hydrocarbon Missile Fuels*, and **Chapter 20**, *Safety Color Coding, Labeling and Marking for Piping Systems*, for additional guidance.

### 36.3.2. Safety Procedures.

36.3.2.1. Adverse weather conditions. See **Chapter 11**.

36.3.2.2. Bond fuel transport vehicles, i.e., tank trucks, to the offloading header to dissipate static electricity charges generated during the handling operations.

36.3.2.3. Place a drip pan under the outlet of each railroad tank car or transport truck before the dust or outlet cap is removed to collect any fuel leaked through the main valve during transportation.

36.3.2.4. During transfer of fuel into an off-loading header, check the receiving tank for sufficient ullage before beginning the transfer. **Warning:** Ensure the initial flow-rate does not exceed three (3) feet per second and is maintained until the liquid level is one (1) foot above the inlet level or until the pan or roof of the aboveground storage tank is floating freely. Allow a minimum waiting time of 30 minutes for electrostatic charges to dissipate before performing manual gauging or temperature measurement.

36.3.2.4.1. Make sure the gauging tape remains in contact with the gauging hatch to provide an electrical bond and prevent electrostatic arcing.

36.3.2.4.2. Upon completion of gauging or temperature measurements, slowly remove the tape from the tank while maintaining contact between gauging hatch and tape.

### 36.3.2.5. Danger signs.

36.3.2.5.1. Place danger signs 50 feet in the front and rear of railroad tank cars or transport trucks prior to off-loading operations into bulk storage. These signs are not required during bulk off-loading operations at installation service stations or off-loading operations within posted secured areas. However, the Fuels Management Flight Chief may require special procedures for unique installations.

36.3.2.5.2. Ensure danger signs are posted on the perimeter fence of fuel storage areas. If unfenced, post signs 50 feet from the dike area or fuel vents of underground storage tanks, or as determined by BE, in conjunction with the installation Ground Safety Office. Signs shall state: "No Open Flame or Ignition Source Beyond This Point," and meet requirements in **Chapter 29**, *Mishap Prevention Signs and Tags*. Signs may include a second language, if needed.

36.3.2.6. Ensure adequate fire protection equipment, i.e., fire extinguishers, grounding/bonding equipment, proper PPE and any other equipment required to prevent these hazards, is available before starting fuel handling operations to protect personnel from fuel vapor and static hazards. Personnel shall not be allowed on above-ground receiving tanks during filling operations or within 30 minutes thereafter.

36.3.2.7. Because fuel may be present, never use open flame or heating element to thaw frozen valves on tank cars and tank trucks.

36.3.2.8. Use a two-person policy during fuel receipts and transfers.



36.3.2.9. All local procedures and checklists for the movement of fuel shall include emergency shutdown procedures.

36.3.2.10. After changing a filter separator element, slowly fill the filter vessel by partially opening the inlet and outlet valves to displace trapped air. The slower flow will reduce static charging of the fuel. Refer to TO 37A-1-101, *Fuel, Water and Lubricant Dispensing Equipment*, for complete details on filling filter separators after element change.

36.3.2.11. Before starting fuel transfer actions, establish intrinsically safe communications, such as hot line, radio, telephone, etc., between pipeline pump station, barge or tanker, and receipt location. To ensure emergency shutdown capability, provide communications throughout the entire receipt.

36.3.2.12. Keep the dike basin area free of vegetation. Containment dikes and basins shall be constructed IAW UFC 3-460-01.

36.3.2.13. Tank water drains and dike drain valves shall be locked (closed position) when not in use.

36.3.2.14. Watch draining floating roof water drains to ensure no fuel runs out with the water from a leak in the drain pipe. When possible, secure roof water drains by lock after draining.

36.3.2.15. Provide adequate lighting in petroleum areas for safe and secure night operations (1-footcandle in general areas; 2-footcandles on catwalks). In areas classified as NFPA hazardous locations, lighting fixtures and wiring must comply with the requirements of NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 70, *National Electric Code*.

### 36.3.3. Truck Fillstand Operations.

36.3.3.1. Position the fuel servicing vehicle to prevent placing a strain on fillstand components.

36.3.3.2. Set the vehicle parking brake and chock the rear wheels.

36.3.3.3. Bond the vehicle to the fillstand by connecting the vehicle conductor reels to a bonding receptacle on the fillstand. When a hose cart or Hydrant Servicing Vehicle (HSV) is used as a fillstand, the hose cart or HSV operator shall bond the hose cart or HSV to the hydrant outlet piping. The refueling unit operator shall bond the refueling unit to the hose cart or HSV.

36.3.3.3.1. Fuel servicing vehicles that have the Scully overfill protection in cab power switch installed and an Intellitrol fillstand system may use the Sculcon cable on the fillstand as an approved ground/bond.

36.3.3.3.2. Fuel servicing vehicles that do not have the Scully in cab power switch installed and still have the paddle switch on the bottom loader that activates the Scully system will need to be grounded/bonded to the fillstand using the grounding/bonding reel installed on the vehicle.

36.3.3.4. Push the stop switch on the fillstand to ensure the transfer pump is not operating when the system does not have a deadman control installed. This ensures the

loading arm or hose is not pressurized prior to connecting to the vehicle and will avoid a possible fuel spill.

36.3.3.5. When beginning filling operations, the operator shall open appropriate fuel transfer valves, turn on the pump and check for leaks. The operator shall check the bottom loading automatic shutoff device by pushing the test button on R-9 or R-11 refuelers during the first 500 gallons of fuel pumped into the vehicle, if equipped.

36.3.3.6. Refueling vehicles equipped with a bottom loader and automatic shutoff valve do not require a person on top of the vehicle during loading. Refer to **Chapter 13**, *Fall Protection*, and **Chapter 24**, *Aircraft Flight line – Ground Operations and Activities*, for proper fall protection precautions and requirements.

36.3.3.7. When filling is complete, disengage the fuel storage system nozzle from the vehicle and obtain required forms from the bulk storage operator. The operator shall conduct a “walk-around” inspection, check for leaks, remove the ground cable and wheel chocks, before departing the area.

36.3.3.8. All fillstands shall be equipped with an emergency shutdown switch capable of stopping all associated transfer pumps in the event of a fire or other mishap. Identify the emergency switch and ensure all personnel are familiar with its location. Inspect the fillstand emergency shutdown switch during system checkout and activate it with the system operating at least every 30 days to ensure proper operation. Ensure the emergency shutdown switch is located no closer than 25 feet from the fillstand.

36.3.4. Railroad Tank Car Operations. When unloading tank cars through bottom valve arrangement into installation bulk storage systems:

36.3.4.1. Isolate railroad tank car off-loading tracks (spur) from main tracks and ground them. The off-loading header need not be grounded to the tank car since there is electrical continuity through the rail and tank car body. The grounded railroad spur shall be checked to ensure a resistance reading of 10,000 ohms or less IAW paragraph **36.1.6.5**.

36.3.4.2. Tank cars being loaded with aviation fuels or Mogas shall be bonded to the loading facilities.

36.3.4.3. Insulate the railroad spur from the adjoining railroad track serving the rest of the installation by means of insulation blocks. Bond each of the rails on both sides of the track by electrical connectors. Connect the insulated and bonded tracks and ground them to the same grounding point with the piping at each unloading manifold. The insulating and bonding of the tracks controls and discharges any static buildup.

36.3.5. Fueling Equipment Safeguarding.

36.3.5.1. Fuel servicing equipment parking areas shall be treated as above-ground fuels facilities and safeguarded accordingly.

36.3.5.2. Fuel servicing equipment parking areas shall be paved, lighted and have sufficient slope to control drainage. The parking area shall:

36.3.5.2.1. Have at least two entrances and/or exits to provide means for rapid egress should a hazardous situation develop.

36.3.5.2.2. Be at least 100 feet from surrounding inhabited buildings and 50 feet from uninhabited buildings and taxiing aircraft. See UFC 3-460-01 for further guidance and separation distances from other fixed facilities. **Note:** The 100-foot requirement may be modified for existing parking areas based on local conditions and the size, nature and importance of nearby buildings. However, this separation distance will not be reduced below 50 feet.

36.3.5.2.3. Maintain at least 25 feet center-to-center between fueling vehicles in parking areas. Vehicles shall be parked in single rows and be capable of driving into and out of parking positions in a single turn.

36.3.5.2.4. Have sufficient firefighting equipment (portable or wheeled units) available and strategically located within the parking areas as required by the installation FES Flight.

36.3.5.2.5. Have danger signs placed IAW paragraph [36.3.2.5.2](#).

36.3.5.3. See [Chapter 32](#), *Motor Vehicle – Operations and Maintenance*, for additional guidance on refueler vehicle maintenance areas.

36.3.5.4. Fuel Barge Operations. Locations that receive fuel by barges over waterways will adhere to requirements IAW 33 CFR Part 156 Subpart A, *Oil and Hazardous Material Transfer Operations*, Section 156.120, *Requirements For Transfer*.

#### **36.4. Fuel Servicing Operations.**

36.4.1. Aircraft Servicing. Eliminate or control hazardous fuel vapors and ignition sources during any aircraft servicing operation.

36.4.1.1. A Fuel Servicing Safety Zone (FSSZ) shall be established during all fueling or defueling operations IAW TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*.

36.4.1.2. All support equipment not required in fueling or defueling operations or in concurrent fueling, maintenance or cargo-handling operations shall be moved outside the FSSZ. Position the equipment so a clear path is maintained to permit rapid evacuation of vehicles and personnel in an emergency.

36.4.1.2.1. Aerospace Ground Equipment (AGE) shall be monitored and a Class B fire extinguisher shall be available in the immediate vicinity when the unit is operating in a FSSZ.

36.4.1.2.2. On flight lines with minimum aircraft separation, i.e., 10-15 feet wing tip to wing tip, and where ramp space is limited, powered support equipment such as generators, air conditioners and air compressors may be left in place if shut down and disconnected from the aircraft.

36.4.1.2.3. When practical, mark support equipment parking locations on the ramp.

36.4.1.2.4. Powered support equipment that is not explosion-proof but required for aircraft fueling and defueling shall be parked the full length of the approved power cable from the aircraft and kept outside the FSSZ. The full length of the approved cable or air-start duct shall be maintained between the fueling point or vents to fighter aircraft. Consider wind direction, ramp slope, locations of aircraft fuel overflow

vents, location of servicing unit or fueling hydrant, and mechanical strain on the power receptacle when using powered support equipment.

36.4.1.2.5. The power unit brakes shall be applied and, if necessary, because of ramp slope, also chocked. Only approved cables shall be used with the power unit.

36.4.1.2.6. Auxiliary power units shall not be parked under any part of an aircraft.

36.4.1.3. Aircraft shall not be fueled or defueled inside any hangar or facility until a System Safety Engineering Analysis (SSEA) has been conducted. Specific facilities that already have an approved SSEA can be found in TO 00-25-172, Table 4.2.

36.4.1.4. The Aircraft Servicing Supervisor shall ensure compliance with requirements of this standard, TO 00-25-172 and specific weapon system TOs; ensure a current checklist is used; know the type and quantity of fuel required; and ensure the proper number of people are present, briefed (to include emergency procedures) and positioned properly prior to the start of the operations.

36.4.1.4.1. Ensure a fire guard is assigned during refueling and defueling operations. A maintenance crew member shall be responsible for coupling the fueling nozzle to the single-point receptacle and assuring it is locked in place. **Note:** For C-5 aircraft, the refueling equipment operator may perform the function of the maintenance crew member, to include monitoring the single point nozzle(s) during the fuel servicing, with installation commander approval. Refer to TO 00-25-172 for additional guidance.

36.4.1.5. Fuels operators are responsible for performing the mission in a safe manner. The operator shall continually monitor the equipment for sparks and other ignition sources, unusual noises and other indications of possible malfunctions. Servicing shall be stopped immediately if the operator determines it is unsafe. When using hydrant systems, all operating personnel shall know the location and proper use of the system emergency shutoff switch.

36.4.1.5.1. Servicing aircraft with the wrong fuel can be catastrophic. Fueling personnel shall ensure aircraft receive the proper fuel.

36.4.1.5.2. All transient alert and maintenance control personnel shall state both the type of aircraft and the fuel desired when requesting support from the Fuels Service Center (FSC).

36.4.1.5.3. Refueling drivers shall verify, prior to commencing any refueling operation, that the type of aircraft to be serviced is the same type aircraft specified on the refueling dispatch log.

36.4.1.5.4. Refueling personnel and the maintenance crew chief shall ensure the fuel in the servicing unit, as indicated on the unit, is the correct type of fuel required for the aircraft to be fueled, as indicated by the TO, aircraft decals or other positive means. Similar precautions are required when refueling units are refilled from bulk sources.

36.4.2. Aircraft Fueling and Defueling by Truck. In addition to the general servicing safety precautions and standards, the following procedures shall be followed when servicing aircraft from fuel trucks.

36.4.2.1. Keep as much distance as possible between aircraft being fueled and other aircraft, at least 20 feet from FSSZ between aircraft (wingtip to wingtip) to be serviced and other aircraft, except for fighter, trainer and light cargo types, which may be within 10 feet (wingtip to wingtip) of each other's FSSZ. In positioning the tank truck and the aircraft, place them so the fuel vapor will not be carried downwind toward a source of ignition.

36.4.2.1.1. Do not drive or park fuel servicing vehicles under any portion of an aircraft. However, fuel servicing vehicles with an elevated platform may be positioned under the wing of aircraft, provided there is ample clearance and the aircraft is configured for and actually performing under-the-wing fueling operations. Alternatively, a maintenance platform shall be used when this type fuel servicing vehicle is not available. Under no circumstances will the vehicle be positioned closer than 10 feet from the aircraft. **Exception:** For A-10, C-5, C-17, C-130, E-4B, VC-25, Boeing 747, C-27 and U-2R aircraft only, the vehicle may be within 10 feet but no closer than 4 feet from the aircraft in any direction. For C-5, C-17, E-4B, VC-25 and Boeing 747 aircraft, the fuel truck may be positioned as far under the wing as necessary for the fuel hose to reach the aircraft.

36.4.2.2. A spotter shall be used when backing refueling trucks toward the aircraft. A chock shall be pre-positioned to act as a stop block to maintain proper aircraft and/or equipment separation. When the truck is in position, the parking brake shall be set and all chocks installed.

36.4.2.3. Aircraft wheel chocks, fabricated according to the applicable aircraft Dash-2 TOs, shall be placed fore and aft of the main landing gear or as specified in applicable aircraft TOs. Vehicle chocks may be constructed as per Commercial Item Specification A-A-52475, or locally manufactured IAW TO 00-25-172.

36.4.2.4. The operator shall monitor the control panel and be prepared to shut down fueling if a fuel leak or other malfunction occurs.

36.4.2.5. Accomplish emergency shutdown IAW TO procedures. For fuel spills, other than minor aircraft venting, the aircraft fuel servicing truck shall not be evacuated until the area is cleaned up and declared safe by the installation FES Flight.

36.4.2.6. During defuel operations with units not equipped with an operable high level shutoff system, a person shall be stationed on the top of the refueling truck to observe the tank fuel level and signal the pump operator when full to prevent an overflow. Units with inoperable high level shutoffs shall not be utilized unless mission essential. Refer to [Chapter 13](#) and [Chapter 24](#) for proper fall protection precautions and requirements.

36.4.2.7. During multiple source refueling, refueling unit operators must continuously monitor fuel-flow meters to detect any indication of reverse fuel flow. **Caution:** If reverse flow occurs, operations shall be stopped immediately and not restarted until the cause(s) are determined and corrected.

### 36.4.3. Aircraft Fueling and Defueling From Hydrant Systems.

36.4.3.1. Hydrant system fueling and defueling operations shall be supervised. Hydrant system pump houses shall be manned IAW TO 37-1-1. The hosecart/HSV operator shall hold the remote control switch, magnet lanyard or deadman control throughout the refueling operation. Before fuel delivery begins, aircraft fuel tank caps shall be checked to ensure they are secure. The hosecart/HSV hoses and valves are heavy and require more than one person to safely handle, especially during a hose evacuation malfunction. To prevent damage, do not drag the hose or valve on the ramp. Other members of the fuel servicing crew shall help the hosecart/HSV operator stow the hoses.

36.4.3.2. On Type I and II systems, the operator shall ensure there is no pressure at the outlet prior to hooking up the “Moosehead” valve.

36.4.3.3. The operator shall inspect the remote control cables to ensure they are hermetically sealed and serviceable when used.

36.4.3.4. Hoses shall be pressurized and inspected for leaks prior to the first servicing of the day.

36.4.3.5. Hoses shall be wrapped in a manner to prevent rubbing on hosecart tires or dragging on pavement.

36.4.3.6. All personnel involved in the servicing operations shall know the location of hydrant emergency shutoff switches.

### 36.4.4. Fueling New or Recently Repaired Aircraft Tanks or Tanks That Have Been Purged.

36.4.4.1. Aircraft fuel tanks/cells with nitrogen inerting systems may be filled at the normal rate of flow with the nitrogen system activated.

36.4.4.2. Aircraft without a nitrogen inerting system must be fueled at the slowest possible flow rate until each fuel tank/cell is full or to the level dictated by the mission.

36.4.5. Fueling From Drums. Refuel from drums IAW TO 00-25-172. Bond fuel containers and aircraft as when fueling from tank trucks or hydrants. **Note:** Fueling from drums shall be accomplished only as an emergency measure. Fueling from cans or “topping off” is particularly hazardous due to the potential for spills and static ignition.

### 36.4.6. Ground Servicing Operations.

36.4.6.1. Aircraft fuel servicing hazards are also present when servicing support equipment, vehicles and organizational and/or support equipment tanks. Therefore, commanders, supervisors and operators must recognize that ground servicing operations warrant the same degree of attention to safety afforded aircraft servicing operations. Refueling units in ground servicing operations shall be inspected for safety deficiencies per the locally established maintenance program. Many aircraft operation procedures that contain fuels, vapors and prevent ignition also apply to ground operations.

36.4.6.2. Service Station Operations. Loading, storage and handling of fuels shall be IAW 29 CFR 1910.106(g), *Service Stations*, unless specifically addressed in paragraph [36.4.6.3](#).

36.4.6.3. Support equipment, vehicles and organizational and/or support equipment tanks shall not be fueled within 50 feet of open flames or spark-producing devices. Personnel shall not smoke during fueling operations and shall allow sufficient time for fuel vapors to dissipate after fueling is completed before smoking if fueling is conducted off the flight line.

36.4.6.3.1. Personnel shall not operate portable electrical devices, i.e., cell phones, drills, flashlights, etc., during fueling operations unless the device is intrinsically safe or listed for use in a fuel vapor environment.

36.4.6.3.2. Static charge may develop when the operator exits and re-enters the vehicle and ignite fuel vapors near the nozzle. Personnel should not re-enter the vehicle during the fueling operation unless they ground themselves prior to re-entering.

36.4.6.3.3. Support equipment and vehicles shall be serviced outdoors, with engines turned off and with parking brakes engaged.

36.4.6.3.4. During fueling, operators shall ensure the nozzle of the fuel hose is in constant contact with the filler pipe of the support equipment, tank and/or vehicle fuel tank, to provide an electrical bond.

36.4.6.3.5. Nozzles used at attended/unattended motor vehicle service stations and fleet fueling sites shall be listed IAW NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, and have automatic-closing type hose nozzles with a latch open device. Nozzles used at attended/unattended marine motor fuel dispensing facilities/sites shall be listed IAW NFPA 30A and have automatic-closing type hose nozzles without a latch open device. Nozzles used for dispensing by gravity from tanks above the dispensing/delivery point shall only be a manually operated nozzle.

36.4.6.3.6. Nozzles used on mobile support refueling equipment shall be automatic-closing type hose nozzles without a latch open device.

36.4.6.3.6.1. Operating instructions shall be conspicuously posted in the dispensing area for unattended self-service stations. The instructions shall include location of emergency controls and a requirement that user stay outside of their vehicle and in view of the fueling nozzle during dispensing operation.

36.4.6.3.6.2. Emergency instructions shall also be conspicuously posted in the dispenser area. The emergency instructions shall incorporate the following or equivalent wording:

36.4.6.3.6.2.1. Use emergency stop button.

36.4.6.3.6.2.2. Report accident by calling (installation FES number) and report location.

36.4.6.3.7. Fuel-dispensing systems including dispensers, hoses, nozzles, breakaway fittings, swivels, flexible connectors, dispenser emergency shutoff valves, vapor recovery systems and pumps that are used for alcohol blended motor fuels greater than 15 percent alcohol content shall be listed or approved for the specific purpose.

36.4.6.3.8. All CNG, LNG and LPG refueling dispensers, hoses, nozzles, breakaway fittings, swivels and flexible connectors, dispenser emergency shutoff valves, vapor recovery systems and pumps shall be listed or approved for the specific purpose. All CNG, LNG and LPG motor vehicle fuel dispensing shall be in an outdoor location.

### 36.5. Fuel Laboratory Operations.

#### 36.5.1. Fuels Handling and Laboratory Personnel.

36.5.1.1. Duty Hours. A normal duty day shall not exceed 12 hours. Duty times begin when personnel report for duty and end when all fuels operations have been completed or transferred to another individual. For personnel dispatched to duty locations removed from the support installation, duty time does not end until travel to the support installation or specified location for rest is completed.

36.5.1.2. Rest Period. A normal rest period shall afford an individual the opportunity for at least 8 hours of sleep.

36.5.1.3. Authorized Duties. Only qualified personnel or personnel under the direct supervision of a lab-qualified individual shall perform laboratory sampling or analyses. Functional managers shall certify personnel authorized to perform specific fuel analysis functions.

36.5.2. Fuels Laboratory Design Requirements. UFC 3-460-01, *Petroleum Fuel Facilities*, UFC 3-600-01, *Fire Protection Engineering for Facilities*, and AF Joint (AFJ) 32-series regulations shall be consulted for existing facilities (as a minimum operating standard) and for new construction. In case of conflict with national fire codes or building codes, these handbooks take precedence. The installation CE, FES Flight, Ground Safety office and BE shall make an initial inspection to certify the acceptability of the fuels laboratory.

36.5.3. Sampling and Analysis Safety. The installation Fuels Management Office shall establish guidance for general safety, sampling safety and laboratory safety during laboratory analyses.

#### 36.5.3.1. General.

36.5.3.1.1. Post safety instructions (**Figure 36.1**) in fuel laboratories.

36.5.3.1.2. Workers shall be informed of chemical hazards IAW 29 CFR 1910.1200., *Hazard Communication*. Additionally, hazard communication training shall be provided for workers labeling containers or developing or using MSDSs. Refer to AFI 90-821, *Hazard Communication*, for additional guidance and information.

36.5.3.1.3. Label outside of doors of non-explosion proof refrigerators to indicate "NOT FOR FLAMMABLE STORAGE." **Warning:** Do not store food or beverage in the refrigerator.

36.5.3.1.4. The laboratory supervisor shall ensure ovens are equipped with a temperature limiting automatic shutoff control. Cooking, eating food or drinking beverages in the fuels laboratory is prohibited.

36.5.3.1.5. The quantity of test fuel in the laboratory shall not exceed 10 gallons, including fuel awaiting analysis, unless analysis specifies a larger sample size.



36.5.3.1.6. Limit glass containers to volumes specified in [Table 36.1](#) for all fuels.

36.5.3.1.7. Do not pour fuel into sinks connected to a sanitary drain. Contact the installation Environmental Management office for disposal guidance.

36.5.3.1.8. Inspect waste fuel drums located outside the laboratory daily and empty them when full.

36.5.3.1.9. Do not use waste fuel to kill vegetation.

36.5.3.1.10. Post “No Smoking Within 50 Feet” signs at all laboratory entrances.

36.5.3.1.11. Ensure fire extinguishers are readily available in the laboratory. Contact the installation FES Flight for proper types and sizes. Refer to [Chapter 6, Fire Protection and Prevention](#), for additional guidance and information.

36.5.3.1.12. Ensure at least two people are in the laboratory when tests involving fuels or acids are performed. One of these people must be a fully qualified lab technician.

36.5.3.1.13. Personnel shall not introduce or handle spark-producing materials such as matches, lighters, keys, etc., while in the laboratory. **Exception:** Flashpoint laboratory equipment.

#### 36.5.3.2. Sampling Safety.

36.5.3.2.1. Bond all sampling equipment when taking samples. Allow time for static charges to equalize before disassembly of the in-line sampling equipment IAW TO 42B-1-1.

36.5.3.2.2. When sampling above-ground storage tanks, use the two-person policy. Ensure personnel ground themselves prior to climbing tank ladders by grasping the guardrail with a bare hand. In extremely cold weather, they shall grasp a warm metal object such as a coin and touch it to the guardrail and ensure the coin contacts the guardrail’s metal surface.

36.5.3.2.3. Do not sample storage tanks during filling operations. Allow at least 30 minutes after filling a tank before taking a sample to allow static electricity charges to dissipate.

36.5.3.2.4. Use only bronze, steel or other conductive tapes, chains or cables to lower the sampler into the tank. Ground all metallic components to the tank before opening the sampling hatch and inserting sampling components. Maintain continuous contact between the tape and the hatch opening while lowering the tape into the tank.

36.5.3.2.5. Do not overfill sampling containers. Allow adequate space for fuel expansion.

36.5.3.2.6. Be careful when taking fuel samples from crashed aircraft to prevent ignition of residual fuel vapors. Contamination is also a problem and personnel shall ensure the sample is representative of the uncontaminated fuel in the aircraft fuel tanks.

36.5.3.2.7. Containers used for sampling shall meet requirements in [Table 36.1](#)

### 36.5.3.3. Safety During Laboratory Analyses.

36.5.3.3.1. Ground or bond all laboratory equipment used in analyzing fuels. Electrical equipment is grounded to the building electrical service ground system when plugged in with a serviceable 3-rong (ground) electrical plug; therefore, no other ground wires are required. Ground waste fuel containers by extending a ground wire with clamps from the container to the laboratory common ground system.

36.5.3.3.2. Do not use fuel analysis thermometers for other purposes.

36.5.3.3.3. Ensure workers understand hazards of handling toxic reagents. Local procedures shall not deviate from TO requirements.

36.5.3.3.4. Minimize eye exposure to ultraviolet (UV) light during operation and repair of the Aeronautical Engine Laboratory (AEL) water detector.

36.5.3.3.5. A safety flask (liquid trap) is required between the vacuum pump and the filtration apparatus to prevent fires in ground fuel filtration equipment. This prevents fires caused by flammable liquid from being drawn into the vacuum pump.

36.5.3.3.6. Petroleum ether used in laboratory analyses is highly flammable. Perform all fuels analyses under operating exhaust hoods.

36.5.3.3.7. Do not leave waste fuel in the laboratory overnight unless properly stored.

36.5.3.3.8. The installation Fuels Management Office shall develop emergency procedures and coordinate them with the installation FES Flight and Ground Safety office. These procedures include, but are not limited to, evacuation, equipment shutdown and notification of the installation FES Flight. Emphasize techniques to extinguish clothing fires.

36.5.3.3.9. Mark all containers in the laboratory, regardless of size, to identify contents. Workers shall not pipette fuels by mouth.

36.5.3.3.10. Do not conduct laboratory analyses or allow fuel in the laboratory unless exhaust systems are functioning.

36.5.3.3.11. Wear approved eye protection when performing or observing fuels analyses. Make sure an approved emergency shower/eyewash is provided IAW [Chapter 19](#).

36.5.3.3.12. Ensure all facility and equipment electrical repairs meet NFPA 70, *National Electric Code*, requirements.

36.5.3.3.13. Electrical receptacles in fuels laboratories shall be at least four (4) feet above floor level or working surface.

36.5.4. Inspection of Fuels Laboratory. Supervisors shall inspect their facilities and operations to identify and control or eliminate hazards before they cause a mishap. Personnel shall be instructed to notify their supervisors of potential hazards. Hazards shall be categorized according to potential severity and probability of occurrence IAW AFI 91-202, *The US Air Force Mishap Prevention Program*. Immediate action shall be taken to eliminate those hazards in Categories IA, IB, IIA, and IIB.

36.5.4.1. External Support Inspections. Periodic inspections shall be accomplished by the installation FES Flight, BE and Ground Safety office. BE shall conduct an OEH risk assessment whenever there is reason to believe an exposure may be hazardous, as necessary. Functional managers shall maintain copies of these inspection reports for a minimum of two (2) years or until the next higher headquarters inspection, whichever comes first.

36.5.4.2. Internal Inspection of Fuels Laboratory. Internal safety inspections are the responsibility of all assigned personnel. Potential safety and health hazards must be identified and hazard abatement plans established as outlined in AFI 91-202. Items requiring special attention during daily, weekly or monthly internal inspections include:

36.5.4.2.1. Inspect all electrical connections of equipment for loose or defective connections and frayed insulation.

36.5.4.2.2. Visually inspect all ground wires for frays or loose connections. Check electrical continuity monthly with a resistance (ohm) meter. Inspections shall be documented on the AFTO Form 95, *Significant Historical Data*, or MAJCOM or locally devised automated systems.

36.5.4.2.3. Inspect electrical grounding of the fuels laboratory building monthly and electrical resistance annually. Electrode resistance to ground shall not exceed 25 ohms under dry conditions. Inspections shall be documented on the AFTO Form 95, or MAJCOM or locally devised automated systems.

36.5.4.2.4. Ensure laboratory personnel use correct PPE when handling acids.

36.5.4.2.5. Make sure all acid solutions are stored in a double container.

36.5.4.2.6. Ensure labels on containers accurately reflect contents.

36.5.4.2.7. Make sure waste fuel containers are emptied daily. Contact the installation Environmental Management office for additional guidance and information.

36.5.4.2.8. Ensure only authorized personnel are in the laboratory when testing fuels.

36.5.5. Housekeeping. Good housekeeping is essential in the fuels laboratory and is the responsibility of all personnel.

36.5.5.1. Provide plainly marked metal containers with self-closing lids for combustible waste such as rags, paper towels and other flammable solid materials. Paint these containers yellow with red letters designating, "COMBUSTIBLE SOLID WASTE."

36.5.5.2. Fuel spills can cause fires and create slipping hazards. Spills shall be cleaned up immediately.

36.5.5.3. Use only noncombustible absorbent materials to clean up spills of flammable/combustible materials. Do not use sawdust or wood shavings as an absorbent.

36.5.5.4. Do not clean fuels laboratory floors with flammable liquids. Use nonskid waxes when waxing floors.

36.5.5.5. Unplug all lab equipment at the end of the work day, unless instructed by TO, manufacturer's instructions or when allowed by the installation FES Flight.

36.5.5.6. Keep outside areas, approximately 25 feet, around fuels laboratories free of weeds, trash and other combustible materials.

36.5.5.7. Ensure aisles in fuels laboratories are clear and permit unobstructed egress of personnel in case of fire.

36.5.5.8. Limit waste fuel containers within the laboratory to five (5) gallons each. Empty the containers when full and at the end of the normal work day. Paint containers red with a two-inch yellow band around the center of the container. Stencil the type of fuel in one-inch letters inside the yellow band on the front side of the drum.

36.5.5.9. Never pour acids into fuel containers.

36.5.5.10. Position a 55-gallon drum, or an equivalent container, outside the laboratory at least 50 feet from the building. Paint the drum red with a four-inch yellow band around the center of the drum. Stencil the grade of fuel in two-inch letters inside the yellow band on the front side of the drum. Ground all waste containers and drums. **Note:** A metal drum (DOT specifications) or approved metal portable tank not exceeding 60 gallons may be placed within the laboratory if equipped with a self closing cover and a device to prevent propagation of flame into the drum/tank; located at least 10 feet, horizontally, from energized electrical outlets; and approved by the installation FES Flight.

**Table 36.1. Maximum Allowable Size of Containers and Metal Portable Tanks For Flammable Liquids/Combustible Liquids.**

Maximum Allowable Size of Containers and Metal Portable Tanks For Flammable Liquids/Combustible Liquids					
Container Type	Class				
	IA	IB	IC	H	M
Glass	1 pt	1 qt	1 gal	1 gal	5 gal
Metal (Other than Department of Transportation (DOT) drums) or approved Plastics	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2 gal	5 gal	5 gal	5 gal	5 gal
Metal Drum (DOT)	60 gal	60 gal	60 gal	60 gal	60 gal
Polyethylene DOT Spec 34 or as authorized by DOT Exemption	1 gal	5 gal	5 gal	60 gal	60 gal
Approved Metal Portable Tanks	660 gal	660 gal	660 gal	660 gal	660 gal

**Figure 36.1. Safety Instructions for Fuels Laboratories (To be posted in all installation fuels laboratories).**

### Safety Instructions For Fuels Laboratories

1. Hazards.
  - 1.1. Body contact with fuel can cause skin or eye irritation.
  - 1.2. Swallowed fuels are poisonous.

- 1.3. Inhaling vapors may cause drowsiness, intoxication or asphyxiation.
- 1.4. Spills can cause slipping and/or fire hazards.

## 2. First Aid.

- 2.1. Remove fuel-contaminated clothing and wash affected skin areas with soap and water.
- 2.2. If fuels are swallowed, DO NOT induce vomiting. Get medical attention immediately.
- 2.3. If fuel is splashed in eyes, flush with water for 15 minutes. Get medical attention.

## 3. Safety Precautions.

- 3.1. Know the general characteristics of fuels.
- 3.2. Verify that personal protective and fire protection equipment are available and in working order prior to operations involving fuel.
- 3.3. All electrical equipment used in fuel operations must be properly grounded unless designed for ungrounded operation.
- 3.4. Avoid spills. Vapors from fuel can form explosive mixtures with air.
- 3.5. Always wash hands thoroughly with soap and water after working with fuels.
- 3.6. Clothing splashed with fuel must be removed, dried out and laundered before being worn again. Use caution removing fuel-soaked clothes to prevent electrostatic ignition. Air clothing until thoroughly dry. DO NOT place fuel-soaked clothing in lockers or other enclosed spaces.

## 36.6. Safety Guide For Hydrocarbon Fuels.

### 36.6.1. Hazards:

- 36.6.1.1. Contact with skin can cause scaling, fissuring of skin, and blistering.
- 36.6.1.2. Contact with eyes causes irritation (liquid fuel or vapors).
- 36.6.1.3. Swallowing fuels may cause poisoning.
- 36.6.1.4. Gasping while swallowing or aspiration from vomiting can introduce fluid into the lungs and may cause chemically induced pneumonia.
- 36.6.1.5. Inhaling vapors may cause dizziness. **Danger:** In confined spaces of pits, fuel vapors may overcome a worker and cause death due to asphyxiation.
- 36.6.1.6. Spills may cause dangerous fire hazards:
  - 36.6.1.6.1. Fuel vapors can burn or explode when exposed to an ignition source.
  - 36.6.1.6.2. If hydrocarbon fuels and rocket oxidizers are spilled and mixed, the mixture can be exploded by chemical reaction, heat, or spark. They may even explode spontaneously.
- 36.6.1.7. Gasoline hydrocarbon fuels with tetraethyl lead are highly toxic to the central nervous system. Tetraethyl lead can be:
  - 36.6.1.7.1. Absorbed through the skin.
  - 36.6.1.7.2. Inhaled.

36.6.1.7.3. Ingested.

36.6.1.7.3.1. By direct contact with the petroleum product.

36.6.1.7.3.2. Indirectly through contact with petroleum sludges, tank scale, and tank rust.

36.6.1.8. Hydrocarbon fuel vapors can displace oxygen in enclosed spaces and pits and cause asphyxiation, unconsciousness, and death.

36.6.2. First Aid:

36.6.2.1. Remove contaminated clothing and wash affected skin areas with soap and water.

36.6.2.2. If fuel is splashed into the eyes, immediately flush the eyes with large amounts of water continuously for at least 15 minutes. Get medical attention immediately.

36.6.2.3. If swallowed, do not induce vomiting. Get medical attention immediately.

36.6.3. Safety Precautions:

36.6.3.1. Know the characteristics of the hydrocarbon fuels being handled.

36.6.3.2. Immediately repair any malfunction of a refueling vehicle's exhaust system.

36.6.3.3. Use only approved electrical plugs, clips, and conductors during servicing operations.

36.6.3.4. Cease fuel operations (except pipeline receipts and military or BX service stations) when advised by the weather officer that a thunderstorm is within a 5 nm radius of the installation. Do not resume operations until advised to do so by the FSC.

36.6.3.5. Know which operations require the presence of two people.

36.6.3.6. Do not wear shoes with exposed nails or metal plates.

36.6.3.7. Do not remove outer garments around fuel storage or servicing operations since this creates static electricity.

36.6.3.8. Remove rings and other items of jewelry while engaged in fuel operations (whenever possible or when required by supervision).

36.6.3.9. Wear an approved self-contained breathing apparatus when entering confined spaces where there are high fuel vapor concentrations. Consult BE personnel for specific requirements.

36.6.3.10. Ensure that eyewashes and personal protective and fire extinguishing equipment are available and operational prior to operations involving hydrocarbon fuels.

36.6.3.11. Ensure that all equipment used in hydrocarbon fuel operations is properly grounded.

36.6.3.12. Immediately clean up Class I fuel spills. For Class II and III fuel spills, immediately notify the fire protection organization (vapors from hydrocarbon fuels can form dangerous explosive mixtures with air).

36.6.3.13. Wash hands thoroughly with soap and water after working with fuels.

36.6.3.14. Remove clothing that has been splashed with hydrocarbon fuels as soon as possible. Air dry and launder before using again. Prior to laundering, air out the contaminated clothing. Do not place fuel-soaked clothing in lockers or other confined spaces. Air clothing until thoroughly dry.

**36.7. Hydrocarbon Fuels Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

36.7.1. Have possible sources of ignition been identified and prohibited from areas where flammable vapor may exist? Reference [36.1.5.1](#)

36.7.2. Have all damaged static grounds been repaired and retested for resistance values? Reference [36.1.6.5](#)

36.7.3. Have all personnel in work environments where petroleum products are present been instructed on hazards of static electricity? Reference [36.2.2.2](#)

36.7.4. Are all personnel involved in fuel handling operations trained in minimizing the possibility of fuel spills and proper response procedures if a spill does occur? Reference [36.2.2.5](#)

36.7.5. Are proper procedures used when entering petroleum storage tanks? Reference [36.2.3](#)

36.7.6. Are the minimum safety features present in locations where petroleum products are handled or stored? Reference [36.2.4](#)

36.7.7. Are emergency shower and eyewash units in place IAW [Chapter 19](#)? Reference [36.2.4.1](#)

36.7.8. Are fuel transport vehicles electrically bonded to the offloading header during fuel handling operations? Reference [36.3.2.2](#)

36.7.9. Are proper procedures utilized for fuel transfer operations, including gauging and temperature measurement? Reference [36.3.2.4](#)

36.7.10. Is fire protection equipment properly located prior to fuel handling operations? Reference [36.3.2.6](#)

36.7.11. Do local fuel movement procedures include emergency shutdown procedures? Reference [36.3.2.9](#)

36.7.12. Are electrical bonding procedures followed for fuel truck-fillstand operations? Reference [36.3.3.3](#)

36.7.13. Have all sources of ignition been eliminated during aircraft servicing operations? Reference [36.4.1](#)

36.7.14. Has a Fuel Servicing Safety Zone (FSSZ) been established for fuel servicing operations? Reference [36.4.1.1](#)

36.7.15. Do refueling drivers verify the type of aircraft to be serviced is the same type aircraft specified on the refueling dispatch log? Reference [36.4.1.5.3](#)

36.7.16. Are spotters used when backing refueling trucks toward the aircraft? Reference [36.4.2.2](#)

36.7.17. Are the specific precautions for hydrant system fueling being followed? Reference [36.4.3](#)



## Chapter 37

### OFFICE/SHOP COMPUTER AND AUTOMATIC DATA PROCESSING EQUIPMENT (ADPE) AND FACILITIES

**37.1. General Information.** This chapter has been substantially changed to clarify safety practices and requirements for office/shop desktop and laptop computers and data processing operations. Administrative changes have been made as required.

37.1.1. Hazards. Hazards shall be engineered out, isolated, guarded against or a safer chemical used whenever possible before considering the use of Personal Protective Equipment (PPE). Refer to **Chapter 1, Introduction**, paragraph 1.5, **Chapter 3, Physical Hazards**, and **Chapter 14, Personal Protective Equipment (PPE)**, for guidance on other hazards which may apply to data processing facilities and operations.

37.1.2. Human Factors. Managers, supervisors and workers shall be aware of human factors that can lead to worker error, injury or adverse effects on their operations. Refer to **Chapter 2, Human Factors**, for additional guidance.

37.1.3. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph 2.3 for additional information.

37.1.4. Static Hazards. Static electricity can damage electrostatic discharge (ESD) sensitive equipment, which includes almost all computers, printers and data processing equipment. Protective measures, such as grounding/bonding, conductive floors and benches, humidity control, antistatic packaging of spare components and other controls shall be used as needed to prevent damage from static electricity.

37.1.5. Application. This chapter applies to computers located in office/shop environments as well as data processing facilities. A data processing facility encompasses the process that covers all computerized and auxiliary automated information handling, including systems analysis and design, conversion of data, computer programming, information storage and retrieval, data and facsimile transmission, requisite system controls, simulation and all related interactions between personnel and machines.

**37.2. Desktop and Laptop Computers and Related Equipment.** Desktop and laptop computers used in administrative, shop areas and classrooms are considered ADPE and shall be used and protected as office/shop equipment and tools. **Warning:** Only communications equipment approved for hazardous locations shall be used when flammable vapors or other environmental hazards may be present. Refer to **Chapter 23, Confined Spaces**, for additional guidance, as required. **Note:** All hazardous locations are not considered confined spaces.

37.2.1. Cord and plug connected computers, servers, local area networks (LAN), multiplex (MUX) and related equipment, built to work in an office or shop environment, without the need for raised floors or separate environmental control systems, shall be treated as typical office/shop equipment, i.e., copiers, printers, typewriters, calculators, fans, desk lights, etc.

37.2.2. Unless there is some hazard which prevents workers from eating or drinking in the work area, allowance of food and drink in these areas is at the discretion of the supervisor.

37.2.3. The area around computers, printers and related equipment shall be adequate to allow sufficient cooling air to reach the equipment. These areas shall be kept clean to prevent buildup of paper and other materials which could pose a fire hazard or restrict cooling airflow and cause excessive temperatures which could damage equipment or pose a fire hazard.

37.2.4. Cooling fans, filters and heat sinks in computers, printers and related equipment shall be checked at least annually, by qualified personnel, for lint and dust buildup which could cause overheating or fire. Any buildup of lint or dust shall be removed. More frequent inspections and cleanings may be needed in dirty or dusty environments. These inspections shall be conducted and documented by qualified personnel as determined locally. The installation Communications Squadron may designate overall responsibility at the Communications Squadron-level, or more commonly, designate the unit computer section as the OPR.

37.2.5. Cords and cables shall not be placed where they are exposed to damage or pose a fire or tripping hazard to personnel.

37.2.6. Equipment requiring a grounded outlet shall only be connected to a grounded outlet.

37.2.7. Used laptop batteries shall be disposed of IAW direction from the installation Environmental Management office.

37.2.8. Temporary Power Taps, such as multi-receptacle surge protectors, shall only be used to power computers and related equipment, such as lights or fans. Neither power taps nor extension cords shall be used with high current items, such as coffee makers, refrigerators, microwave ovens, heaters, food preparation equipment, etc. Equipment plugged into power taps shall not exceed the capacity of the power tap or facility wiring. Extension cords shall not be used with power taps in place of permanent facility wiring. Additionally, extension cords, power strips and UPS devices shall not be "piggy-backed" or plugged into each other. **Note:** Heavy-duty, three pronged extension cords may be used temporarily (not to exceed two (2) days) when it is not feasible or is impractical to power computer and related equipment from facility wiring, such as in large hangars, flight line locations, field environments and when using generators.

37.2.9. Desktop and laptop computers, printers and related equipment may be left on and unattended, i.e., nights and weekends.

37.2.10. To protect against loss of data, some desktop computers are powered through an uninterruptible power supply (UPS). In the event of a power outage, personnel shall assume all computer, printer, LAN, etc., circuits are energized until properly tested, turned off or disconnected from their power supply.

### **37.3. ADPE and Facility Requirements.**

37.3.1. Proper layout, spacing and arrangement of equipment and machinery are essential to safe operations. Good layout of a data processing installation can best be achieved in the planning stages by considering current and future uses of the facility. .

37.3.2. Good housekeeping is important to prevent mishaps in data processing facilities. Poor housekeeping may lead to fires, injuries to personnel or unhealthful working conditions. Refer to **Chapter 5**, *Housekeeping*, for additional guidance.

37.3.3. All aisle ways within data processing rooms shall be clearly defined and kept free of obstructions.

37.3.4. Suitable noncombustible containers with self-closing lids shall be used for scraps and wastes as they accumulate. These containers shall be emptied when full and/or at the end of each shift. If not emptied, they shall be moved to a location outside the data processing room. Consult the installation environmental management office for disposal guidelines.

37.3.5. Dropping heavy cartons and other data processing equipment and supplies could cause serious injuries to personnel. Adequate normal and emergency lighting helps ensure hazardous conditions can be seen and avoided.

37.3.6. Floor maintenance.

37.3.6.1. Building floors, especially raised floors in data processing rooms, shall be kept smooth, clean and free of obstructions and slippery materials.

37.3.6.2. Floor loading capacities shall be identified and posted IAW **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*. Capacities shall not be exceeded.

37.3.6.3. Floors shall not be cleaned with flammable liquids or abrasive scrubbing powders. If toxic cleaning agents are used, adequate ventilation shall be provided to remove vapors. Carpeted floors shall be vacuumed daily, except where high efficiency filters are installed in the ventilation system. For rooms with conductive floors, used to control static buildup/discharge, cleaning and maintenance products used will not adversely affect the conductivity of the floor, i.e., conductive waxes shall be used.

37.3.6.4. To prevent buildup of trash and foreign objects, sub-floors under raised floors in data processing rooms shall be cleaned periodically, but not less than once every 60 days. If cleaning history shows that a longer period between cleanings is feasible, the Fire Protection Flight may allow extending the time between cleanings. Areas under raised floors shall not be used for storage. Openings in raised floors, including raised training platforms, for electrical cables or other uses shall be protected to preclude collecting debris and to prevent tripping. Sub-floors shall be inspected once each operational day to ensure no flooding or leaking is present, unless the sub-floor area is provided with an automatic water leakage detection system. **Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

37.3.6.5. Oil, cleaning fluids, water and other substances spilled on data processing room floors will not only cause slipping hazards, but may also short-circuit equipment. When spills occur, they shall be cleaned up immediately with approved cleaning materials. The area beneath raised floors shall also be cleaned if any spilled material penetrates the raised floor.

37.3.7. Electric equipment, such as buffing machines, shall be suitable for use in a data processing environment. Equipment requiring a three-wire grounding cord and three-prong plug shall be connected to a three wire grounded outlet. Operating procedures for all

equipment shall include inspection and maintenance procedures, and any cautions that shall be taken during machine operation.

37.3.8. Tools shall not be left on equipment or lying in aisle ways. Suitable racks or cabinets shall be provided for tool storage.

37.3.9. To prevent electromagnetic interference, electrically-operated vending machines or other equipment which may cause interference shall not be installed in data processing rooms or rooms containing ADPE, such as remote terminal units or data entry equipment.

37.3.10. Coat racks shall not be allowed in data processing rooms, since they contribute to undesirable traffic, dust and lint conditions.

37.3.11. Eating or drinking shall not be allowed within data processing rooms or while operating remote equipment. Signs prohibiting food or drinks shall be posted at each entrance to data processing rooms and at each remote terminal location. Such authorization shall be posted in each room or area.

37.3.12. Materials stored within data processing facility supply rooms shall be neatly stacked and readily reached by adequate aisle ways. Care shall be taken to stack materials so they shall not topple over. Under no circumstances shall materials be stacked within 18 inches of ceiling fire sprinkler heads or Halon nozzles. Material shall be stored so that it does not project into aisles or passageways, possibly causing personnel to trip or hindering firefighting personnel. Material shall not be stored above suspended ceilings.

37.3.13. Emergency control switches shall be installed in all data processing rooms and located at designated exit doors. These controls shall be readily accessible to operators and remain unobstructed at all times. These controls shall disconnect the ventilation system serving the room, and selective power to all electrical equipment in the room except lighting. Specific power shutdown procedures shall be tailored to the individual facility. In addition, these controls shall be plainly marked as to their function and covered to prevent accidental shut-off.

37.3.14. Improper fire prevention practices can be a major source of injury and equipment damage. Damages and injuries may result from the improper use of fire extinguishers, including using the wrong type of extinguisher agent. For example, water or foam on electrical fires may cause equipment damage or pose a shock hazard to people using the extinguisher. Carbon dioxide (CO<sub>2</sub>) used on a cathode-ray tube (CRT) display could cause the tube to implode and injure personnel. Flammable cleaning fluids may release toxic gases and pose a greater hazard than nonflammable fluids. Inadequately marked egress routes could inhibit or prohibit escape in the event of a fire or other emergency. Refer to [Chapter 6, \*Fire Protection and Prevention\*](#), for additional guidance.

37.3.15. Only fire suppression and extinguishing equipment approved by the installation FES Flight shall be installed within data processing facilities. Refer to [Chapter 6, UFC 3-600-01, \*Fire Protection Engineering For Facilities\*](#), NFPA 75, *Standard for the Protection of Information Technology Equipment*, or the installation FES Flight for guidance on extinguishing agents and systems.

37.3.16. Toxic fume exposure. Due to the production of toxic fumes from burning plastics, the FES Flight shall approve the location, method and quantity of tapes, disk packs and other storage media stored in a facility. All changes shall be approved by the FES Flight. Tapes and disk packs may need to be stored in separate rooms or vaults. All tape stands, cabinets and storage racks shall be of sound construction and shall not exceed seven (7) feet in height. Tapes and disk packs shall not be stored in aisles, corners or on top of equipment.

37.3.17. All non-metal furniture and furnishings within data processing rooms shall be made of fire-resistant materials. Only metal or other fire-resistant containers shall be used for the storage of operating manuals and frequently used forms, paper and other supplies. Production outputs from production runs shall be removed from data processing rooms immediately upon completion of the run, unless preliminary checking is required. If preliminary checking is required, adequate work space shall be provided. Only non-combustible wastebaskets equipped with self-closing lids shall be used. These wastebaskets shall be strategically located to reduce traffic in the data processing room and shall be emptied IAW paragraph [37.3.4](#).

37.3.18. Only cleaning materials approved by the equipment manufacturer, TO or other guidance shall be used to clean ADPE. To the maximum extent possible, only nonflammable and nontoxic cleaning fluids shall be used for cleaning data processing equipment. If it is necessary to use flammable or toxic cleaning fluid, no more than a one-day supply shall be maintained within the data processing facility. All flammable and toxic cleaning fluids shall be stored in approved self-closing metal containers. Only lint-free or treated cloths recommended for this type cleaning shall be used with cleaning fluids. Soiled cloths and wipes shall be removed from the work area and disposed of IAW paragraph [37.3.4](#).

37.3.19. BE shall be advised of routine maintenance procedures that involve the use of cleaning chemicals. BE will conduct an OEH risk assessment.

37.3.20. Many ADPE installations have a UPS and/or backup generators to prevent unplanned shutdown of equipment if a power failure occurs. In the event of power failure, personnel shall assume all circuits are energized until properly tested or locked out/tagged out.

37.3.20.1. UPS and/or backup generators shall be periodically functional tested to ensure they are working properly and to train new personnel on use and maintenance.

37.3.20.2. Generators and UPS systems shall be maintained by qualified personnel IAW applicable TO, manufacturer's instructions, NEC and UFC guidance.

37.3.21. Battery-operated emergency lighting units shall be installed as part of the data processing facility's fixed electrical wiring system. These units shall provide illumination in work areas, hallways and exits in the event of a power failure. Units shall be inspected at least annually and immediately repaired or replaced when found to be defective or inoperative.

37.3.22. Illuminated exit signs shall be provided for each exit and passageway. Consult the installation FES Flight or refer to NFPA 101, *The Life Safety Code*, for further guidance.

37.3.23. To preclude water damage:

37.3.23.1. Data processing rooms located below floors equipped with water sprinkler systems are susceptible to water damage if the sprinkler systems are actuated. Managers shall provide a means of protecting data processing equipment in the event of a water leak or sprinkler activation (time permitting). This may be accomplished by strategically locating pre-cut pieces of plastic sheeting within data processing rooms. In the event of a water leak or spill, equipment shall be shut down before it is covered with the plastic sheeting. This will reduce the possibility of the equipment overheating and catching on fire. The plastic sheeting shall be removed before restarting equipment.

37.3.23.2. A survey of each data processing facility by the installation CE shall be requested to determine if a water hazard exists. The building custodian shall keep the completed survey on file and brief incoming personnel during initial safety orientation.

37.3.24. Contact with energized electrical circuits could result in serious injury or electrocution. Refer to **Chapter 8, *Electrical Safety***, for additional guidance.

37.3.25. Emergency Equipment (Electrical Safety Boards). Refer to paragraph **8.12** for guidance on Electrical Safety Boards.

37.3.26. When sound levels are suspected to be abnormally high, the supervisor shall contact BE and request a sound level survey. If the survey indicates hazardous noise levels, the functional manager shall initiate engineering and/or administrative controls, as determined by BE. Refer to AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, and 29 CFR 1910.95, *Occupational Noise Exposure*, for additional information.

**37.4. Office/Shop Computer and Automatic Data Processing Equipment (ADPE) Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

37.4.1. Are hazards engineered out, isolated, guarded against or a safer chemical used whenever possible before considering the use of PPE? (Reference **37.1.1**)

37.4.2. Are electrostatic discharge (ESD) sensitive equipment computers, printers and data processing equipment protected as needed to prevent damage from static electricity? (Reference **37.1.4**)

37.4.3. Do supervisors prohibit eating and drinking in hazardous work areas? (Reference **37.2.2**)

37.4.4. Is sufficient cooling air available for computers, printers and related equipment? (Reference **37.2.3**)

37.4.5. Is the area around computers, printers and related equipment kept clean to prevent buildup of paper and other materials which could pose a fire hazard or restrict cooling airflow and cause excessive temperatures which could damage equipment or pose a fire hazard? (Reference **37.2.3**)

- 37.4.6. Are cooling fans, filters and heat sinks in computers, printers and related equipment checked at least annually, by qualified personnel, for lint and dust buildup which could cause overheating or fire? (Reference [37.2.4](#))
- 37.4.7. Are cords and cables placed such that they do not pose a fire hazard or a tripping hazard to personnel? (Reference [37.2.5](#))
- 37.4.8. Are used laptop batteries disposed of IAW direction from the installation Environmental Management office? (Reference [37.2.7](#))
- 37.4.9. Are power taps and extension cords prohibited from use with high current items, such as coffee makers, microwave ovens, heaters, food preparation equipment, etc.? (Reference [37.2.8](#))
- 37.4.10. Does equipment plugged into power taps exceed the capacity of the power tap or facility wiring? (Reference [37.2.8](#))
- 37.4.11. Are all aisle ways within data processing rooms clearly defined and kept free of obstructions? (Reference [37.3.3](#))
- 37.4.12. Are suitable noncombustible containers used for scraps and wastes as they accumulate? (Reference [37.3.4](#))
- 37.4.13. Are building floors, especially raised floors in data processing rooms, kept smooth, clean and free of obstructions and slippery materials? (Reference [37.3.6.1](#))
- 37.4.14. Are floor loading capacities identified and posted? (Reference [37.3.6.2](#))
- 37.4.15. Are rooms with conductive floors cleaned and maintained with products which will not adversely affect the conductivity of the floor? (Reference [37.3.6.3](#))
- 37.4.16. Are sub-floors under raised floors in data processing rooms cleaned periodically, but not less than once every 60 days, unless extended by the FES Flight? (Reference [37.3.6.4](#))
- 37.4.17. Is storage prohibited in sub-floor areas? (Reference [37.3.6.4](#))
- 37.4.18. Is the area beneath raised floors cleaned if any spilled material penetrates the raised floor? (Reference [37.3.6.5](#))
- 37.4.19. Are signs prohibiting food or drinks posted at each entrance to data processing rooms and at each remote terminal location? (Reference [37.3.11](#))
- 37.4.20. If supervisors determine food and drink are authorized in data entry equipment rooms, is such authorization posted in each data entry room or area? (Reference [37.3.11](#))
- 37.4.21. Is storage of materials above suspended ceilings prohibited? (Reference [37.3.12](#))
- 37.4.22. Are plainly marked emergency control switches installed in all data processing rooms and located at designated exit doors? (Reference [37.3.13](#))
- 37.4.23. Does the FES Flight approve the location, method and quantity of tapes, disk packs and other data storage media stored in a facility? (Reference [37.3.16](#))
- 37.4.24. Are battery-operated emergency lighting units immediately repaired or replaced when found to be defective or inoperative? (Reference [37.3.21](#))

37.4.25. Are illuminated exit signs provided for each exit and passageway? (Reference [37.3.22](#))

37.4.26. Has a survey of each data processing facility been completed by the installation CE to determine if a water hazard exists? (Reference [37.3.23.2](#))



## Chapter 38

### MULTIMEDIA OPERATIONS

#### 38.1. Specific Requirements.

38.1.1. Material Safety Data Sheets (MSDS) information on all lab chemicals shall be immediately accessible to all workers. Ensure MSDS are obtained for any new chemicals or products. All workers shall know and understand the hazards present in their job tasks. Refer to AFI 90-821, *Hazard Communication*, for additional guidance and training requirements.

38.1.2. Good housekeeping practices shall be followed in all areas, especially in areas where chemicals are handled.

38.1.3. Ensure processing rooms have adequate ventilation, typically eight air changes per hour. Refer to UFC 3-410-01FA, *Mechanical Design Heating, Ventilation and Air Conditioning*, and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional information and guidance.

38.1.4. Maintenance personnel and visitors shall avoid skin contact with chemicals or work surfaces contaminated with chemical residues. All personnel shall be briefed on hazards in the photographic facility prior to entry and commencing work.

38.1.5. Store all chemicals in cool, dry, dark areas or as directed by the manufacturer. Maintain separate storage areas for chemicals that are known to react violently with each other.

38.1.6. Store chemicals on shelves strong enough to support their loads. Design each shelf with coping or front ledges to prevent containers and equipment from extending over the edges or inadvertently falling. Chemical storage areas or rooms shall be sloped and drained into an approved holding tank or be capable of containing a spill.

38.1.7. Keep all corrosive chemicals in thick-walled or shatterproof glass containers protected by wooden frames or boxes. If the capacity of the container is five (5) gallons or more, support the frame by a sturdy wooden or metal cradle that is pivoted or hinged for ease in dispensing.

38.1.8. Ignition sources are not allowed in photographic laboratories. Post appropriate signs at entrances.

38.1.9. All electrical sources in wet locations shall meet appropriate electrical standards. Electrical equipment shall be protected with a ground fault circuit interrupter or circuit breaker. Refer to NFPA 70, *National Electrical Code*, for additional electrical guidance.

**38.2. Communications.** Photographic darkrooms and laboratories may have small special use rooms where personnel could be isolated. All such rooms shall be linked by an intercom system or other means for routine communication and in case of illness, accident or emergencies. Where required, this intercom must be intrinsically safe. An audible/visible alarm may be fitted to alert other staff members of a problem in darkrooms.

**38.3. Eyewash and Emergency Shower Units.** Supervisors or facility managers shall ensure units are available so workers exposed to hazardous chemicals can flush their eyes and bodies.

Contact the installation Ground Safety Office to determine the type of equipment required. Refer to **Chapter 19**, *Emergency Shower and Eyewash Units*, for additional guidance and information on shower/eyewash units.

**38.4. Fire Safety and Emergency Requirements.** A multi-purpose ABC dry chemical portable fire extinguisher shall be present in each laboratory. The location of each extinguisher shall be clearly marked. Refer to **Chapter 6**, *Fire Protection and Prevention*, or the installation Fire Emergency Services (FES) Flight for information on location, type and placement of fire extinguishers. Refer to paragraph **6.3** for additional guidance on emergency lighting and exit markings.

**38.5. Electronic Flash Equipment.** Supervisors shall ensure workers are aware of potential risks associated with flash equipment. Electronic flash equipment is designed to work at a high voltage, typically 450 to 4000 volts. When charged, the flash capacitors carry a heavy electrical charge, which must be depleted or “bled off” before any repair work is attempted. There may be an additional danger from sparking of the contact points in the power packs.

38.5.1. Supervisors/functional managers shall ensure only qualified personnel who have received training service high voltage electronic flash equipment.

38.5.2. Do not operate electronic flash equipment in potentially hazardous atmospheres containing explosive vapors, dusts or fumes above the Lower Explosive Limit (LEL).

38.5.3. A flash unit shall not be charged for firing unless the flash lamp is installed and the complete assembly is ready for use. If the assembly was not fired after it was charged, and approved procedures for discharging the high voltage capacitor are not available, the flash lamp shall not be removed for at least an hour.

38.5.4. The power cord shall be disconnected from the power pack before removing the lamp or touching the metal part of the lamp socket.

38.5.5. Before the batteries are removed, workers shall ensure the assembly has been discharged and that the charging switch has been changed from the “charge” position.

38.5.6. Stored energy in electronic flash units can be lethal. Depending on the rate of discharge, the amount of current can cause severe burns or fatal injury to a worker. Workers shall follow the manufacturer’s instruction for the proper waiting time to deplete any stored charge before removing a broken tube from strobe equipment. **Note:** Newer flash products have a misfire alarm with a reset feature that bleeds off stored energy. Follow the manufacturer’s instructions for safe operations of flash equipment.

### **38.6. Photography of Research Materials.**

38.6.1. Photographers shall consult with clients to determine hazards that may be associated with the materials being photographed. Clients shall be responsible for providing required PPE to photographers prior to materials being photographed. Some examples of hazards that could be associated with research materials are:

38.6.1.1. Biological pathogens present in cultures.

38.6.1.2. Chemical hazards in some biochemical samples.

38.6.1.3. Corrosive chemical solvents in gel samples (e.g., ammonia, acetic acid).

38.6.1.4. Radiation hazards.

38.6.1.5. Ultraviolet (UV) light from fluorescent materials

38.6.2. Supervisors and photographers shall be briefed on the specific hazards associated with the research materials, PPE required and any special program requirements associated with the materials. Consult the installation Ground Safety Office or BE for additional information on specific hazards associated with research materials.

### **38.7. Disposal of Photographic Chemicals.**

38.7.1. Current photographic chemicals are predominantly water-based, with individual chemicals designed to be biodegradable. Consult the installation Environmental Management office for guidance on disposal of photographic chemicals.

38.7.2. Pretreatment of used chemicals requires recovery of silver from all fixing and bleaching operations, and pH balancing where necessary to control extreme pH levels. Hazardous chemicals or solvents shall be disposed IAW guidance from the installation Environmental Management office.

**38.8. Multimedia Operations Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

38.8.1. Have photographic laboratory personnel been trained in AFI 90-821, *Hazardous Communication*, procedures? Reference [38.1.1](#)

38.8.2. Are processing rooms ventilation systems designed to meet UFC 3-410-01FA and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance* 0 requirements? Reference [38.1.3](#)

38.8.3. Are all maintenance personnel and visitors briefed on hazards in the photographic facility prior to entry and commencing work? Reference [38.1.4](#)

38.8.4. Are chemicals stored in compliance with the guidelines provided by their MSDS? Reference [38.1.5](#)

38.8.5. Do floor drains in the chemical storage area connect to holding tanks? Reference [38.1.6](#)

38.8.6. Are corrosives stored in shatterproof or thick-walled glass containers protected with wooded/plastic frames? Reference [38.1.7](#)

38.8.7. Do electrical sources in wet locations meet appropriate electrical standards? Reference [38.1.9](#)

38.8.8. Is an inter-room communication/alarm system installed in the photographic laboratory areas where workers can be isolated? Reference [38.2](#)

38.8.9. Are eyewash and emergency shower facilities available in areas where hazardous chemicals are handled? Reference [38.3](#)

38.8.10. Are the fire extinguishers of the correct size, type and quantity available in the facility per the installation FES Flight? Reference [38.4](#)

38.8.11. Are all egress pathways identified and labeled with signage visible in normal lighting and in subdued lighting? Reference [38.4.2](#)

38.8.12. Are all exits pathways kept clear to facilitate the evacuation of the workspace? Reference [38.4.3](#)

38.8.13. Are photographers who use electronic flash equipment trained on the potential hazards associated with the equipment? Reference [38.5](#)

38.8.14. Do photographers consult with clients on hazards they may be exposed to prior to photographic assignments? Reference [38.6.1](#)

38.8.15. Are all photographic chemicals disposed of in compliance with the installation Environmental Management office? Reference [38.7.2](#)

## Chapter 39

### LAUNDRIES AND DRY CLEANING OPERATIONS

**39.1. Specific Requirements.** The purpose of a laundry or dry cleaners is to produce clean garments. Establishments for washing, drying and dry cleaning range from hand laundries to highly mechanized plants. Sanitary or industrial hazards may occur at any point in the process, from delivery of contaminated clothing to the finished product.

39.1.1. All materials to be dry-cleaned shall be searched thoroughly in the receiving room and all foreign materials, especially patches and metallic substances, shall be removed.

39.1.2. Personnel working in the processing area of laundries or dry cleaning plants shall wear clean, washable outer garments in lieu of street clothing.

39.1.3. Personal hygiene shall be stressed. Frequent hand washing, particularly after visiting the toilet or handling soiled linen, is mandatory.

39.1.4. Systems. For the purpose of this standard, dry cleaning plants or systems shall be classified as follows:

39.1.4.1. Type I—Systems employing Class I solvents are prohibited by this standard, e.g., 50° F (10° C) flash point naphtha.

39.1.4.2. Type II—Systems employing Class II solvents, e.g., Stoddard solvent.

39.1.4.3. Type IIIA—Systems employing Class IIIA solvents, e.g., 140° F (60° C) solvent.

39.1.4.4. Type IIIB—Systems employing Class IIIB liquids, e.g., specially compounded oils.

39.1.4.5. Type IV—Systems employing Class IV solvents (non-flammable).

39.1.5. Application. This guideline is for the commercial type laundries and dry cleaning plants used in the Air Force. This standard applies to installation facilities including billeting laundries and laundry facilities in shops/workplaces.

### 39.2. Facility Requirements.

39.2.1. Laundry and dry cleaning premises shall be maintained in a clean and sanitary condition, free from rodents and insect infestations. Refer to **Chapter 5, Housekeeping**, for additional housekeeping guidance.

39.2.2. Floors shall be cleaned daily using a dustless method. Paper and trash shall be placed in covered containers and lint removed from bulk-heads, overheads and structural supports, as necessary.

39.2.3. Slippery floor surfaces or work decks shall be mopped dry or mats provided to minimize slipping hazards. Aisles shall not be cluttered with laundry bags or other materials.

39.2.4. Plumbing fixtures and appliances shall be installed IAW AFI 32-1066, *Backflow Prevention Program*, maintained in good repair and kept in a sanitary condition. These fixtures and appliances shall be connected to prevent backflow into or cross-connections with the facility potable water supply.

39.2.5. Sanitary water fountains shall be provided for drinking water and shall be located away from the industrial process.

39.2.6. Eating, cooking, smoking or storage of food, drinks or smoking material is prohibited in rooms where clothing is handled, sorted, marked, washed or dry cleaned. A separate room or space shall be provided if meals are eaten on the premises.

39.2.7. Laundries and dry cleaning plants shall have separate areas designated for receiving and issue. Unwashed clothes must never be received, sorted, marked or handled in close proximity to washed clothes.

39.2.8. Rooms or spaces shall be designed, and machines and equipment arranged so a separate flow of clean and soiled garments is maintained throughout the laundry or cleaning process. This flow requires separate contact surfaces, such as tables, carts, shelves, etc. Ventilation must move air from clean to soiled areas to prevent cross contamination.

39.2.9. Workrooms associated with laundry and dry cleaning operations where machinery or apparatus emit steam, vapors or heat shall be properly ventilated. Such operations shall have general and/or local exhaust ventilation to minimize personnel exposure to potentially hazardous materials/agents. Clean, tempered replacement (supply) air shall be provided. The ventilation system of all dry cleaning equipment shall be designed to automatically draw air into the machine upon opening the loading door, thus preventing the release of solvent vapors into the work area. Any proposed changes or modifications to the ventilation system shall be coordinated with BE for review. Refer to UFC 3-410-01FA, *Heating, Ventilating, and Air Conditioning*, paragraph 4.17., and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance.

39.2.10. All steam and hot water pipes within seven (7) feet of the floor or working surface shall be insulated with approved (non-asbestos) insulation/lagging and labeled properly with the direction of flow. Backflow preventers shall be installed as required to prevent chemicals from flowing into the sanitary water line.

39.2.11. Adequate lighting levels shall be maintained in all work areas. Refer to 29 CFR 1926.26, *General Safety and Health Provisions, Illumination* and 1926.56, *Illumination*, for additional guidance.

39.2.12. No interlock safeguard, safety appliance or device, attached to or forming an integral part of any machinery, shall be removed or made ineffective except for the purpose of making immediate repairs or adjustments. Any such interlock safeguard, safety appliance or device removed or made ineffective during the repair or adjustment of such machinery shall be replaced immediately upon the completion of such repairs or adjustments.

39.2.13. Automatic safety devices on all equipment shall be clearly identified, properly maintained and shall not be removed or bypassed.

39.2.14. Each washing machine, drying tumbler, shaker or clothes tumbler shall be provided with a means to hold open the doors or covers of inner and outer cylinders or shells while being loaded or unloaded.

39.2.15. Laundry and dry cleaning equipment shall be guarded to prevent worker contact with dangerous parts. Drive shafts, exposed belts and gears shall be enclosed. Refer to **Chapter 18, Machinery**, for additional guidance on machine guarding.

39.2.16. Signs shall be conspicuously posted to warn unauthorized personnel to stay clear of dangerous or restricted areas.

39.2.17. First aid kits shall be provided if the facility is more than 3 or 4 minutes from a medical facility. First aid kits shall be inspected and maintained IAW installation medical facility guidance.

39.2.18. Fire regulations shall be prominently displayed and enforced.

39.2.19. Flammable and combustible liquids shall not be used for cleaning floors.

39.2.20. Vehicles and containers used for transportation and storage of laundry and dry cleaning shall be kept in a clean and sanitary condition.

### **39.3. Supervisors Responsibilities.**

39.3.1. Ensure compliance with occupational safety, fire prevention and health program requirements.

39.3.2. Provide a safe and healthful workplace.

39.3.3. Establish and implement a hazard reporting and abatement program. Conduct a job safety analysis (JSA) for each work task not governed by TO or other applicable directives and when a new work task or process is introduced to the workplace to determine potential hazards. Consult the installation Ground Safety office and BE for assistance with the JSA.

39.3.4. Provide occupational safety, fire prevention and protection, and health training for workers as required by OSH guidelines. Training shall be documented on **AF IMT 55, Employee Safety and Health Record**, or equivalent IAW AFI 91-202, *The US Air Force Mishap Prevention Program*.

39.3.4.1. Workers shall be properly instructed on hazards of their work and in safe practices, by bulletins, printed rules, verbal instructions, CBTs and Safety, Fire and Health On-the-Job Training (OJT) or by normal training programs.

39.3.4.2. Training shall include safety, first aid and use of health controls to include PPE. Refer to **Chapter 14, Personal Protective Equipment (PPE)**, AFI 90-821, *Hazard Communication*, and 29 CFR 1910.151., *Medical Services and First Aid*. Contact BE for an OEH risk assessment.

39.3.5. Ensure only properly trained workers operate laundry/dry cleaning equipment.

39.3.6. Ensure workers who handle soiled clothes are warned not to touch their eyes, mouth or other body parts where the skin has been broken, scratched or abraded. **Caution:** Ensure markers, those who receive articles of clothing for laundry/dry cleaning, do not touch or eat any food until they have thoroughly washed their hands.

39.3.7. Conduct self-inspections of laundries and dry cleaning facilities for hazards or deficiencies at least quarterly. Copies of these inspections shall be maintained on file until the next higher headquarters inspection. Supervisors shall use the requirements of this

chapter, **Figure 39.1** and guidance/information from higher headquarters or other inspections, as applicable, to prepare their self-inspection checklist.

#### **39.4. Safety.**

39.4.1. Appropriate control measures shall be used to ensure airborne concentrations of dry cleaning solvent vapors do not exceed safe levels determined by BE.

39.4.2. Spills of Cleaning Materials or Solvents. The installation Fire Emergency Services (FES) Flight shall be immediately notified of any flammable solvent spills. Cleanup of solvent spills shall be IAW installation spill prevention control and reporting plans. Contact BE and/or Environmental Management office for additional guidance and information on spill procedures.

39.4.3. Machinery producing potentially hazardous noise/vibration levels shall be identified and corrective measures initiated IAW BE's OEH risk assessment. Refer to paragraphs **2.3** and **3.1.2.11** for additional guidance.

39.4.4. Eye protection (chemical splash proof goggles, face shields, etc.) is required where splashes may occur such as replenishment of dry cleaning fluid or the addition of bleaches and detergents. An emergency shower and/or eye wash station shall be provided within the work area. Refer to **Chapter 14, Personal Protective Equipment (PPE)**, and **Chapter 19, Emergency Shower and Eyewash Units**, for additional guidance and information on PPE and eyewash units.

39.4.5. Material Safety Data Sheets (MSDS) shall be maintained in the workcenter for chemicals being used. Workers shall familiarize themselves with the MSDS prior to using the chemical.

#### **39.5. Fire Prevention and Protection.**

39.5.1. Fire Protection (General). Fire extinguishing systems and equipment shall be installed, inspected, tested and maintained IAW **Chapter 6, Fire Protection and Prevention**, NFPA 10, *Standard for Portable Fire Extinguishers*, NFPA 13, *Standard for the Installation of Sprinkler Systems*, and UFC 3-600-01, *Fire Protection Engineering for Facilities*. Refer to the above-mentioned references for additional guidance and detailed information.

39.5.2. Automatic Fire Extinguishing Systems. Automatic fire extinguishing systems shall be periodically inspected, tested and maintained IAW the manufacturers' operation and maintenance manuals, and the installation FES Flight procedures.

39.5.3. Portable Fire Extinguishers. Suitable numbers and types of portable fire extinguishers, as recommended by the installation FES Flight, shall be installed and maintained throughout the dry-cleaning room/facility.

39.5.4. Floors in dry-cleaning rooms shall be of fire-resistant construction with a surface of noncombustible and solvent-resistant surface.

#### **39.6. Storage and Handling.**

39.6.1. All employees shall be informed of the hazards of the solvents and processes employed in the plant and shall be trained in the proper storage, handling, use and disposal of materials and wastes.



39.6.2. Lint and Refuse Removal. Lint and refuse shall be removed from all traps at the end of each day, deposited in approved waste cans, removed from the premises and disposed of safely. Trap covers shall remain securely in place at all other times.

39.6.3. Spill and Leak Prevention. Proper maintenance and operating practices shall be followed to prevent leakage or unintentional escape of solvent or solvent vapors. Where solvent-saturated materials are manually transferred from one piece of equipment to another, operating practices shall be designed to minimize the amount of solvent dripping on the floor.

39.6.4. Hazardous and flammable materials used in laundry and dry cleaning processes shall be stored IAW [Chapter 22](#), *Flammables and Combustibles*.

### **39.7. Hospital/Health Care Facility Laundry.**

39.7.1. The Joint Commission or Accreditation Association for Ambulatory Health Care (AAAH) standards for linen management shall be followed. Proper linen management requires a joint effort of the Infection Control Committee, the Preventive Medicine Service and laundry supervisory personnel. Hospitals/medical facilities using commercial linen services shall establish adequate quality assurance procedures.

39.7.2. The handling of linen in or from hospitals/medical facilities is critical to prevent bacterial contamination from infected patients. The normal laundering process (hot water wash, bleach and ironing) reduces the survival of pathogenic microorganisms. Individual impervious laundry bags shall be used for each area. Linen carts shall be lined with washable material that can be removed and replaced. Linen shall only be sorted in the laundry sorting room. Sorting prior to washing shall be done by trained personnel wearing clean uniforms, masks and gloves. Any sharp objects, such as broken glass, surgical instruments, etc., shall be carefully removed by sorting personnel to prevent injury to personnel or damage to machinery and linen.

39.7.3. Contaminated laundry from isolation rooms, surgical cases, etc., requires special precautions and personnel shall be specifically trained on procedures and potential health implications (i.e., blood borne pathogens, other potentially infectious materials, etc.) of handling contaminated articles. Contaminated linen shall be received in impervious, well sealed double bags. The outer bag shall be labeled with the universal biohazard symbol, the word "Biohazard," or be red in color. The inner bag must be hot water soluble. Contaminated linen shall not be sorted. Follow the latest Centers for Disease Control and Prevention (CDC) guidelines for blood and body fluid exposures to blood borne pathogens as stated in the facility Infection Control Program. Refer to AFI 44-108, *Infection Control Program*, for additional guidance.

**39.8. Laundries and Dry Cleaning Operations Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

39.8.1. Are plumbing and appliances installed IAW AFI 32-1066, *Backflow Prevention Program*? Reference [39.2.4](#)

- 39.8.2. Are signs prominently displayed reminding workers to wash their hands after using toilet facilities? Reference [39.2.6](#)
- 39.8.3. Is ingestion and preparation of food items prohibited in working areas? Reference [39.2.7](#).
- 39.8.4. Are separate areas provided for processing clean and dirty clothing? Reference [39.2.8](#)
- 39.8.5. Is proper ventilation provided to remove hazardous vapors and excess moisture from the facility? Reference [39.2.10](#)
- 39.8.6. Are all machine safety devices in place and properly maintained? Reference [39.2.13](#)
- 39.8.7. Are workers instructed as to the hazards of the work? Reference [39.3.4.1](#)
- 39.8.8. Are workers made aware of the required health/safety controls to include PPE? Reference [39.3.4.2](#)
- 39.8.9. Are workers informed of the hazards of touching their skin after exposure to dirty clothing? Reference [39.3.6](#)
- 39.8.10. Are BE approved hearing protection devices used when engineering and/or administrative controls are not feasible? Reference [39.4.3](#)
- 39.8.11. Are facility fire detection and protection devices in place and operating properly? Reference [39.5.1](#)
- 39.8.12. Are fire detection and protection devices tested on a periodic basis IAW appropriate references? Reference [39.5.1](#)
- 39.8.13. Are floors in dry cleaning rooms fire resistant and covered with solvent resistant materials? Reference [39.5.4](#)
- 39.8.14. Are all lint traps and collection points cleaned at the end of each day? Reference [39.6.2](#)
- 39.8.15. Are hazardous and flammable materials stored IAW [Chapter 22](#) requirements?
- 39.8.16. Is contaminated laundry from a health care facility received in impervious laundry bags? Reference [39.7.2](#)
- 39.8.17. Are workers trained on the special precautions for handling of contaminated articles? Reference [39.7.3](#)

## Chapter 40

### COMPRESSED GASES

#### 40.1. General Requirements.

40.1.1. Applicability. The large amount of stored energy in compressed gas cylinders presents a potential mishap hazard. All workers who store, handle or use such items shall be thoroughly familiar with procedures and safety requirements relating to their use.

40.1.1.1. Workers using compressed gas shall be familiar with the properties and inherent hazards of the products they use. Information pertaining to each specific gas is contained within its product labeling and Material Safety Data Sheet (MSDS). **Note:** Compliance with precautions provided on product labels and MSDSs is mandatory.

40.1.1.2. Refer to the following documents for additional information: 29 CFR 1910 Subpart H, *Hazardous Materials*, 1910.101 *Compressed Gases* (General Requirements), NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, and the *Compressed Gas Association* (CGA).

#### 40.1.2. Responsibilities.

40.1.2.1. Supervisors shall ensure only trained workers handle or use compressed gas cylinders. Supervisors shall ensure valves, hoses, pipes, etc., are compatible with the compressed gases being used and non-compatible with breathing air. **Warning:** Valves, hoses, pipes, etc., used with breathing air will not be interchanged with other compressed gases under any circumstances, even though the parts may be physically compatible.

40.1.2.2. Workers are responsible for the safe use of the container/cylinder and its contents and for returning the container/cylinder to the gas manufacturer or distributor in the same condition as received. The worker shall ensure the cylinder and attached equipment are in proper working condition and any discrepancies are fixed or reported to the supervisor.

#### 40.2. Specific Care and Use.

40.2.1. All cylinders shall be inspected for damage, i.e., dents, gouges, evidence of leakage or cracks before use. Damaged cylinders shall be tagged, "Out of Service," and returned to the manufacturer or distributor. Compressed gas cylinders must be hydrostatically tested every five (5) years. Check the cylinder upon arrival for the test date, usually stamped on the neck of the cylinder. Do not accept a cylinder if the most recent test date is more than five (5) years old. Workers shall store the cylinder with the newest delivery behind older deliveries to ensure cylinders are used in the sequence received.

40.2.1.1. Cylinders shall be hydrostatically tested IAW DoD and Department of Transportation (DOT) regulations. Refer to AFMAN 23-227(I), *Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders*, paragraph 3-3, *Cylinder Re-qualification*, and MIL-STD-1411A, *Department of Defense, Inspection and Maintenance of Compressed Gas Cylinders*, for additional guidance.

40.2.1.2. Each time a cylinder is re-qualified, the date of the test or inspection indicating the month and year shall be stamped into the shoulder, collar or foot ring of the cylinder with a steel stamp. This date is used to determine the next scheduled re-qualification date. The service period for each type of cylinder is considered expired if the latest marked re-qualification date precedes the current date by more than the period indicated in AFMAN23-227(I). Cylinders shall not be accepted or used if the re-qualification date does not meet specifications. **Figure 40.1** is an example of typical cylinder parts and markings, and their locations, that shall be inspected upon receipt of a cylinder.

40.2.2. Workers must know cylinder contents. Do not use a cylinder if you cannot quickly determine its contents either by wording on the cylinder or a tag securely attached to the cylinder. If the tag has become detached or the label defaced, do not use the cylinder. Do not rely on color coding of the cylinder. Different manufacturers use different color codes.

40.2.2.1. US Air Force- or Department of Defense-owned cylinders will be color-coded and contents stenciled on the cylinder IAW MIL-STD-101B, *Color Code for Pipelines and Compressed Gas Cylinders*, as in **Table 40.1** Color codes for commonly used gases will be posted in the cylinder storage area. Two (2) DD Form 1574s, *Serviceable Tag—Materiel*, shall be placed on all cylinders. The first tag is used to identify the contents of the cylinder and the second tag will identify the cylinder. Additionally, the cylinder will carry a DOT identification label and a hazard class label. For commercially filled cylinders, the user is responsible for affixing a three (3) part cylinder status tag (Full, In-use, Empty), which is useful for identifying content status and cylinder inventory. Refer to TO 42B5-1-2, *Use, Handling, and Maintenance Instruction – Storage Type Gas Cylinders*, paragraphs 2.2. and 2.2.a. for additional guidance and information.

40.2.3. Workers shall be aware of the flammability, corrosiveness or oxidation potential as well as the physiological properties, i.e., toxic, anesthetic or irritating, of compressed gases they use or handle.

40.2.4. Handle all cylinders carefully. Careless handling may damage cylinders and valves. Install valve and dust covers when cylinders are not in use. Use cylinders for no purpose other than containing compressed gases; handle them with the same care whether full or empty.

40.2.5. Secure all cylinders, whether in use or in storage, full or empty, by using a chain or other fastening device to a solid fixture (wall, stanchion, etc.) to prevent cylinders from falling over. Non-metallic or synthetic straps may be used to secure non-flammable gases, except oxygen.

40.2.6. Move cylinders safely. Appropriate dollies or hand trucks shall be used to move cylinders weighing more than 50 pounds (see **Figure 40.2**). The cylinder shall be secured to the hand-truck prior to and during movement. Movement by spinning, sliding, rolling, etc., is prohibited. Cylinders less than 50 pounds may be moved without using a dolly or hand-truck. **Note:** Personnel shall be aware of the potential for injury if improper lifting techniques are used when lifting cylinders.

40.2.6.1. Electromagnets or slings shall not be used to move cylinders.

40.2.6.2. Cylinders shall not be moved unless the regulator is removed and the protective cap is in place and securely fastened to the cylinder. (Cylinders secured to a hand-truck, i.e., oxy-acetylene welding torches, are exempt from this requirement as long as regulators and hoses are connected to the cylinders.)

40.2.7. Some gases/cylinders pose problems if placed in a horizontal position. Keep all cylinders in a vertical position at all times, unless the cylinders are designed to work in a horizontal position, i.e., lift truck propane cylinders.

40.2.8. Do not tamper with cylinder valves or any part of a valve, such as a safety nut or stem-packing nut.

40.2.9. Use cylinders only with the appropriate equipment. Do not force connections or use unauthorized adapters. Never use a cylinder without a regulator.

40.2.10. Always close the cylinder valve when the cylinder is not in use or when it is empty. Replace safety covers and dust caps.

40.2.11. Oxygen will support the rapid combustion of most materials. Flammable materials, such as oil, paint or grease, may ignite if exposed to pressurized oxygen gas.

40.2.11.1. Most compressed oxygen is not intended for breathing and shall not be substituted for air used in ventilation systems. Oxygen will not be used as a substitute for compressed air.

40.2.11.2. Never oil or grease an oxygen regulator. If oil or grease is found on an oxygen cylinder or regulator, it must be taken out of service immediately and the cylinder returned to the supplier.

40.2.12. Before attempting to place regulators or other fittings on a cylinder, ensure the threads on the cylinder match those on the fittings. The type of thread, number of threads per inch and the hand of the thread must match to ensure a satisfactory seal. If the fittings are hard to turn, do not force them; instead, check the threads.

40.2.13. Open cylinder valves slowly (cracking) so the gas is not released suddenly into the regulators. Operate valve hand-wheels only by hand. Do not use cheaters or pipes. Cylinders without fixed hand-wheels shall be equipped with keys, handles or nonadjustable wrenches on the valve stems during the time they are in service.

40.2.14. Before removing a regulator from a cylinder, close the control valves and allow the gas to escape from the regulator. Welders shall not leave an area with regulators or lines pressurized.

40.2.15. On oxygen cylinders, do not use a regulator previously used for oil-pumped gases or any combustible gases. Gauges on oxygen regulators shall be marked, "USE NO OIL."

40.2.16. Acetylene is a colorless, flammable gas with a distinctive garlic-like odor. A mixture of this gas with oxygen or air in a confined area will explode on contact with a flame or other ignition source. A pressure-reducing regulator must be used when drawing acetylene from a cylinder. Acetylene delivery pressure shall not exceed 15 psig or 30 psia.

40.2.16.1. Acetylene readily forms explosive compounds with copper, silver and mercury. Avoid contact between acetylene and these metals, their salts, compounds and high-concentration alloys.

40.2.16.2. Acetylene cylinders will never be placed on their sides, or laid down for any reason.

40.2.17. Only cylinders that are in use should be located in the lab or work area. Cylinders shall be secured by a chain or other effective fastening device to a solid fixture (wall, stanchion, etc.) to prevent cylinders from falling over. Spare or empty cylinders shall only be stored in a designated storage area.

40.2.18. Compressed gas cylinders represent a hazard because the gases may be:

40.2.18.1. Flammable. These gases can burn or explode if ignited.

40.2.18.2. Asphyxiants (Inert). Gases that are chemically inactive, but may displace oxygen and cause death.

40.2.18.3. Oxidizers. Oxidizing gases such as compressed oxygen and nitrous oxide do not burn, but support combustion of flammable materials by releasing oxygen or other oxidizing substances. Increasing the concentration of an oxidizer can stimulate and accelerate combustion. Materials that are nonflammable under normal conditions may burn in oxygen-enriched atmospheres.

40.2.18.4. Corrosive. A gas that causes destruction of living tissue by chemical action.

40.2.18.5. Toxic. A gas that may cause illness or death if inhaled, ingested or from skin contact. Refer to 29 CFR 1910.1200., *Hazard Communication*, for additional information.

40.2.18.6. Extremely Cold (Cryogenic). A cryogenic liquid has a boiling point below minus 150° F (minus 65.5° C) at 14.7 psia.

### 40.3. Storage.

40.3.1. All cylinders shall be secured by a metal chain, straps, braces or other restraining devices to a solid fixture (wall, stanchion, etc.) to prevent cylinders from falling over. Synthetic, i.e., nylon, straps shall not be used to secure cylinders of flammable gases or oxygen. While in storage, cylinder valve protection caps shall be firmly in place. Refer to **Figure 40.3** for examples of recommended and not recommended methods for securing cylinders.

40.3.1.1. Doors or gates for gas cylinder supply areas shall be locked.

40.3.1.2. Enclosures for gas supply systems shall not be used for storage purposes other than for cylinders.

40.3.1.3. Cylinders attached to a manifold shall also be secured to solid fixtures to prevent the cylinder from falling over.

40.3.1.4. The enclosure shall be posted as a “No Smoking Area.”

40.3.2. Do not store cylinders in locations where temperatures may exceed 125°F (51.7°C) or near other sources of heat to prevent excessive pressures in the cylinders. Many cylinders have fusible safety plugs that will release the contents when high temperatures or pressures exist in the cylinder.

40.3.2.1. Do not store cylinders where there is danger of accidental damage or in areas where they will be subject to corrosive chemicals. Do not store flammable gases near electrical wires, batteries or other conductors or sources of electricity.

40.3.2.2. Empty cylinders must be plainly marked "EMPTY" and stored in a separate area, segregated, if possible, from full cylinders. When stored together, full and empty cylinders shall be stored so that the older cylinders (old stock) can be removed first with minimum handling of other cylinders (newer stock). Refer to TO 42B5-1-2, *Gas Cylinders (Storage Type) Use, Handling, and Maintenance*, for additional guidance and information.

40.3.2.3. The preferred method of securing compressed gas cylinders is by enclosure within a length of chain firmly anchored at both ends to a solid fixture (wall, stanchion, etc.). An alternative method of securing is with a canvas tank strap securely clamped to an immovable table or bench top. In either case, the anchor points of the chain or strap shall be about 2/3 the way up the tank. Metallic or synthetic, i.e., nylon, straps shall not be used to secure cylinders of flammable gases or oxygen.

40.3.2.4. Cylinders stored in the open shall be adequately protected from extreme heat and cold. Cold weather usually increases the brittleness of the cylinder metal, and if brittle cylinders are handled roughly, they can rupture. Remove accumulated ice or snow to prevent cylinders from rusting.

40.3.2.5. When gas cylinders are stored indoors, ventilate the area to prevent accumulation of flammable or asphyxiating gases in the atmosphere. Cylinders shall not be kept in unventilated enclosures.

40.3.3. Cryogenic cylinders shall be fitted with stainless steel or other suitable plumbing only.

40.3.4. Stored cylinders (either inside or outside) shall not obstruct exit routes or other traffic areas.

40.3.5. All stored cylinders shall have their valves closed. Valve protection caps shall always be in place and hand tight except when cylinders are in use or connected for use. All cylinders shall be stored valve end up.

40.3.6. Oxygen cylinders shall not be stored within 20 feet of combustible material (especially oil and grease), reserve stocks of acetylene, other fuel gas cylinders or near any other substance likely to cause or accelerate fire. The only exception is when oxygen and acetylene cylinders are secured on a welding cart with regulator and hoses attached. If the cart is not used several times a week, the regulators shall be removed and the cylinders properly stored.

40.3.7. Storage facilities shall be prominently labeled/posted with the types of gases being stored. Where gases of different types are stored at the same location, cylinders shall be grouped by type of gas and the groups arranged to take into account the gases contained. Cylinders shall be prominently labeled IAW DOT regulations. Refer to [Figure 40.4](#) for examples of appropriate signage to be used in storage areas.

#### **40.4. Disposal and Shipping.**

40.4.1. Disposal of Compressed Gas Cylinders. Disposal of compressed gas cylinders shall be accomplished IAW AFMAN23-227(I) and DoD 4160.21-M, *Defense Materiel Disposition Manual*. Refer to TO 42B5-1-2, *Use, Handling, and Maintenance Instruction – Storage Type Gas Cylinders*, Section 10.4, *Disposition of Cylinders*, for additional guidance.

40.4.1.1. Non-government owned cylinders shall be returned to the owner. If the owner cannot be determined, cylinders shall be processed IAW DoD 4160.21-M.

40.4.1.2. Cylinders rejected for failure to pass hydrostatic testing or any other reason shall be disposed of as condemned property IAW AFMAN 23-110 after the identification numbers, symbols and cylinder contents have been destroyed.

40.4.1.3. Acetylene cylinders are filled with a porous mass and a solvent that keeps the acetylene in solution. An unserviceable cylinder may retain varying quantities of solvent and gas. Prior to attempting to destroy one of these cylinders, it is important every precaution be taken to de-energize the cylinder.

40.4.2. Prior to shipment, empty cylinders shall be inspected for dents, bulges, oxidation pits or other damage. Faulty cylinders shall be handled as required by the latest DOT regulations and AFMAN 23-227(I). Cylinders shall be shipped IAW the instructions in AFMAN 23-110 and AFMAN 24-204.

40.4.2.1. Ensure cylinders (especially oxygen) will not be contaminated with oil, grease, paint, etc., by the shipper while en route to or from the filling agency.

40.4.2.2. All acetylene cylinders, when classified empty, shall be required to have 5 – 38 psig gage pressure. This requirement prevents ambient air from contaminating the cylinder and allows the cylinder to be shipped at an empty cylinder rate.

**Table 40.1. DoD Color Code for Pipelines and Compressed Gas Cylinders (Data from MIL-STD-101B, *Color Code for Pipelines and Compressed Gas Cylinders*, 3 December 1970).**

<b>DoD Color Code for Pipelines and Compressed Gas Cylinders (Data from MIL-STD-101B, <i>Color Code for Pipelines and Compressed Gas Cylinders</i>, 3 December 1970)</b>				
The following color-code is mandatory for all Department of Defense owned compressed gas cylinders.				
<b>Title</b>	<b>Top “A”</b>	<b>Band “B”</b>	<b>Band “C”</b>	<b>Body</b>
Acetylene	Yellow	Yellow	Yellow	Yellow
Acrolein	Yellow	Brown	Black	Brown
Aerosol Insecticide	Buff	Buff	Buff	Buff
Air, compressed, breathing	Black	Green	Black	Black
Air, dry, special purpose	Black	Green	Black	Black
Air, oil-free	Black	Green	Black	Black
Air, oil-tolerant	Black	Green	Green	Black
Alkyl Decaborane	Yellow	Brown	Brown	Yellow
Alkyl Pentaborane	Yellow	Brown	Brown	Yellow
Ammonia	Brown	Yellow	Orange	Orange
Argon, oil-free	Gray	White	Gray	Gray
Argon, oil-tolerant	Gray	White	White	Gray
Argon-Oxygen Mixture	Gray	Green	White	Gray

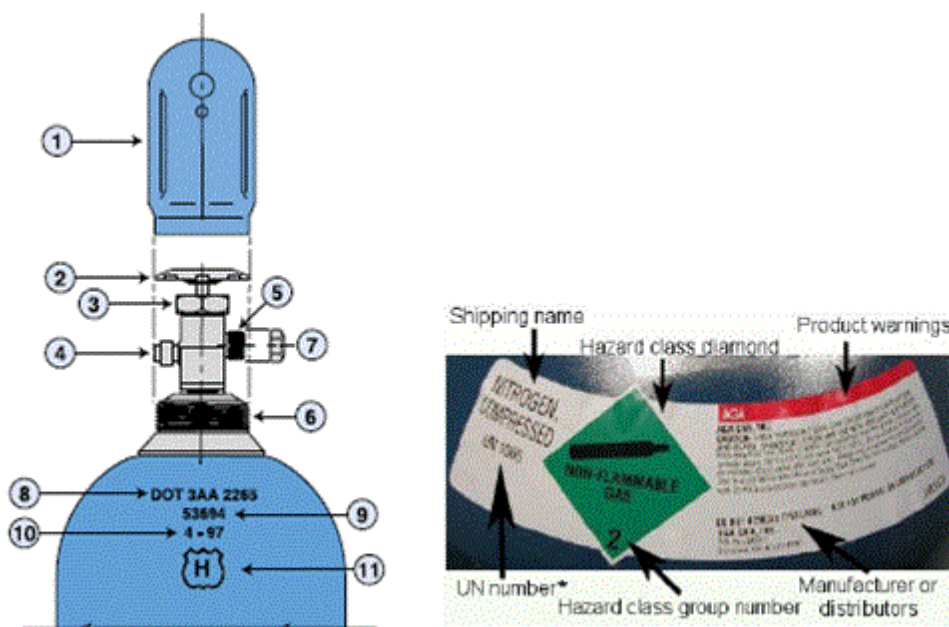


<b>DoD Color Code for Pipelines and Compressed Gas Cylinders (Data from MIL-STD-101B, <i>Color Code for Pipelines and Compressed Gas Cylinders</i>, 3 December 1970)</b>				
The following color-code is mandatory for all Department of Defense owned compressed gas cylinders.				
<b>Title</b>	<b>Top "A"</b>	<b>Band "B"</b>	<b>Band "C"</b>	<b>Body</b>
Boron Trichloride	Gray	Brown	Gray	Brown
Boron Trifluoride	Gray	Brown	Brown	Brown
Bromoacetone	Brown	Black	Black	Brown
Bromochloromethane	Buff	Gray	Buff	Buff
Bromochloromethane (Fire)	Red	Gray	Red	Red
Bromotrifluoromethane	Orange	White	Gray	Orange
Bromotrifluoromethane (Fire)	Red	White	Gray	Red
Butadiene	Yellow	White	Buff	Buff
Carbon Dioxide	Gray	Gray	Gray	Gray
Carbon Dioxide (Fire)	Red	Red	Red	Red
Carbon Monoxide	Yellow	Brown	Brown	Brown
Chloroacetone	Black	Brown	Black	Brown
Chlorine	Brown	Brown	Brown	Brown
Chlorine Trifluoride	Brown	Green	Brown	Brown
Chloropicrin	Brown	Orange	Orange	Brown
Cyanogen	Yellow	Brown	Yellow	Brown
Cyclopropane, medical	Orange	Yellow	Blue	Blue
Diborane	Yellow	Brown	Brown	Yellow
Dibromodifluoromethane	Buff	White	Buff	Buff
Dibromodifluoromethane (Fire)	Red	White	Red	Red
Difluorochloroethane	Gray	Yellow	Yellow	Orange
Difluoroethane	Gray	Yellow	Orange	Orange
Dihydrodetraborane	Yellow	Brown	Brown	Yellow
Dimethylamine, anhydrous	Yellow	Blue	White	Buff
Dimethylether	Yellow	Brown	Buff	Buff
Dispersant, Dichlorodifluoromethane /Difluoroethane Mixture (Halocarbon)	Buff	Gray	Gray	Buff
Ethane	Yellow	Blue	Yellow	Yellow
Ethyl Chloride	Buff	Blue	Yellow	Buff
Ethyl Nitrite	Yellow	Buff	Buff	Buff
Ethylamine, anhydrous	Yellow	Blue	Blue	Buff
Ethylene, Industrial	Blue	Yellow	Buff	Buff
Ethylene, Medical	Yellow	Blue	Blue	Blue
Ethylene Oxide	Yellow	Blue	Buff	Buff
Fluorine	Brown	Green	Green	Brown
Fumigant, Carbon Dioxide/ Ethylene Oxide Mix	Buff	Blue	Buff	Buff
Fumigant, Ethylene Oxide/ Dichlorodifluoromethane Mix	Buff	Buff	Buff	Buff
Helium, oil-free / medical	Buff	Gray	Gray	Gray
Helium, oil-tolerant	Gray	Orange	Gray	Gray
Helium-Oxygen mixture	Buff	White	Green	Green
Hydrogen	Yellow	Black	Yellow	Yellow

<b>DoD Color Code for Pipelines and Compressed Gas Cylinders (Data from MIL-STD-101B, Color Code for Pipelines and Compressed Gas Cylinders, 3 December 1970)</b>				
The following color-code is mandatory for all Department of Defense owned compressed gas cylinders.				
<b>Title</b>	<b>Top "A"</b>	<b>Band "B"</b>	<b>Band "C"</b>	<b>Body</b>
Hydrogen Bromide	Black	Brown	Brown	Brown
Hydrogen Chloride, anhydrous	Brown	White	Brown	Brown
Hydrogen Cyanide, anhydrous	Yellow	Brown	White	Brown
Hydrogen Fluoride, anhydrous	Green	Brown	Brown	Brown
Hydrogen Sulfide	Brown	Yellow	Brown	Brown
Krypton, oil-free	Gray	Buff	Gray	Gray
Krypton, oil-tolerant	Gray	Buff	Buff	Gray
Methane	Yellow	White	Yellow	Yellow
Methyl Acetylene Propadiene (MAPP)	Yellow	Orange	Yellow	Yellow
Methylamine	Yellow	Brown	Yellow	Buff
Methyl Bromide	Brown	Black	Brown	Brown
Methyl Bromide (Fire)	Red	Brown	Red	Red
Methyl Chloride	Yellow	Brown	Orange	Orange
Methyl Mercaptan	Brown	Yellow	Yellow	Brown
Methyl Sulfide	Yellow	Brown	Buff	Brown
Methylene Chloride	Gray	Blue	Orange	Orange
Natural Gas	Yellow	Brown	Yellow	Yellow
Neon, oil-free	White	Buff	Buff	Gray
Neon, oil-tolerant	White	Buff	Gray	Gray
Nickel Carbonyl	Yellow	White	Yellow	Brown
Nitric Oxide	Brown	Buff	Brown	Brown
Nitrogen, Oil-Free	Gray	Black	Black	Gray
Nitrogen, Oil-Tolerant	Gray	Black	Gray	Gray
Nitrogen Dioxide	Brown	Buff	Buff	Brown
Nitrogen-Helium Mixture	Gray	Black	Orange	Gray
Nitrogen-Oxygen Mixture	Black	White	Green	Green
Nitrosyl Chloride	Brown	White	White	Brown
Nitrous Oxide	Blue	Blue	Blue	Blue
Oxygen	Green	Green	Green	Green
Oxygen, Aviator's	Green	White	Green	Green
Oxygen, Electrolytic	Green	White	White	Green
Oxygen, Medical	White	Green	Green	Green
Oxygen - Carbon Dioxide Mix	Gray	White	Green	Green
Oxygen Fluoride	Green	Brown	Green	Brown
Ozone	Brown	Green	Green	Green
Pentaborane, Stable	Yellow	Brown	Brown	Yellow
Petroleum gas: Acetogen, Butane, butane-propane, Isobutane, Isobutylene, Neopentane, Propane	Yellow	Orange	Yellow	Yellow
Phenylcarblamine Chloride	Brown	Gray	Gray	Brown
Phosgene	Brown	Orange	Brown	Brown

<b>DoD Color Code for Pipelines and Compressed Gas Cylinders (Data from MIL-STD-101B, <i>Color Code for Pipelines and Compressed Gas Cylinders</i>, 3 December 1970)</b>				
The following color-code is mandatory for all Department of Defense owned compressed gas cylinders.				
<b>Title</b>	<b>Top "A"</b>	<b>Band "B"</b>	<b>Band "C"</b>	<b>Body</b>
Propylene	Yellow	Gray	Buff	Buff
R-11, Trichlorofluoromethane	Orange	Orange	Orange	Orange
R-12, Dichlorodifluoromethane	Orange	Orange	Orange	Orange
R-13, Chlorotrifluoromethane	Orange	Orange	Orange	Orange
R-22, Chlorodifluoromethane	Orange	Orange	Orange	Orange
R-113, Trichlorotrifluoromethane	Orange	Orange	Orange	Orange
R-114, Dichlorotetrafluoroethane	Orange	Orange	Orange	Orange
R-500, Dichlorodifluoromethane /Difluoroethane Mixture (Halocarbon)	Orange	Orange	Orange	Orange
R-502, Monochlorodifluoromethane	Orange	Orange	Orange	Orange
R-134a, Tetrafluoroethane	Orange	Orange	Orange	Orange
Sulfur Dioxide	Brown	Gray	Brown	Brown
Sulfur Hexafluoride	Gray	White	Black	Gray
Tetrafluoroethylene, inhibited	Buff	White	White	Buff
Trimethylamine	Yellow	Blue	Orange	Buff
Vinyl Bromide	Buff	Blue	Blue	Buff
Vinyl Chloride	Yellow	Orange	Buff	Buff
Vinyl Methyl Ether	Yellow	Black	Buff	Buff
Xenon, oil-free	White	Black	Gray	Gray
Xenon, oil-tolerant	White	Black	Black	Gray

**Figure 40.1. Examples of Typical Cylinder Parts and Markings.**



The cylinder cap (1) protects the cylinder valve. The valve handwheel (2) is used to open and close the cylinder valve. Valves not equipped with handwheels may require special wrenches to operate. The valve packing nut (3) contains a packing gland and packing around the stem.

Packing shall not be tampered with. A pressure relief device (4) permits gas to escape if unsafe pressures occur. The valve outlet connection (5) connects to pressure and/or flow-regulating equipment. Various types of connections are provided to prevent interchange of equipment for incompatible gases, usually identified by CGA (Compressed Gas Association) number; for example, CGA No.350 is used for hydrogen service. A cylinder collar (6) holds the cylinder cap at all times, except when regulating equipment is attached to the cylinder valve. The valve outlet cap (7) protects valve threads from damage and keeps the outlet clean; it is not used universally. Specification number (8) signifies the cylinder conforms to DOT specification DOT-3AA, governing materials of construction, capacities and test procedures, and that the design service pressure for the cylinder is 2265 psig at 70°F. The cylinder serial number is indicated by (9), and (10) indicates the date (month and year: in this case, April 1997) of initial hydrostatic testing. Thereafter, hydrostatic pressure tests are performed on cylinders, for most gases, every five (5) years to determine their fitness for further use. At this time, new test dates are stamped into the shoulder of the cylinder. Present regulations permit a visual test in lieu of hydrostatic tests for low-pressure cylinders for certain gases free of corrosive agents; regulations also allow hydrostatic pressure tests at 10-year intervals for cylinders in high-pressure service for certain gases. The original inspector's insignia for conducting hydrostatic and other required tests to approve the cylinder under DOT specifications is shown by (11).

**Figure 40.2. Examples of Typical Cylinder Hand Trucks.**

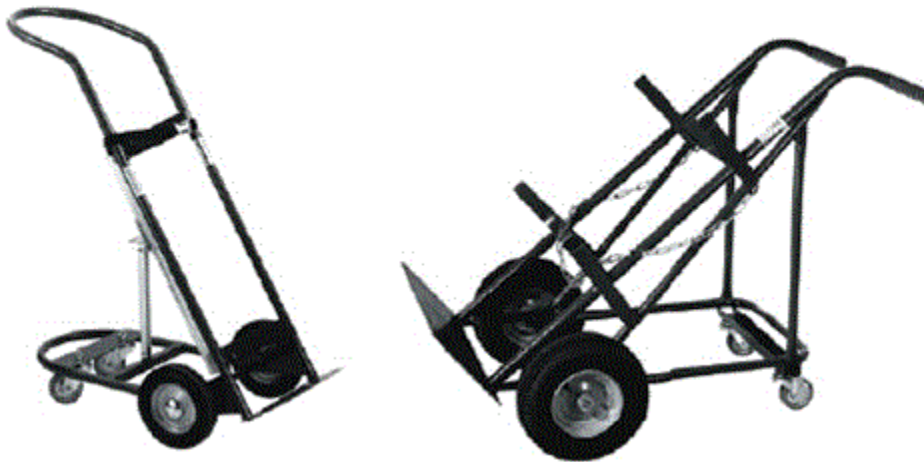


Figure 40.3. Examples of Properly and Improperly Securing Compressed Gas Cylinders.

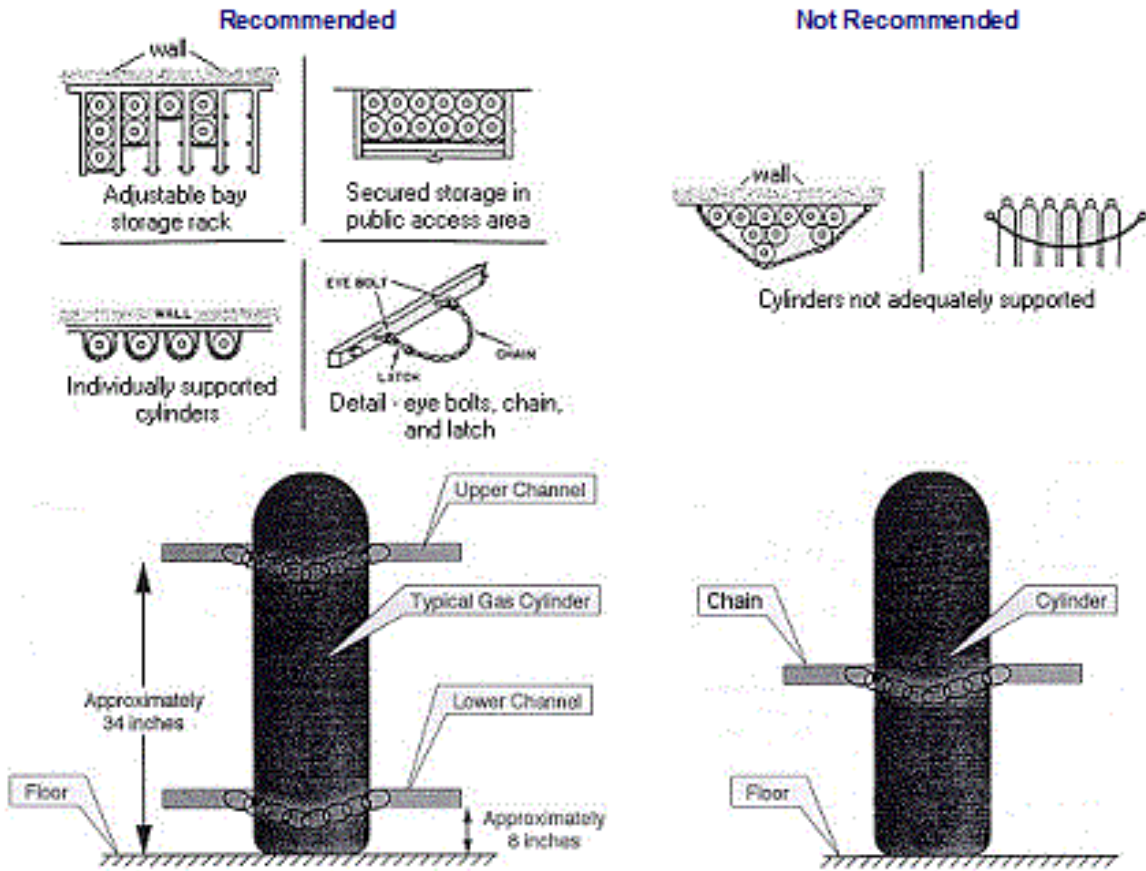





Figure 40.4. Examples of Signage to be Used In/On Cylinder Storage Areas, Workplace Areas and for Transport.

Examples of Signage to be Used In/On Cylinder Storage Areas, Workplace Areas and for Transport		
Gas Type	Characteristics	DOT / DOD Hazard Class Signs
Non-Flammable	Gases that will not fuel a fire or ignite	
Flammable	Gases that can fuel a fire or can ignite when exposed to a spark	

Corrosive	Gases that will corrode unprotected metal or surfaces	 A diamond-shaped hazard label with a black background and white border. It shows two hands being corroded by liquid dripping from test tubes. The word "CORROSIVE" is written in white capital letters at the bottom.
Toxic	Gases that are toxic/poisonous	 A diamond-shaped hazard label with a white background and black border. It features a skull and crossbones symbol at the top. Below the symbol, the words "TOXIC GAS" are written in black capital letters. At the bottom, the number "2" is written in black.
Not Applicable	Combine NFPA® ratings and warning information to alert emergency responders and employees of the hazards associated with a specific material	 A diamond-shaped hazard label divided into four quadrants. The top quadrant is red, the left quadrant is blue, the right quadrant is yellow, and the bottom quadrant is white.

**40.5. Compressed Gases Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

40.5.1. Are only trained workers permitted to handle or use compressed gas cylinders?  
Reference [40.1.2.1](#)

40.5.2. Are cylinders inspected for damage (i.e., dents, gouges, evidence of leakage or cracks) when received and before use? Reference [40.2.1](#)

40.5.3. Have compressed gas cylinders been hydrostatically tested within the last five (5) years? Reference [40.2.1](#)

40.5.4. Are compressed gas cylinders properly handled and secured? Reference [40.2.6](#)

40.5.5. When cylinders are not in use, are they capped and secured to solid fixtures to prevent cylinders from falling over? Reference [40.3.1](#)

40.5.6. When cylinders are attached to a manifold, are they also secured to a solid fixture to prevent cylinders from falling over? Reference [40.3.1.3](#)

40.5.7. Are cylinder enclosures posted as No Smoking Areas? Reference [40.3.1.4](#)

40.5.8. Are cylinders stored in locations where their temperatures will not rise above 125° F? Reference [40.3.2](#)

40.5.9. Are cylinders stored in areas where there is no danger of accidental damage? Reference [40.3.2.1](#)

40.5.10. Have empty cylinders been plainly marked EMPTY and stored separately from full cylinders? Reference [40.3.2.2](#).

40.5.11. When cylinders are stored indoors, are these areas ventilated to prevent accumulation of flammable or asphyxiating gases? Reference [40.3.2.5](#)

40.5.12. Are cryogenic cylinders fitted with only stainless steel or other suitable plumbing? Reference [40.3.3](#)

40.5.13. Do stored cylinders (either indoors or outdoors) obstruct exit routes or other traffic areas? Reference [40.3.4](#)

40.5.14. Are oxygen cylinders stored at least 20 feet from combustible materials (i.e., oil, grease), or near any other substance likely to cause or accelerate fire? Reference [40.3.6](#)

## Chapter 41

### LODGING

#### 41.1. General Requirements.

41.1.1. Training. Lodging facilities vary from base to base. Consequently, the best approach to preventing mishaps is a good local training program, coupled with appropriately marked hazards and warnings. Job safety training is required by AFI 91-202, *The US Air Force Mishap Prevention Program*. Supervisors and workers who handle, use or are potentially exposed to hazardous materials shall be provided information and training on the Air Force Hazard Communication Program (AFHCP) and specific hazards in their work area. This training shall be conducted upon initial work area assignment and whenever a new hazard is introduced into their work area. If workers have already been trained on the hazards of a new material, process, operation or condition, retraining is not required. **Note:** Applicable collective bargaining agreements may also address safety and health training. Refer to AFI 90-821, *Hazard Communication*, and 29 CFR 1910.1200, *Hazard Communications*, for additional guidance and information.

41.1.2. All lodging workers shall receive a thorough indoctrination and orientation on their facilities and work environments. This orientation shall include, as a minimum:

41.1.2.1. Design and layout of the facilities.

41.1.2.2. Ground irregularities adjacent to the facility and walkway or passageway hazards.

41.1.2.3. Facility entrances, fire exits, fire prevention and the location of installed fire protection equipment and fire extinguishers, fire alarms and fire reporting procedures.

41.1.2.4. Proper procedures for use, handling and storage of cleaning materials.

41.1.2.5. Stairwell hazards and proper methods of ascending or descending stairs with loads.

41.1.2.6. Hazards of the job tasks they will do.

41.1.2.7. Hazards of the work areas to include physical and chemical hazards.

41.1.2.8. OSHA and/or AFOSH requirements that apply to their job and workplace.

41.1.2.9. Use and maintenance of required personal protective clothing and equipment.

41.1.2.10. Emergency procedures, including building evacuation procedures.

41.1.2.11. How to identify and report hazards.

41.1.2.12. How to report work-related injuries and illnesses.

41.1.2.13. Worker rights and responsibilities under the AFOSH Program.

41.1.2.14. Proper lifting procedures.

41.1.2.15. Fire Prevention. Most lodging fires are caused by careless use of smoking materials, ignition of combustible materials left in storage areas, ignition of accumulated



grease in kitchens, overheating of appliances left in the “on” position while unattended or use of unauthorized cooking and heating appliances.

#### **41.2. Lodging Facilities.**

41.2.1. General lodging operations present a variety of hazards requiring care and attention of both worker and supervisor to prevent injuries and loss of property. Multi-floor units present hazards inherent in climbing stairs. Other hazards include cleaning equipment left in hallways when adequate storage does not exist, slick floors when cleaning with water and wax mixtures, uneven stairs and sidewalks and natural landscape hazards. Older facilities have high walls and ceilings which may require stretching or the use of ladders. Facilities are usually geographically dispersed from the central office location, which may create problems with snow or ice removal from sidewalks and entrances.

41.2.2. Lodging facilities shall comply with DoD standards, UFC 3-600-01, *Fire Protection Engineering for Facilities*, Air Force directives and NFPA 101, *The Life Safety Code*. The installation CE shall ensure applicable directives are included when contracting for construction of new lodging facilities or renovation of existing facilities.

41.2.2.1. Fire extinguishers shall be installed in lodging facilities. The number, type and location of extinguishers depend upon the size and layout of the facility, the number of floors and whether the facility is equipped with sprinklers. Refer to **Chapter 6, *Fire Protection and Prevention***, for information on installation, inspection, maintenance and hydrostatic testing of portable fire extinguishers.

41.2.2.2. Fire extinguishers shall meet 29 CFR 1910.157, *Portable Fire Extinguishers*, requirements. Extinguishers shall be inspected by management or a designated worker at least monthly to ensure they:

41.2.2.2.1. Are not obstructed or obscured from view.

41.2.2.2.2. Are fully charged and in their designated places along normal paths of travel.

41.2.2.2.3. Have not been tampered with or actuated.

41.2.2.2.4. Do not have corrosion or other impairments.

41.2.2.2.5. Are recharged or repaired as needed to ensure operability and safety.

41.2.2.2.6. Are placed so maximum travel distances, unless there are extremely hazardous conditions, do not exceed 75 feet for Class A fires or 50 feet for Class B fires.

41.2.2.3. All kitchens shall have a dry chemical fire extinguisher or equivalent installed to combat grease or electrical fires.

41.2.2.4. All workers shall be trained in the use of these extinguishers.

41.2.2.5. The building custodian shall ensure correct phone numbers for the installation Fire Emergency Services (FES) Flight, security forces and medical facility are updated monthly and posted on telephones.

41.2.3. Flammable and combustible liquids, when not in use, shall be stored in an approved flammable storage locker. Refer to **Chapter 22**, *Flammables and Combustibles*, for additional guidance.

41.2.4. Exits and Exit Markings. Refer to paragraph **6.3**, 29 CFR 1910, Subpart E, *Means of Egress*, and NFPA 101 for additional guidance and information.

41.2.5. Walking and Working Surfaces, Aisles and Passageways. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, 29 CFR 1910, Subpart D, *Walking—Working Surfaces*, and NFPA 101, for additional requirements and guidance.

41.2.5.1. Every open-sided floor or platform four (4) feet or more above adjacent floor or ground level shall be guarded by a standard railing on all open sides, except where there is an entrance to a ramp, stairway or fixed ladder. The railing shall be provided with a toeboard if personnel walk or work beneath the open sides.

41.2.5.2. Every stairway floor opening shall be guarded on all exposed sides, except the entrance to the stairway.

41.2.5.3. Every ladderway floor opening shall be guarded by a standard railing and toeboard on all sides, with a gateway opening constructed so personnel are prevented from walking directly into the opening, i.e., a floor gate that when opened/lifted, is visible by all.

41.2.5.4. Every runway or ramp shall have railings on all open sides four (4) feet or more above ground or floor level.

41.2.5.5. All passageways and storage areas shall be maintained clean, dry, orderly and in sanitary condition with spills promptly cleaned up and signs posted stating, “Caution Wet Floors,” whenever the floor surface is wet or being cleaned.

41.2.5.6. Every floor, work area, aisle and passageway shall be maintained free from protruding nails, splinters, holes, loose boards and in a dry condition.

41.2.5.7. Non-slip surfaces and handrails shall be provided for ramps with excessive slope. Refer to **Table 7.2** for a consideration of excessive slope.

41.2.5.8. Aisles shall be at least 44 inches wide to permit free movement of workers, equipment and supplies.

41.2.5.9. The following requirements apply to flights of stairs with four or more risers:

41.2.5.9.1. A stair railing is required on each open side.

41.2.5.9.2. If the stairway is less than 44 inches wide and both sides are enclosed, at least one handrail is required, preferably on the right side descending.

41.2.5.9.3. If the stairway is greater than 44 inches wide, a handrail is required on each enclosed side and a handrail on each open side.

41.2.5.9.4. If the stairway is greater than 88 inches wide, an intermediate handrail located midway is required.

41.2.5.10. Riser height and tread width shall be uniform throughout any flight of stairs (plus or minus 1/8-inch tolerance).

41.2.5.11. All treads shall be reasonably slip-resistant and free of projections or lips that could cause a tripping hazard.

41.2.5.12. Vertical clearance above any stair tread to any overhead obstruction shall be at least seven (7) feet, measured from the leading edge of the tread.

41.2.5.13. Sidewalk ramps shall be installed where heavy equipment is used and mechanical lifting and moving equipment is impractical.

41.2.6. Electrical Installation and Equipment. Refer to **Chapter 8**, *Electrical Safety*, NFPA 70, *National Electrical Code*, and NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*, for additional guidance on electrical installation and equipment.

41.2.6.1. Circuit breakers and fuse boxes shall be legibly marked to indicate their purpose.

41.2.6.2. Frames of electrical motors, regardless of voltage, shall be grounded IAW NFPA 70.

41.2.6.3. Wherever wires are joined they shall be covered, such as at outlets, switches, junction boxes, etc. Flexible cords shall not be used as a substitute for fixed wiring, run through holes in walls, ceilings or floors or attached to building surfaces.

41.2.6.4. Equipment connected by flexible cords shall be grounded either by a 3-wire cord or by a separate ground wire. Metal-clad plugs are prohibited unless specifically authorized by the NEC. This paragraph does not apply to double insulated equipment or equipment such as clocks, radios, can openers, etc., which are not normally manufactured with a grounding plug.

41.2.6.5. Splices, joints and the free ends of conductors shall be properly insulated and installed by a qualified electrician. Refer to NFPA 70, Article 400-9, for additional guidance. Power cords frequently placed under tensile stress, e.g., vacuum cleaner cords, shall not be spliced or taped. Cords shall be fastened so there is no pull on joints or screws and shall be replaced when frayed or when insulation has deteriorated.

41.2.6.6. Portable or fixed electrical tools shall function without developing surface temperatures high enough to ignite any flammable and combustible vapors which may be present in the work area.

41.2.6.7. All electrical receptacles (125 volt, single phase, 15- and 20-ampere) installed in bathrooms or any outlet installed to service a countertop surface shall have Ground-Fault Circuit-Interrupter (GFCI) protection.

41.2.7. Machinery, Shop Equipment, Machine Guarding and Power Transmission. Refer to **Chapter 18**, *Machinery*, for additional information on machines.

41.2.7.1. Minor maintenance shops. Buffers, vacuum cleaners and other electrical equipment used in wet areas shall be specifically approved for such use and cords, plugs and grounds inspected before use. Although lodging machinery and appliances, such as buffers and vacuum cleaners, are generally portable and require minimal instructions, all machinery, appliances and other shop equipment shall be maintained and operated only

by qualified workers. A sign stating, "Unauthorized Use of Equipment Not Permitted," shall be posted where personnel can see it.

41.2.7.2. All machines and equipment shall be guarded to protect residents, the operator and other workers from hazards created by the point of operation, rotating parts, flying parts or chips, sparks and power transmission apparatus.

41.2.7.3. The type of operation, size or shape of stock, method of handling stock, physical layout, and type of material and production requirements or limitations shall determine the types of guarding required.

41.2.7.4. Machine guards shall prevent any part of the operator's body from entering a danger zone during the operating cycle of the machine. Guards shall be securely attached to the machine and not installed in a way that creates a hazard. Machines designed for fixed locations shall be securely anchored to prevent "walking" or tipping.

41.2.7.5. Refer to **Chapter 8**, *Electrical Safety*, for machine under-voltage protection requirements.

41.2.7.6. Where mechanical handling equipment such as lift trucks are used, sufficient safe clearance shall be provided for aisles at loading docks, through doorways and passageways. Aisles shall be marked at least two (2) feet wider than the widest vehicle used and obstructions that could create hazards shall not be permitted in aisles.

### **41.3. Specific Applications.**

41.3.1. First aid supplies shall be readily available in housekeeping rooms or offices. They shall be in sanitary containers with individually sealed packages for material such as gauze, bandages and dressings. Other items may include adhesive tape, scissors and mild soap for cleaning wounds or abrasions.

41.3.2. Lifting and Carrying. Many lodging mishaps involve failure to lift or carry objects properly. Physical capabilities of individuals are different and knowing one's limitations and practicing proper lifting and carrying techniques will reduce the possibility of injury. Maintaining good physical health and keeping one's self in good physical condition can reduce the likelihood of injury. Some items are too heavy, bulky or awkward to be carried by hand. Many tasks could be made safer by applying basic ergonomic principles. Mechanical lifting and/or carrying devices shall be used whenever possible. Refer to **Chapter 4**, *Manual Material Handling and Lifting Techniques*, for additional guidance on manual material handling.

41.3.2.1. Supervisors shall ensure personnel receive thorough instruction on proper lifting and carrying techniques and the use of mechanical lifting devices, if available. Contact the installation Ground Safety office or hospital physical therapy unit for additional information on preventing back injuries.

41.3.2.2. Workers shall follow proper lifting procedures:

41.3.2.2.1. Position feet correctly. Place feet far enough apart for balance with one foot to the rear of the object and the other foot slightly ahead of the other and to the side of the object.

41.3.2.2.2. Crouch close to the load. Bend with buttocks resting on the heels of shoes. Stay close to the load to minimize strain on the muscles. Lift with legs and body and keep the back straight.

41.3.2.2.3. Pick up materials with a full palm grip. Do not attempt to pick up materials with only a fingertip grip. Ensure the load is free of grease, which could allow the load to slip, or sharp points, which could cause injury. Use suitable gloves when necessary.

41.3.2.2.4. Always keep the back as straight as possible. It may not be possible to keep the back in the vertical plane, but avoid arching the back. Bend from the hips and not from the middle of the back.

41.3.2.2.5. With the arms, slide the object toward the body to give it some motion (kinetic energy). Simultaneously, use the legs to lift the object and bring the back to a vertical position.

#### 41.3.3. Housekeeping and Material Storage.

41.3.3.1. Falling Objects. Items improperly stacked or stored can fall. Falling debris and flaking paint can get into eyes when janitorial personnel clean items above eye level. Improperly positioned or lifted furniture items can also fall.

41.3.3.2. Visually scan each work area for loose objects lying in piles or in pathways.

41.3.3.3. Place soiled linens on shelves or in bags or containers on the housekeeper's cart. Do not throw these items on the floor.

41.3.3.4. Place carts, vacuums, pails and other housekeeping equipment in an area where customers and employees will not trip or fall over them.

41.3.3.5. Always ensure lamp shades are on lamps. Because light bulbs may be hot, avoid bulb contact with combustible materials. Turn off all appliances and allow them to stop moving and/or cool down before cleaning.

41.3.3.6. Ensure there is no smoking, smoking waste or exposed flames in storage areas.

41.3.3.7. Ensure all hazardous chemical containers are properly labeled to ensure their appropriate use.

#### 41.3.4. Cleaning Rooms, Suites and Other Common Use Areas.

41.3.4.1. Furnishings are generally heavy, bulky and require frequent rearrangements or movement for cleaning. Improper lifting, moving and carrying may cause back strains, abrasions and cuts. When lifting or turning mattresses and beds or moving bulky refrigerators, get sufficient assistance so one individual isn't overstressed. Heavy furniture that must be moved frequently for cleaning shall have rollers or casters installed.

41.3.4.2. Trash receptacles may contain sharp objects, cans or broken glass. Vacuum cleaning bags may also contain sharp objects. If possible, place broken glass or jagged items in a container, other than a plastic bag, or enclose broken pieces in a cardboard or protective shield before placing in a bag. This will reduce the possibility of cuts from

glass protruding from bags. Wear appropriate gloves when picking up glass, jagged metal or potentially injurious trash.

41.3.4.3. Place smoking materials in approved containers rather than mixing with combustible trash. Containers shall be emptied at the end of each duty shift.

41.3.4.4. Check work areas for loose objects lying in pathways.

41.3.4.5. Check for out-of-position furniture or obstacles before entering the room.

41.3.4.6. Do not climb on chairs or other furniture. Use approved ladders and stepstools.

41.3.4.7. Do not allow people to walk or work under overhead fixtures while being cleaned. Refer to **Chapter 14, Personal Protective Equipment (PPE)**, for suitable eye protection from dust and dirt.

41.3.4.8. Cleaning agents can cause skin and eye irritation and respiratory problems if improperly used. All workers shall be informed of the hazards of chemicals used and know the location of MSDS information. Example: Ammonia solution is frequently used as a cleaning agent. Ammonia gas is released from the solution and prolonged exposure to vapors, especially in confined spaces, can be harmful.

#### 41.3.5. Cleaning Bathrooms and Latrines.

41.3.5.1. Ensure the room or area being cleaned is well ventilated. Turn on bathroom ventilating fans, and open doors and windows, as needed.

41.3.5.2. Ensure infrared heat lamps are turned off when working in bathrooms.

41.3.5.3. Ultraviolet (UV) and heat lamps and other appliances shall be turned off and allowed to stop moving and/or cool prior to cleaning.

41.3.5.4. Caustic solutions are often used for cleaning bathroom, latrine, shower and kitchen facilities. Some chemicals, such as drain cleaners, can burn skin or damage eyes. Soaps and detergents may cause dermatitis (skin rash) and throat and respiratory irritation if inhaled.

#### 41.3.6. Cleaning Kitchens.

41.3.6.1. Turn off all appliances and allow them to stop moving and/or cool down before cleaning.

41.3.6.2. Clean grease from burners and ranges to prevent grease fires. Wear eye protection (safety goggles) to prevent foreign material from entering the eyes.

41.3.6.3. Unplug heat producing appliances such as irons and coffee makers when not in use. **Exception:** Commercial coffee urns hard plumbed to the water service and coffee makers/machines with integral timers, i.e., Bunn-type coffee brewers, need not be unplugged at the end of the work day if they are in an occupied/observable space.

41.3.6.4. Clean microwave ovens daily. Disconnect the power source if microwave doors do not latch or are broken so personnel will not be exposed to microwave energy. Place an **AF Form 981, Out of Order Tag**, on it and remove the equipment from service until

repaired. Refer to **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, for additional information.

41.3.6.5. Use gloves to handle or touch burners, chassis and appliance elements that may produce burns or cuts. Refer to **Chapter 14** for additional guidance.

#### 41.3.7. Laundry Rooms and Facilities.

41.3.7.1. Check for gas leaks and immediately ventilate the room if gas is detected. Do not turn on any heat producing or electrical equipment. Evacuate the facility, block the room to preclude entry and call emergency repair service. Also, notify the installation FES Flight.

41.3.7.2. Tag defective equipment and remove from service until repaired.

41.3.7.3. If water exists on the floor near electrically powered machinery or equipment, ensure power is disabled at the power source prior to touching electrical plugs or connections.

41.3.7.4. Ensure dryers are vented to the outside and dryer exhaust pipes are cleaned as needed to prevent buildup of flammable lint.

41.3.7.5. Make sure area is clean and free of spills or debris.

41.3.8. Warehousing. Some housing supply operations require forklift trucks. Refer to **Chapter 35**, *Materials Handling Equipment*, 29 CFR 1910.178, *Powered Industrial Trucks*, and DoD 4145.19-R-1, *Storage and Materials Handling*, for warehousing information.

41.3.8.1. Receiving and Loading Docks. Loading docks can be hazardous. Movement of vehicles and materials in a relatively small area requires care and attention. Uneven matchups between vehicles and docks can pose tripping hazards. Trucks or trailers shall have brakes set, wheels blocked and gear shift placed in park to prevent movement while loading or unloading.

41.3.8.1.1. Loading dock injuries can occur when an individual steps off an open dock or the dock is not the same height as the back of the vehicle. This factor causes workers to jump down (or up) and can cause back or knee sprain or other injuries.

41.3.8.1.2. Safeguard pedestrians at all times. Do not drive a truck up to anyone standing in front of a fixed object. Use a spotter when necessary, i.e., when driving in extremely tight areas or when the operator's vision is obstructed while backing.

41.3.8.2. Use mechanized equipment when appropriate. Refer to **Chapter 35** for additional guidance and information on warehouse equipment.

41.3.8.3. Keep warehouse floors, platforms and ramps clean and in good condition.

41.3.8.4. Ensure workers wear safety-toe shoes, gloves and other PPE as necessary while working in the warehouse or handling material. Watch for projecting nails, jagged hoops, metal bands, ends of wires and splinters when handling materials.

41.3.8.5. Slow down and sound vehicle/lift truck horn at intersections when entering warehouses and in other situations where vision is obstructed. Stop at blind corners. Stop before going through doorways.

41.3.8.6. Avoid overhead objects such as sprinkler heads and electrical fixtures. Protect critical equipment, such as electrical panels, fire equipment and load-supporting columns, with barriers or posts.

41.3.8.7. Never refuel vehicles inside a warehouse or while engine is running.

41.3.8.8. Never walk backwards with a hand truck in a warehouse.

41.3.9. Portable Equipment and Appliances. Lodging equipment includes hand-held electric powered cleaning and buffing equipment, as found in household or commercial establishments. Use only equipment that is double-insulated or has a three-prong grounding plug. Equipment shall be disconnected from its power source prior to removing filters, bags, belts, devices or moving parts. Power cords shall be carefully wound and the equipment returned to its storage area after use. Equipment with frayed or damaged power cords shall be removed from service and tagged until repaired.

41.3.10. Trash Removal. Wear appropriate gloves when picking up glass, jagged metal or potentially injurious trash. Place jagged items in a protective wrapping or solid container. Items placed in a plastic trash bag can pierce the bag and cause injury.

41.3.11. Furniture Repair Operations and Warehouses.

41.3.11.1. Electrical mishaps can occur when appliance plugs are not properly grounded. Frayed cords and broken plugs shall be repaired by a certified electrician to prevent shocks, burns and fires.

41.3.11.2. Equipment and appliances shall be turned off and power disconnected after use or when cleaning belts or doing minor maintenance work.

41.3.11.3. Hand and power tools shall be maintained in safe, useable condition. Refer to [Chapter 12, Hand Tool and Portable Power Tools](#), for guidance on use and care of hand and power tools.

41.3.11.4. Transporting Furniture and Supplies. To avoid vehicle mishaps:

41.3.11.4.1. Use spotters when backing and visibility is limited or impaired, especially in narrow or confining spaces.

41.3.11.4.2. Load for maximum visibility.

41.3.11.4.3. Drive defensively. The bulk of the vehicle can block the vision of pedestrians and vehicles.

41.3.11.4.4. Ensure workers do not ride in the beds of trucks.

41.3.12. Landscape Maintenance.

41.3.12.1. Landscaping or ground maintenance equipment is designed to grind, mulch or cut. This equipment can throw debris (rocks, wire, nails) hidden in the grass and injure bystanders and/or the operator. Mower operators shall turn off the engine and disconnect the spark plug wire (unplug the electrical cord) before attempting to clean out lodged debris or grass clipping from the mower housing. To prevent burns or fires, personnel shall not refuel gasoline powered mowers with the engine running or while the manifold is still hot.



41.3.12.2. Before mowing grass or edging with powered mowers or edgers, visually check areas for loose objects such as rocks, bricks or wire that can be thrown or ejected by mower or edger blades. Always wear protective footwear when operating walk-behind mowers and edgers. The protective footwear shall be safety-toed with slip-resistant soles, meeting ASTM F2413 requirements. **Note:** Protective footwear is required for all mowing and edging operations, including those involving mowers equipped with rear drag plates designed to protect the operator's feet or edgers with nylon filament line cutters.

41.3.12.3. Never operate a power mower without either the entire grass catcher or the guard and/or deflector in place.

41.3.12.4. Ice and Snow Removal. Snow and ice on sidewalks and entryways contribute to slips and falls. Wear protective footwear when walking or working on ice. Use sand, salt or other material to assist in reducing the hazard. Promptly remove snow and ice from all exterior stairs, ramps, exit discharges (doors used for emergency or normal exits) and walkways as soon as possible to prevent melting and refreezing of the walkway. In areas subject to heavy to severe snow/ice conditions, organizations may permit use of removable metallic shoe cleats to improve traction on ice/snow covered surfaces and prevent worker slips and falls. Organizations shall define the type(s) of footwear to be worn, the conditions and locations where such footwear may be worn. Footwear with metallic shoe cleats/spikes/studs shall not be worn inside lodging facilities. Refer to **Chapter 14** for additional guidance.

41.3.13. Insect and Vertebrate Pest Control. Construct, equip and maintain workplaces and personal service areas to prevent entrance of insects and vertebrate pests. Contact the installation CE Pest Management and refer to AFI 32-1053, *Pest Management Program*, for additional guidance and policies on pest control.

41.3.14. Elevators. The lodging supervisor shall ensure elevators in lodging facilities comply with the requirements of ANSI A17.1, *Safety Code for Elevators and Escalators*. Elevators shall be inspected by qualified inspectors IAW ANSI A17.2, *Guide for Inspection of Elevators, Escalators and Moving-Walkways*. Refer to 29 CFR 1926.552, *Material Hoists, Personnel Hoists and Elevators*, for additional guidance.

**41.4. Lodging Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

41.4.1. Are fire extinguishers installed in and around lodging facilities? Reference **41.2.2.1**

41.4.2. Does the building custodian ensure correct phone numbers for the FES Flight, security forces and medical facility are posted on telephones on a monthly basis? Reference **41.2.2.5**

41.4.3. Are all fire exits clearly marked and the path of exit kept clear of equipment and materials? Reference **41.2.4.1**

41.4.4. Are all employees trained in proper evacuation procedures? Reference **41.2.4.1**

- 41.4.5. Are all circuit breakers and fuse boxes legibly marked to indicate their purpose? Reference [41.2.6.1](#)
- 41.4.6. Are machine guards installed so they do not create a hazardous situation? Reference [41.2.7.4](#)
- 41.4.7. Are first aid supplies readily available in housekeeping rooms or offices? Reference [41.3.1](#)
- 41.4.8. Do supervisors ensure personnel receive thorough instruction on proper lifting and carry techniques and the use of mechanical lifting devices? Reference [41.3.2.1](#)
- 41.4.9. Are soiled linens placed on shelves or in bags or containers on the housekeeper's cart? Reference [41.3.3.3](#)
- 41.4.10. Do workers unplug heat producing appliances such as irons and coffee makers when not in use? Reference [41.3.3.5](#)
- 41.4.11. Does heavy furniture that must be moved frequently have rollers or casters installed? Reference [41.3.4.1](#)
- 41.4.12. Is defective equipment tagged and removed from service until repaired? Reference [41.3.7.2](#)
- 41.4.13. Is equipment disconnected from its power source prior to removing filters, bags, belts, devices or moving parts? Reference [41.3.9](#)
- 41.4.14. Does the supervisor ensure workers wear appropriate gloves when picking up glass, jagged metal or potentially injurious trash? Reference [41.3.10](#)
- 41.4.15. Before mowing grass or edging with powered mowers or edgers, does the operator visually check areas for loose objects such as rocks, bricks or wire that can be thrown or ejected by mower or edger blades? Reference [41.3.12.2](#)
- 41.4.16. Does the supervisor ensure snow and ice is removed from all exterior stairs, ramps, exit discharges and paths, sidewalks and other walkways? Reference [41.3.12.4](#)
- 41.4.17. Are enclosed workplaces and personal service rooms constructed, equipped and maintained to prevent the entrance of rodents, insects and vermin? Reference [41.3.13](#)

## Chapter 42

### NDI AND OIL ANALYSIS

**42.1. General Information.** Personal Protective Equipment (PPE) shall be provided for Nondestructive Inspection (NDI) personnel IAW **Chapter 14**, *Personal Protective Equipment (PPE)*, requirements. PPE shall be kept clean, and if not individually issued, shall be prominently displayed and/or stored in the immediate vicinity where its use is required. Particular attention shall be given to keeping the insides of gloves clean and dry. Where a requirement for respirators has been established IAW AFOSH Standard 48-137, *Respiratory Protection Program*, they shall be individually issued and have a respiratory protection program in place. The NDI supervisor shall ensure all personnel are trained in the proper care and use of PPE and shall enforce its proper use. Refer to **Chapter 14** for additional guidance and information.

#### **42.2. General Requirements.**

42.2.1. Compressed Gases. Compressed gases commonly used in nondestructive inspection (NDI) and/or oil analysis program (OAP) laboratories are nitrous oxide, acetylene and sulfur hexafluoride. Care and attention must be given to handling, storage, marking and disposition of all compressed gas cylinders. Personnel working with compressed gases and gas cylinders shall be trained and have a thorough knowledge of compressed gas characteristics, cylinders, valves, markings and, at least, a thorough comprehension of applicable parts of TO 42B5-1-2, *Gas Cylinders, Use, Handling, and Storage*.

42.2.1.1. Sulfur hexafluoride (SF<sub>6</sub>) is a colorless, odorless, nontoxic, nonflammable gas. In high concentrations, it can cause asphyxiation by displacing oxygen. To preclude asphyxiation, do not release large quantities of the gas in unvented work areas. SF<sub>6</sub> exists in most X-ray tube heads. SF<sub>6</sub> leakage during normal X-ray tube repair does not pose an asphyxiation hazard. However, when heated, SF<sub>6</sub> liberates hazardous fluorine gas. Precautions must be taken to guard against inhalation of SF<sub>6</sub> released from energized or hot X-ray tubes.

42.2.1.2. Compressed Air. Compressed air, especially at high pressures, can cause personal injury, such as propelling foreign particles into workers' eyes. Compressed air used for cleaning shall be reduced to less than 30-psig and used with effective chip guarding and PPE. Refer to **Chapter 40**, *Compressed Gases*, for additional guidance.

42.2.2. Housekeeping. Good housekeeping is essential to safe operations in the NDI and OAP laboratories. All work and storage areas shall be kept clean. Equipment and materials shall be stored in a proper and orderly manner. Floors shall be free of spilled liquids to minimize slips and falls. Refer to **Chapter 5**, *Housekeeping*, for additional guidance.

42.2.3. Ventilation Systems. Only basic guidelines for NDI and/or OAP laboratory ventilation are provided in this standard. For more details on permissible exposure limits, flow rate requirements and design criteria, refer to UFC 4-024-01, *Security Engineering: Procedures for Designing Airborne Chemical, Biological, and Radiological Protection for Buildings*, ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*. Ventilation for OAP spectrometers shall also comply with TO and

manufacturer's requirements. Refer to BE's OEH risk assessment and paragraph 2.3 for additional guidance.

42.2.3.1. Ventilation fans shall run for a sufficient time after a job is complete to minimize residual vapors. Adequate makeup air shall be provided so that exhaust air is replaced. Surface area exhaust ventilation evaluations shall be conducted at least annually.

42.2.3.2. As a minimum, areas that may require an evaluation for adequate ventilation include cleaning areas, penetrant tanks, remover tanks, penetrant inspection viewing booths, stationary magnetic particle units, film processing rooms and the OAP work area. Ventilation evaluation frequency is determined by BE in the OEH risk assessment.

#### 42.2.4. Occupational Health.

42.2.4.1. Hazardous Chemicals. Chemical and petroleum products used in NDI and OAP may cause respiratory irritation, skin irritation or dermatitis. Adequate ventilation, respiratory protection and PPE shall be provided when required by Air Force directives or when specified by the installation Ground Safety office or BE. Where the eyes or body parts may be exposed to injurious corrosive materials, a suitable emergency shower and eyewash unit for quick drenching or flushing of the eyes or body shall be provided. If personnel are exposed to an eye irritant, a portable eye wash that provides 15 minutes continuous flow may be used in place of a plumbed eye wash. Medical attention shall be obtained as soon as practical after adequate flushing and/or drenching of the eyes and/or body. Refer to [Chapter 19](#), *Emergency Shower and Eyewash Units*, for guidelines on plumbed emergency showers and eye wash stations.

42.2.4.2. Ultraviolet Radiation (UV). Electric arc and the mercury vapor lamps in oil analysis instruments can emit harmful ultraviolet radiation. Light shields provided in the instrument shall be used. UV black lights used in penetrant and magnetic particle inspection shall be checked for cracked lenses and filters prior to use. Battery powered black lights shall only be used when it is impossible to use a 110/220 volt powered light. TO 33B-1-1, *Nondestructive Inspection Methods, Basic Theory*, gives detailed instructions for testing of black lights. **Warning:** Unfiltered UV can be harmful to the eyes and skin. Black light bulbs shall not be operated without proper lenses and/or filters. Cracked, chipped or ill-fitting lenses and/or filters shall be replaced before using the lamp. Prolonged direct exposure of hands to the filtered black light main beam may be harmful. White cotton glove liners or other suitable gloves shall be worn when exposing hands to the main beam. UV-A filtering safety glasses shall also be worn. Some black light bulbs reach temperatures of 750°F (399°C). **Warning:** Black lights can severely burn hands, arms, face or other exposed body areas and ignite fuel vapors. Black lights shall not be operated when flammable vapors are present.

42.2.4.3. Ionizing Radiation. Personnel who may be exposed to ionizing radiation during the normal course of their duties shall wear personal radiation monitoring devices. These devices shall be individually issued and worn IAW guidance provided by BE and TO 33B-1-1, Chapter 6. Exposure levels at shielded and/or unshielded operating locations (X-ray machine control station) and areas accessible to non-monitored personnel are continuously monitored during each operation with survey meters to determine ionizing

radiation levels. Refer to OSHA 1910.1096, *Ionizing Radiation*, and AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, for additional guidance and information on ionizing radiation operations.

42.2.4.4. Most X-ray equipment is designed to minimize the danger of direct or stray radiation. Excessive X-ray or gamma radiation exposure is harmful, and failure to comply with safety procedures may result in serious injury to personnel. Coordinate initial operational and structural designs, and all changes, with the installation Radiation Safety Officer (usually the BE or assigned to BE). Refer to TO 33B-1-1, paragraph 6.8., for additional guidance and information on radiation protection requirements.

42.2.4.5. Air and Water Pollution. Petroleum products and film processing chemicals shall be disposed of IAW AFI 32-7042, *Waste Management*, AFI 32-7080, *Pollution Prevention Program*, AFPAM 32-7043, *Hazardous Waste Management Guide*, and the installation Environmental Management office.

42.2.4.6. Supervisors shall contact the installation Ground Safety and Environmental Management offices, and BE to help evaluate new chemicals, machines or processes prior to introduction into the work area. Once evaluated, supervisors shall brief personnel according to AFI 91-202, *The US Air Force Mishap Prevention Program*.

42.2.4.7. Precautions with eyewear. Personnel who wear contact lenses shall identify this to their supervisor and refer to the appropriate MSDS for possible hazards involved in wearing contact lenses around chemicals. Photo-chromatic lenses (lenses that darken when exposed to sunlight or ultraviolet light), sunglasses and colored contacts reduce the visibility of fluorescent indications and may prevent an inspector from seeing faint indications. Therefore, such lenses shall not be worn when performing fluorescent penetrant or fluorescent magnetic particle inspections.

#### 42.2.5. Fire Prevention.

42.2.5.1. Storage, use and handling of flammable and combustible liquids shall be IAW **Chapter 22**, *Flammables and Combustibles*, and in coordination with the installation Fire Emergency Services (FES) Flight.

42.2.5.2. Supervisors shall ensure that:

42.2.5.2.1. Personnel are trained on the location, selection and use of fire extinguishers, alarm systems and evacuation procedures IAW procedures in **Chapter 6**, *Fire Protection and Prevention*.

42.2.5.2.2. Fire extinguishers shall be securely mounted, readily accessible, in a serviceable condition and clearly visible. Directional arrows shall be provided to indicate the location of extinguishers that are obstructed to the sight and the arrow shall be marked with the extinguisher classification. Refer to UFC 3-120-01, *Air Force Sign Standard*, for additional information and contact the installation FES Flight when deficiencies exist.

42.2.5.2.3. All fire exits shall be kept unlocked and easily accessible at all times when the area is occupied.

42.2.5.3. Operations using petroleum solvents and removers for cleaning are carefully evaluated for fire and health hazards.

- 42.2.5.3.1. Penetrants. Petroleum-based penetrants are combustible and have a flashpoint of approximately 175° F.
- 42.2.5.3.2. Developers. Non-aqueous developers are flammable and may have a flashpoint as low as 50° F.
- 42.2.5.3.3. Solvents and Removers. Deodorized kerosene and PD680 Type II are combustible petroleum distillates with flashpoints of approximately 140° F. These shall be handled carefully and kept away from heat and open flames.
- 42.2.5.3.4. Storage. Penetrants, deodorized kerosene, PD680 Type II, aerosol cans of penetrants, removers and magnetic particle baths are combustible and/or flammable materials and shall be stored IAW **Chapter 22**.
- 42.2.5.4. Housekeeping. Soiled rags, paper towels, craft paper and other trash contaminated with oil or grease shall be placed in self-closing metal containers plainly marked to indicate contents. At the end of each shift, these containers will be emptied or placed in an approved location outside the shop for pickup or disposal IAW guidance from the installation Environmental Management office. Clean rags shall be kept in covered metal containers.
- 42.2.6. Electrical Safety. NDI equipment to be used in hazardous areas shall meet TO 1-1-688, *Use of Electronic Equipment in Hazardous Areas*, and NFPA 70, *National Electrical Code*, requirements.

### **42.3. NDI Specific Requirements.**

- 42.3.1. Penetrant Inspection. The following are minimum safety and PPE requirements:
- 42.3.1.1. Provide adequate ventilation when penetrant inspection is performed. Consult BE's OEH risk assessment to determine if respiratory protection is required. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraph **2.3** and **Chapter 14** for additional guidance.
- 42.3.1.2. Continuous contact with penetrant materials may cause skin irritation and remove natural body oils. When handling penetrant materials, wear appropriate gloves, i.e., nitrile, neoprene or other gloves approved by BE, and keep insides of gloves clean. Wash exposed skin with soap and water. Do not allow cleaners and removers to come in direct contact with the skin.
- 42.3.1.3. Wear appropriate eye protection, apron and gloves when spraying penetrant or processing parts in tanks. Contact BE for an OEH risk assessment. Refer to paragraph **2.3** and **Chapter 14** for additional guidance on PPE requirements.
- 42.3.1.4. Avoid exposing pressurized spray cans to excessive heat or open flames. Temperatures in excess of 120° F may cause the can to burst with possible injury to personnel.
- 42.3.1.5. Store penetrant materials in cool dry areas protected from direct sunlight.
- 42.3.1.6. Place properly rated electric insulating floor matting on the floor in front of the penetrant line to reduce electrical and slipping hazards. This matting shall extend at least 24 inches past each end of the penetrant line IAW TO 33B-1-1, paragraph 2.8.5.

42.3.1.7. Do not lay hot black lights on combustible surfaces. Provide brackets or hangers in the area of black light use.

42.3.1.8. Because of electrical hazards when washing parts, ensure workers do not handle black lights at the penetrant rinse station. When practical, permanently mount black lights at the wash station.

42.3.2. Magnetic Particle Inspection. Magnetic particle inspection hazards include exposure to oils, pastes and electrical current. The following safety requirements shall be observed:

42.3.2.1. Rubber insulating floor matting, rated for the voltage of the equipment being worked on, shall be placed in front of magnetic particle units and shall be replaced when worn to one-half original thickness (approximately 1/8 inch). Matting shall be in one continuous length and extend at least 24 inches past the ends of the equipment IAW TO 33B-1-1, paragraph 3.8.3.

42.3.2.2. Arcing from poor contact between the heads of the stationary magnetic particle machine or excessive magnetizing current may injure the eyes or cause ignition of combustible particle baths. Ensure good electrical contact between the heads and the inspected part to prevent these hazards.

42.3.2.3. Use care when handling articles placed between the heads of a magnetizing unit to prevent hand injuries.

42.3.2.4. Since nontoxic, continuous exposure to oils and pastes in the wet bath method may cause dermatitis or cracking of the skin, appropriate protective gloves shall be used.

42.3.2.5. The following minimum safety requirements apply when using a magnetic particle suspension oil with a flashpoint less than 200° F in a Type II stationary magnetic particle machine:

42.3.2.5.1. Provide an adequate surface area exhaust ventilation system as determined by BE's OEH risk assessment. Refer to paragraph 2.3 for additional guidance.

42.3.2.5.2. Maintain less than 25 gallons of liquid suspension in the tank.

42.3.2.5.3. Cover the oil with a screened drain board.

42.3.2.5.4. Provide a portable fire extinguisher, sufficient in size and/or volume to suppress any fire which may occur from the oil. The fire extinguisher size and/or volume shall be determined by the installation FES Flight.

42.3.2.6. Prods are handheld electrodes attached to cables to transmit the magnetizing current from the source to the item being inspected. Prods shall not be used on aircraft parts or in any hazardous area.

42.3.3. Eddy Current and Ultrasonic Inspection. Eddy current and ultrasonic equipment can be used in and around aircraft provided the following electrical safety guidelines are followed:

42.3.3.1. Exercise care when performing maintenance on or around the cathode-ray tube (CRT) as a violent implosion can occur if the CRT is broken.

42.3.3.2. Ensure the CRT is electrically discharged IAW applicable TO or manufacturer's technical manuals prior to performing any maintenance on the equipment.

42.3.3.3. An extreme hazard exists if eddy current and ultrasonic equipment are used improperly in hazardous areas. **Caution:** An eddy current test generates an electrical charge which, in a volatile atmosphere, could result in an explosion.

42.3.4. Radiographic Inspection. This section covers minimum essential safety requirements for industrial radiography. Refer to TO 33B-1-1, *Nondestructive Inspection Methods, Basic Theory*, for more detailed coverage of radiographic inspection procedures and radiation protection standards, inspection requirements, equipment selection and operational procedures.

42.3.4.1. Supervisors will:

42.3.4.1.1. Maintain storage and operational control of all industrial radiographic equipment.

42.3.4.1.2. Provide personal dosimeter for individuals who may be exposed to ionizing radiation during their duties. Refer to AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, TO 33B-1-1, and BE for instructions on issue and wear of monitoring devices.

42.3.4.1.3. Procure and maintain adequate radiation survey instruments and establish a survey instrument calibration program.

42.3.4.1.4. Maintain exposure devices, radiographic facilities, radiation warning signs and associated safety equipment.

42.3.4.1.5. Maintain utilization logs as required by TO 33B-1-1.

42.3.4.1.6. Keep a copy of the latest radiation protection survey report performed by BE or the United States Air Force School of Aerospace Medicine (USAFSAM) and ensure corrective actions are taken and documented on all report recommendations.

42.3.4.1.7. Use the full length of control cables and coolant hoses to keep cooler and control unit as far away from the X-ray tube as possible.

42.3.4.1.8. If working from ground level, in an enclosure, elevate the X-ray control and cooler on a secure frame or maintenance stand at least 18 inches above ground.

42.3.4.2. Qualification of Industrial Radiographers. All industrial radiographers shall complete an Air Force-approved course on use of industrial X-ray equipment, including radiation hazard control, and demonstrate an understanding of approved radiographic practice. Qualification of radiographers shall be through the US Air Force Nondestructive Inspection Course, or through equivalent training courses conducted by industry or civilian institutions. The AF NDI Program Office, Tinker AFB, Oklahoma, shall approve training if non-US Air Force courses will be substituted for Air Education and Training Command courses.

42.3.4.3. Radiation Protection Surveys for Shielded Installations.



42.3.4.3.1. A radiation protection survey of all new installations and existing installations not previously surveyed shall be made by a health physicist or a qualified bioenvironmental engineer before the installation is placed in routine operation. The installation shall be inspected to verify the safety of workers in adjacent areas, the operation for audible or visible warning signals, interlocks, mechanical or electrical restrictions for positioning of the radiation source, delay switches, and other devices that have a bearing on radiation protection as required in TO 33B-1-1, and manufacturer's instructions.

42.3.4.3.2. A re-survey or evaluation by a health physicist or qualified bioenvironmental engineer shall be conducted annually or when changes are made in shielding, operation, workload, equipment or occupancy of adjacent areas which may have compromised radiation protection. If supplementary shielding is installed as a result of a radiation protection survey, another survey shall be made to confirm the adequacy of the shielding after the modification. Radiation exposure measurements shall be made in all adjacent areas that can be occupied. The measurements shall be made under practical conditions of operation which produce the greatest exposure at the point of interest, i.e., X-ray apparatus shall be operated at the maximum kilovoltage and at its maximum milliamperage for continuous operation. When evaluating the survey results, consideration shall be given to actual operating conditions, including workload, use factors, occupancy factors and any attenuation provided by objects permanently in the path of the useful beam.

42.3.4.3.3. All interlocks, safety and warning devices, remote monitoring systems, etc., shall be inspected for proper operation.

42.3.4.3.4. A qualified industrial radiographer will establish a perimeter for unshielded installations each time portable equipment is used in open areas to ensure exposures are adequately controlled.

42.3.4.3.5. When radiography requires the use of an industrial radiographer and radiation monitors, the X-ray machine controls shall be placed so all monitors of the entire perimeter of the barrier can be seen or heard by the radiographer. If this is not possible, adequate means of communications may include two-way radios, whistles, electronic/propellant-activated noise alarms or ultrasonic infrared intrusion barriers, but need not be limited to these methods.

42.3.4.4. Radiation Protection Standards. AFMAN 48-125, AFI 48-148 and TO 33B-1-1, Chapter 6, Section 8, are the basic radiation protection standards and shall be maintained in the NDI office at all times.

42.3.4.5. Calibration and Use of Radiation Survey Instruments. During radiographic operations, at least two operable, calibrated survey instruments shall be used during unshielded radiographic operations and one during shielded operations. These instruments shall have an adequate instrument response for the range of radiation energies encountered.

42.3.4.6. Personnel Monitoring Requirements. A personal monitoring device (film badge or thermoluminescent dosimeter [TLD]) shall be worn by all industrial radiographers

during all radiographic operations. A personal monitoring device shall be assigned to and worn by only one person as required by AFMAN 48-125.

42.3.4.7. Classification of Installations. Radiographic installations are classified as shielded and unshielded.

**42.4. Oil Analysis Program (OAP) Specific Requirements.** Hazards present during oil analysis operations include exposure to acids, electric current and petroleum distillates.

42.4.1. Skin contact with cleaners and solvents shall be avoided. Workers shall use BE-approved impervious gloves when handling trichloroethane. Mechanical ventilation shall be provided when cleaning sample vessels IAW the requirements in the BE OEH risk assessment and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*.

42.4.2. Personnel performing spectrometer maintenance with power applied shall be thoroughly familiar with safety and grounding procedures in the TO and manufacturer's maintenance manual. A safety observer shall be present when power-on maintenance is performed.

42.4.3. Waste oil and cleaning rags shall not be allowed to accumulate in the OAP lab. Waste oil, not to exceed five (5) gallons, may be stored in the lab in an approved self-closing metal waste container. Waste cleaning rags and towels shall be removed from the lab at the end of each shift.

42.4.4. Hot electrodes and sample vessels used in the atomic emission spectrometer can burn hands. Used electrodes shall be removed with a folded tissue or towel. Tongs shall be used to remove overheated sample vessels.

42.4.5. To prevent eye damage from UV radiation, light from spectrometers or other analysis equipment shall not be viewed with the naked eye. Light shields and filters in the instrument shall be used.

**42.5. Aircraft Maintenance NDI Operations.** Personnel performing NDI operations on aircraft shall be familiar with general aircraft safety procedures and safety procedures associated with NDI. The major sources of aircraft maintenance accidents are falls, strains from lifting, fire or explosion, electrical shock, crushing of body or limbs in moving components and walking into protruding objects. NDI maintenance personnel working on aircraft shall be familiar with the hazards of the aircraft they work on. Refer to applicable aircraft technical orders for additional guidance and information.

**42.6. NDI Equipment and Fire Protection Systems.** Contact the installation FES Flight prior to operating equipment which utilizes black lights, X-rays, UV and/or infrared rays. Some fire suppression systems are actuated by UV or infrared detectors and must be disabled, or other management actions taken, prior to using this NDI equipment to preclude actuation of the fire suppression systems.

**42.7. NDI and Oil Analysis Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs,

DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

42.7.1. If there is a respiratory protection program in place, does it meet the requirements of AFOSH Standard 48-137? Reference [42.1](#)

42.7.2. Do workers receive, as a minimum, training consistent with a thorough comprehension of the applicable parts of TO 42B5-1-2? Reference [42.2.1](#)

42.7.3. Does the ventilation system meet requirements of UFC 4-024-01, ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance* and AFMAN 48-155? Reference [42.2.3](#)

42.7.4. Does BE perform an annual surface area exhaust ventilation evaluation? Reference [42.2.3.1](#)

42.7.5. Is a suitable emergency shower and eyewash unit provided within the work area for quick drenching or flushing of the eyes or body where workers are exposed to hazardous materials? Reference [42.2.4.1](#)

42.7.6. Are UV black lights used in penetrant and magnetic particle inspection checked prior to use for cracked filters and lenses? Reference [42.2.4.2](#)

42.7.7. Do personnel who may be exposed to ionizing radiation during their duties or occupation wear personal radiation monitoring devices? Reference [42.2.4.3](#)

42.7.8. Are petroleum products and film processing chemicals disposed of IAW AFI 32-7042, AFI 32-7080, AFPAM 32-7043 and the installation Environmental Management office? Reference [42.2.4.5](#)

42.7.9. Do supervisors contact the installation Ground Safety and Environmental offices, and BE when new chemicals, machines or processes are introduced into the work area? Reference [42.2.4.6](#)

42.7.10. Is the storage, use and handling of flammable and combustible liquids coordinated with the installation FES Flight? Reference [42.2.5.1](#)

42.7.11. Are all workers trained on the location, selection and use of fire extinguishers, alarm systems and evacuation procedures IAW [Chapter 6, Fire Protection and Prevention](#)? Reference [42.2.5.2.1](#)

42.7.12. Does all NDI equipment used in hazardous areas meet TO 1-1-688, *Use of Electronic Equipment in Hazardous Areas*, and NFPA 70, *National Electrical Code*, requirements? Reference [42.2.6](#)

42.7.13. Have all industrial radiographers completed an Air Force-approved course of instruction in the use of industrial X-ray equipment, including radiation hazard control? Reference [42.3.4.2](#)

42.7.14. Are all waste cleaning rags and towels removed from the lab at the end of each shift? Reference [42.4.3](#)

## Chapter 43

### LIQUID NITROGEN (LN<sub>2</sub>), OXYGEN (LOX) AND CRYOGENS

#### 43.1. Specific Hazards.

##### 43.1.1. Physical Hazards.

43.1.1.1. Liquid nitrogen (LN<sub>2</sub>) or liquid oxygen (LOX) hazards are primarily associated with phase change and low temperature effects of cryogenics. A tremendous volume increase occurs when either liquid undergoes a phase change from liquid to gas. When LN<sub>2</sub> vaporizes, each cubic foot of liquid expands to 695 cubic feet of nitrogen gas. For LOX, the expansion ratio is 860 to 1. Containment of cryogenics may create a tremendous pressure increase if liquid to gas conversion occurs, so a sealed container can become a bomb. Expansion ratio of LN<sub>2</sub> can displace oxygen in a confined space, causing an asphyxiation hazard. Expansion of LOX can cause oxygen enrichment, producing fire and explosion hazards. See paragraph 43.1.3 for additional information.

43.1.1.2. The cold temperature of LN<sub>2</sub> (-320° F) and LOX (-297° F) can alter the strength, ductility, thermal expansion, thermal conductivity and heat capacity of materials. Mild carbon steels become brittle and failure-prone when exposed to cryogenics. However, properly treated metals such as austenitic steels, nickel, aluminum, copper and a number of alloys are safe for low temperature work.

43.1.1.3. LN<sub>2</sub> can liquefy oxygen from the air it contacts. Therefore, an open container of LN<sub>2</sub> will slowly condense air causing a LOX concentration buildup within the LN<sub>2</sub>. The presence of LOX within LN<sub>2</sub> can cause unexpected chemical reactions with other materials. See paragraphs 43.1.3 and 43.1.4 for additional information on LOX reactivity with chemicals.

##### 43.1.2. Physiological Hazards.

43.1.2.1. Evaporation of LN<sub>2</sub> in a poorly ventilated or unventilated enclosure may reduce the oxygen content of the air and produce asphyxiation and death. Because the brain requires the most oxygen, a reduction in available oxygen will first affect the mental processes. A slight impairment of the ability to concentrate and think clearly is an early symptom, which then progresses to a loss of consciousness. Unconsciousness can occur in seconds in atmospheres with very high concentrations of nitrogen. Recovery in fresh air is rapid and complete if exposure to high concentrations of nitrogen is short. Prolonged exposure can cause death.

43.1.2.2. The extremely cold temperature of LN<sub>2</sub> and LOX can freeze or seriously damage human tissue upon contact. The effect is similar to frostbite or thermal burn and is instantaneous. Uninsulated parts of equipment are cooled to extremely low temperatures by LN<sub>2</sub> and LOX and will freeze to the skin on contact. Flesh can be badly burned and severely torn in an attempt to free it, which must be done immediately since the results of prolonged skin contact are worse.

43.1.3. LOX Chemical Hazards. Normal air contains about 21 percent oxygen and 79 percent nitrogen. LOX contains about 4,100 times more oxygen than the same volume of air.

Under these conditions, combustible materials and organic compounds react at explosive rates, and materials not normally thought of as combustible can burn or explode. Because of this, control of combustible and potentially reactive materials in LOX work is as important as the control of ignition sources when flammable gases or liquids are handled. Because of the severe reaction of LOX with various materials, unauthorized substitutions of various LOX-service parts, fittings, hoses, seals, lubricants and so forth can be disastrous. Such reactions can arise out of hydrocarbon contamination or substitution of unsuitable materials. Hydrocarbon contamination can cause explosions and fires. Oil, dirt and other foreign debris are a special concern during aircraft servicing where serious aircraft fires have resulted from combustible foreign matter in aircraft LOX systems. LOX must be handled only in areas where it will not come in contact with hydrocarbon materials when leaked or spilled, including all areas where LOX might flow after a spill. If spilled onto asphalt, LOX will seep into cracks and form shock-sensitive compounds which can explode violently upon impact. LOX spills also cause localized atmospheric oxygen enrichment, which increases the fire danger until dissipated.

43.1.4. Solvents and Chemical Hazards. Some solvents and chemicals used for LN<sub>2</sub> and LOX production and storage cause skin irritation or burns, and can be absorbed through the skin. It may also cause liver damage and poisonous if taken internally.

43.1.5. Spill Hazards. LN<sub>2</sub> and LOX spills may cause asphyxiation, fire, explosion, severe cryogenic burns or equipment damage. Whenever the cryogenic liquid is exposed to the atmosphere, moisture condenses from the air and forms a fog over the immediate area. Refer to the installation and work area spill plans and the National Institute for Occupational Safety and Health (NIOSH) *Pocket Guide to Chemical Hazards* ([www.cdc.gov/niosh/npg/](http://www.cdc.gov/niosh/npg/)) for additional information on handling cryogenic spills.

## 43.2. General Requirements.

### 43.2.1. Characteristics and Production of LN<sub>2</sub> and LOX.

43.2.1.1. Liquid Nitrogen. LN<sub>2</sub> is a colorless, odorless, nonflammable, nontoxic and chemically inactive water-like fluid with a boiling point of -320° Fahrenheit (F). LN<sub>2</sub>, less dense than water, weighs approximately 6.7 pounds per gallon. The expansion ratio for LN<sub>2</sub> (from LN<sub>2</sub> to gaseous nitrogen) is 695 to 1 at normal temperature and pressure. The critical temperature of LN<sub>2</sub> is -233° F at 493 pounds per square inch absolute (psia). At temperatures higher than this, LN<sub>2</sub> cannot be liquefied regardless of pressure. Refer to **Table 43.1** for physical properties of LN<sub>2</sub> and LOX.

43.2.1.2. Liquid Oxygen. LOX is a pale blue, nontoxic, water-like fluid with a boiling point of -297° F. It is heavier than water, weighing approximately 9.5 pounds per gallon. The expansion ratio for LOX is 860 to 1 at normal temperature and pressure. The critical temperature of oxygen is -181° F at 737 psia. At temperatures higher than this, LOX cannot be liquefied regardless of pressure. Liquid oxygen is attracted to an electromagnet much like iron and will combine readily with other substances to actively support combustion.

### 43.2.2. Production of LN<sub>2</sub> and LOX.

43.2.2.1. Storage Tanks (Cryotainers). LN<sub>2</sub> and LOX storage tanks are constructed with an inner cylinder supported in an outer vacuum insulated jacket to reduce radiation and

convection heat transfer. The evacuated space between the inner and outer vessels contains a highly efficient insulating material, which reduces boil off of the LN<sub>2</sub> or LOX. Pressure buildup in the inner tank, necessary to transfer liquid from the tank, is accomplished by vaporizing liquid in coils located beneath the tank. All operating controls are located in a cabinet at the front end of the tank. Storage tanks are manufactured in various sizes and shall be designed and constructed IAW the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. Safety relief valves shall be installed so moisture cannot collect, freeze and interfere with proper operation of the valves. Frangible disks shall also be included in the design of pressurized tanks. **Note:** Tanks operating at atmospheric pressure do not require pressure relief devices if adequately vented. Refer to [Figure 43.1](#) and 29 CFR 1910.104., *Oxygen*, for additional guidance.

43.2.3. Generating Plants. Air Force LN<sub>2</sub> and LOX plants can typically produce one and one-half to five tons of liquid oxygen per day (24 hours). These plants produce four products: liquid and gaseous nitrogen, and liquid and gaseous oxygen. LN<sub>2</sub> and LOX are generated from atmospheric air through five basic steps: compression, purification, refrigeration, expansion and distillation as seen in [Figure 43.1](#)

**Table 43.1. Physical Properties of LN<sub>2</sub> and LOX.**

Physical Properties of LN <sub>2</sub> and LOX		
Property	LN <sub>2</sub>	LOX
Boiling Point	-320°F (-195°C)	-297° F (-182° C)
Freezing Point	-346°F (-210°C)	-361°F (-218°C)
Density, Liquid	6.74 lb./gal at -320°F (-195°C)	9.52 lb./gal at -297°F (-182°C)
Liquid-to-Gas Expansion Ratio (Gas Vol/Liq Vol)	695	860
Critical Pressure	493 psia <sup>1</sup>	737 psia <sup>1</sup>
Critical Temperature	-233°F (-147°C)	-181°F (-118°C)

**Note:** <sup>1</sup> = psia (pounds-force per square inch absolute)

Figure 43.1. Cutaway Drawing of a Typical LN2 and LOX Storage Tank.

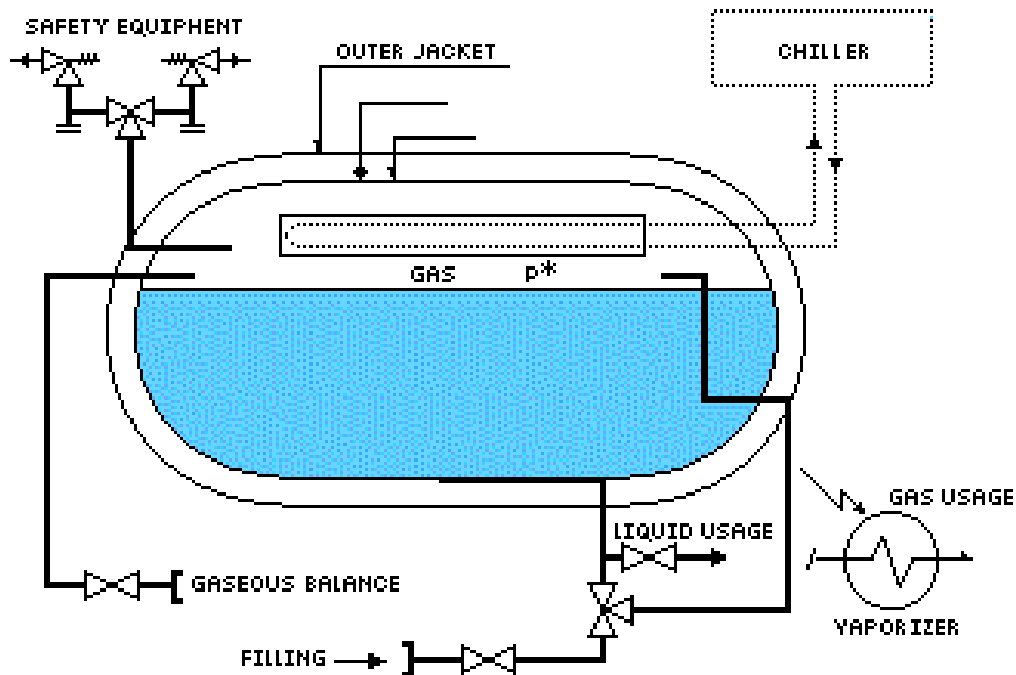
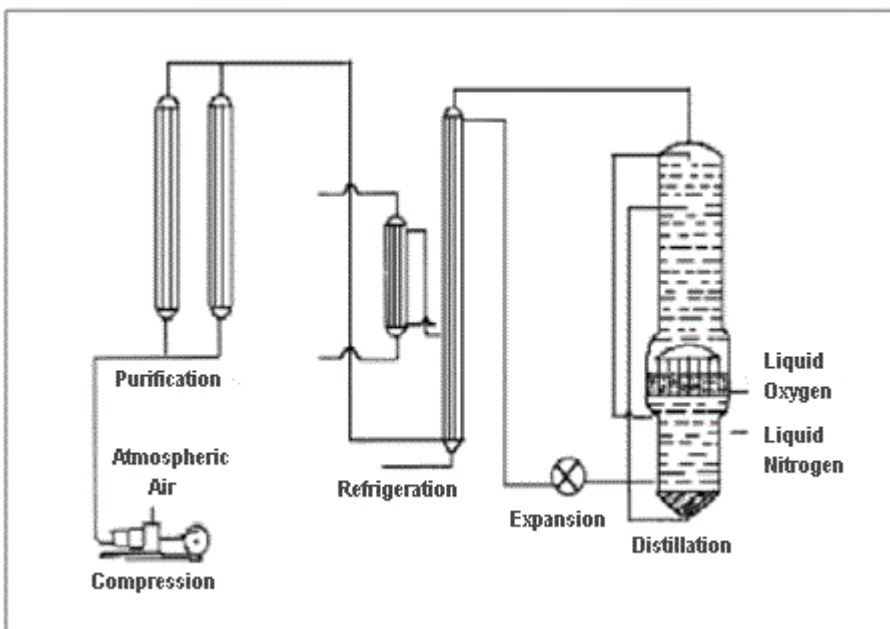


Figure 43.2. Generating Plant Flow.



43.2.4. High Pressure. Pressures approaching 4,000 pounds per square inch (psi) may be found in production facilities. To prevent personnel injury and property damage from whipping of failed lines, all high-pressure lines shall be secured with brackets, braces or other suitable tie-down devices.

43.2.5. Contamination. Atmospheric contamination during production runs may introduce impurities into the cryogenics. To avoid this hazard, the following operations are not permitted during production:

43.2.5.1. Painting.

43.2.5.2. Welding, cutting and brazing.

43.2.5.3. Solvent use.

43.2.5.4. Any operation generating toxic and noxious gases or vapors.

### 43.3. Cryogenic Facility Siting.

43.3.1. Safe Distance Criteria. The special hazards associated with LN<sub>2</sub> and LOX require care be exercised in siting these facilities. Production or storage facilities of 100 gallons or more shall conform to the following minimum separation distances. Refer to UFC 3-600-01, *Fire Protection Engineering for Facilities* and TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. IAW AFMAN 91-201, *Explosives Safety Standards*, and DoD 6055.09-STD, *DOD Ammunition and Explosives Safety Standards*, if the cryogen is used as a propellant and/or fuel, the most stringent distance shall apply.

43.3.1.1. Stationary Cryogenic Containers, Cylinders and Tanks. Stationary containers located outdoors shall be separated from exposure hazards IAW the minimum separation distances indicated in **Table 43.2**. Refer to NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, Chapter 8, for additional guidance.

**Table 43.2. Minimum Separation Distance Between Stationary Cryogenic Containers and Exposure Hazards.**

Minimum Separation Distance Between Stationary Cryogenic Containers and Exposure Hazards		
Type of Exposure	Minimum Distance	
	Feet	Meters
1 - Buildings (regardless of construction type) <sup>1</sup>	1	0.3
2 - Wall Openings	1	0.3
3 - Air Intakes	10	3
4 - Property Lines <sup>1</sup>	5	1.5
5 - Places of Public Assembly	50	15
6 - Public Sidewalks	10	3
7 - Non-ambulatory patient areas	50	15
8 - Combustible materials (papers, leaves, weeds, dry grass, debris) <sup>1</sup>	15	4.5
9 - Incompatible hazardous materials <sup>1</sup>	20	6.1

**Note:** <sup>1</sup> = A 2-hour **fire barrier** wall shall be permitted in lieu of the distances specified by **Table 43.2.**, for items 1, 4, 8, and 9

43.3.1.2. Bulk oxygen systems (100 gallons or more) located outdoors shall be separated from exposure hazards IAW the requirements of **Table 43.3**, as applicable.



#### 43.3.2. Facility Requirements.

43.3.2.1. Security fencing and lighting shall be IAW AFI 23-201, *Fuels Management*.

43.3.2.2. LOX production and storage facilities shall be permanently placarded to indicate “OXYGEN—NO SMOKING—NO OPEN FLAMES” or an equivalent warning.

43.3.2.3. Notify the installation CE prior to installation, modification or repair of utility services (water, electricity, sewage, telephone).

43.3.2.4. Joint sealer shall be LOX-compatible in LOX handling and storage areas (where spills are most likely to occur). This area will cover a 25-foot radius (minimum) from the LOX cart fill point during servicing. The area around the LN<sub>2</sub> and LOX plant itself (where spills are most likely to occur) shall be concrete. Refer to AFI 23-201 for additional guidance.

43.3.2.5. A paved road shall be provided to and from the facility for delivery, maintenance and emergency vehicles. Refer to AFI 23-201 for additional guidance.

43.3.2.6. Generator plants shall be permanently grounded. Storage and servicing tanks shall have adequate grounding points. Refer to AFI 23-201 for additional guidance.

43.3.2.7. Generating plants shall be sited to minimize airborne contamination of the local area.

#### 43.4. Occupational Health.

43.4.1. Solvents and Chemicals. Refer to paragraphs 43.1.3 and 43.1.4 for hazards of chemicals used in LN<sub>2</sub> and LOX production and storage. BE’s OEH risk assessment recommends appropriate controls. Refer to paragraph 2.3 and Chapter 14 for additional guidance.

**Table 43.3. Minimum Separation Distances Between Bulk LOX Systems and Exposure Hazards.**

<b>Minimum Separation Distances Between Bulk LOX Systems and Exposure Hazards</b>		
<b>Type of Exposure</b>	<b>Minimum Distance</b>	
	<b>Feet</b>	<b>Meters</b>
1 - Buildings of Type I and II construction as defined by NFPA 5000	1	0.3
2 – Buildings of Type III, IV or V construction as defined by NFPA 5000 <sup>1</sup>	50	15
3 - Wall Openings as measured from high-pressure gas or liquefied gas regulators, pressure relief devices, vaporizers, manifolds and interconnected piping	10	3
4 - Property Lines <sup>1</sup>	5	1.5
5 - Public Sidewalks <sup>1</sup>	10	3
6 - Public Assembly	50	15
7 – Areas occupied by non-ambulatory patients as measured from the primary pressure relief device discharging vent and from filling and vent connections	50	15
8 – Parked Vehicles <sup>1</sup>	10	3

Minimum Separation Distances Between Bulk LOX Systems and Exposure Hazards		
Type of Exposure	Minimum Distance	
	Feet	Meters
9 – Exterior walls that encroach on the container to form a court with three or more sides	See NFPA 55, 8.12.2.6	
10 – All classes of flammable and combustible liquids above ground: <sup>1</sup>		
- 0 to 1000 gallons (3785 L)	25	7.5
- Over 1000 gallons (3785 L)	50	15

**Note:** <sup>1</sup> = The distances shown in items 2, 4, 5, 8 and 10 of Table 43.3 shall not apply where a fire barrier wall having a minimum fire resistance of 2 hours, which interrupts the line of sight between un-insulated portions of the bulk storage system and the exposure.

43.4.2. Noise. Noise levels in generating plants can reach high levels, particularly during defrost, start-up and shutdown operations. AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, addresses program responsibilities, designation of hazardous noise-producing equipment and hazardous noise areas, required PPE and required medical examinations for workers exposed to hazardous noise. If process not already evaluated, contact BE for an OEH risk assessment. Refer to paragraphs 2.3 and 3.1.2.11 for additional guidance.

43.4.3. First Aid Medical Treatment For Cryogenic Burns. Remove the victim from exposure immediately and transport to the nearest emergency room as soon as possible. Identify exposure to LN<sub>2</sub> or LOX. Keep the victim warm and dry by wrapping exposed areas in a blanket. No attempt to re-warm frozen body parts shall be made until the victim is under proper medical care. Affected parts will not be rubbed because the tissues may be damaged. Clothing that may restrict circulation to the frozen area shall be loosened or removed. Do not allow the victim to drink alcoholic beverages or smoke, because these actions decrease blood flow to the frozen tissue. Control of shock and pain and re-warming of frozen parts shall be done only by medical services personnel.

#### 43.5. Safety Precautions When Working With LN<sub>2</sub> and LOX.

43.5.1. Personal Protective Equipment (PPE) for LN<sub>2</sub> or LOX. PPE is of two distinct types — cryogenic and chemical protection; and may not be interchangeable. Local procedures shall be developed to prevent hydrocarbon or chemical contaminated PPE from being used during cryogen transfers. **Figure 43.3** lists the minimum required PPE for LN<sub>2</sub> or LOX operations. **Chapter 14**, *Personal Protective Equipment (PPE)*, and TO 00-25-172 provide additional PPE information.

43.5.1.1. Personnel handling or transferring LN<sub>2</sub> or LOX shall wear clean, intact, cryogenic liquid protective gloves with gauntlet cuffs approved by BE. Non-absorbent long sleeves shall extend to the gloves. Cuffless trousers shall be worn outside leather boots or over high-top leather shoes to shed spilled liquid. Boots and shoes shall have no mesh sides or air holes and will be tightly laced to prevent spilled cryogen seeping inside. Only tightly woven materials shall be worn during LN<sub>2</sub> or LOX operations. A face shield, eye protection (unvented safety goggles or safety glasses with side shields) and apron (leather or other BE approved) shall be worn.

43.5.1.2. LN<sub>2</sub> and LOX both saturate clothing. Such contact holds the LN<sub>2</sub>/LOX against the skin and may be more hazardous than a direct splash. Contaminated clothing will be removed, hung up and air dried for one hour. **Figure 43.3**, TO 00-25-172 and **Chapter 14** list PPE needed for chemicals used in LN<sub>2</sub> and LOX operations.

43.5.2. Low Temperature Precautions:

43.5.2.1. Avoid splashing on exposed skin. Cryogenics burn on contact.

43.5.2.2. Do not touch an uninsulated cryogenic surface unless wearing the proper PPE. Bare skin will freeze to any uninsulated cryogenic surface and portions of the skin will continue to adhere to the surface after removal of the affected part. Remove the affected part immediately, as leaving the skin in contact with the surface will freeze the underlying tissue and cause additional damage.

43.5.2.3. Assume all surfaces are cold until proven otherwise. External frost may not always be present.

43.5.3. Equipment and Materials Precautions:

43.5.3.1. Most metal becomes very brittle at cryogenic temperatures and will shatter or crack under stress.

43.5.3.2. Valves may freeze if any moisture is present in the system. Droplets of moisture can freeze into balls and pit valve seats causing them to leak.

43.5.3.3. Most glass and some plastics will shatter on contact with LN<sub>2</sub> or LOX due to thermal stress.

43.5.4. Asphyxiation Prevention:

43.5.4.1. Small amounts of liquid generate large amounts of gas. Avoid using cryogenics in small unventilated rooms.

43.5.4.2. LN<sub>2</sub>, when vaporized, is initially heavier than air, sinks to the floor or lowest point, and displaces oxygen. There may not be sufficient oxygen remaining to support life.

**43.6. Fire Prevention and Protection.**

43.6.1. Always avoid contact between LOX and petroleum-based products. Such a mixture is shock sensitive and will explode when struck. Note: Most cosmetics and hair care products are petroleum-based.

43.6.2. Ensure no oil or grease is present on clothing or equipment when working with or around LOX. Remove and replace soiled clothes with clean ones. Remove oil or grease on equipment with approved non-petroleum solvents.

43.6.3. Static electricity may ignite combustible materials in an oxygen-rich atmosphere. Workers shall wear only approved clothing and shall ground themselves before beginning LOX operations.

43.6.4. Never use LOX for cooling people, parts, equipment or food.

43.6.5. Avoid open containers of LN<sub>2</sub>. Although inert, LN<sub>2</sub> is colder than LOX. It liquefies oxygen from the surrounding air and, therefore, an open container of LN<sub>2</sub> will slowly

condense oxygen from the air causing a LOX concentration buildup within the LN<sub>2</sub>. When the LN<sub>2</sub> is pale blue in color, there is LOX present in the mixture. The LOX contamination can cause unexpected chemical reactions with other materials.

43.6.6. Consult the installation Fire Emergency Services (FES) Flight on fire protection and compatible fire fighting agents for LN<sub>2</sub> and LOX production and storage facilities. Nitrogen is a fire suppressant but oxygen supports combustion. In an oxygen supported fire, stop the oxygen flow if possible. Use large quantities of water, preferably in the form of a spray, to cool the burning material. If electrical equipment is involved in the fire, ensure electrical power is turned off before applying water. LOX is a vigorous oxidizing agent and supports combustion of many materials not flammable in air. A LOX fire cannot be extinguished with carbon dioxide (CO<sub>2</sub>), dry chemical or foam. Unless the LOX flow can be stopped or the combustible materials isolated from the LOX, such fires are difficult if not impossible to extinguish.

43.6.7. Always maintain a clear and unobstructed access to and from LN<sub>2</sub> and LOX facilities for firefighting equipment.

43.6.8. Do not permit LOX to come in contact with organic material or flammable substances. Some materials react violently with oxygen under certain conditions of pressure and temperature. These include oil, grease, asphalt, kerosene, cloth, paint, tar and dirt, and anything which may contain oil or grease. If LOX is spilled on asphalt or surfaces contaminated with combustibles (for example, oil-soaked concrete or gravel), do not walk on or roll equipment over the area of the spill. Keep sources of ignition away for at least 15 minutes after all frost has disappeared.

**43.7. Electrical Safety.** LN<sub>2</sub> and LOX production plants and tank support equipment may require electrical service up to 480 volts alternating current (AC). Use extreme care when working around any electrical connections, panels, motors or other energized components. Moving fluids, drive belts, removal of clothing and almost any form of friction can generate a static charge. Ground LN<sub>2</sub> and LOX plant components and storage tanks at all times.

#### **43.8. Housekeeping.**

43.8.1. LOX reacts violently when it contacts many commonly used materials. Therefore, it is important that floors and drip pans in LOX plants and storage areas are kept in spotless condition. Tanks shall be kept clean and free of all hydrocarbons.

43.8.2. Because dirty tools and equipment are sources of hydrocarbon contamination, all tools and equipment used with oxygen components and systems shall be kept meticulously clean and properly stored.

#### **43.9. Receipt, Storage and Issue of LN<sub>2</sub> or LOX.**

43.9.1. Because of the catastrophic consequences of mixing LN<sub>2</sub> and LOX in storage tanks and carts, workers shall exercise care in verifying the correct product is transferred to the correct storage tank or cart. Refer to TOs 42B6-1-1, *Quality Control Aviators Breathing Oxygen and Aviators Gaseous Breathing Oxygen*, and 42B7-3-1-1, *Quality Control of Nitrogen*, for detailed procedures. Only fittings designed specifically for LOX or LN<sub>2</sub>

equipment will be used; workers will never fabricate or use ones that are compatible with both LOX or LN<sub>2</sub> equipment.

43.9.2. At least two workers, fully knowledgeable in Air Force safety criteria and operational procedures, shall be within normal voice or eye contact when generating or transferring cryogenic fluids. This also applies to maintenance actions on cryotainers or plants when cryogenic fluids are present in the system. Personnel requirements for aircraft servicing operations shall be IAW TO 00-25-172.

43.9.3. All transfers of LN<sub>2</sub> and LOX shall be closely monitored to minimize the extent of spills or leaks. The use of drip pans is required. Asphyxiation or oxygen enrichment hazards will exist if a spill occurs within a building or confined space. Appropriate local emergency procedures shall be developed for this contingency.

#### **43.10. Mission-limiting Weather Conditions.**

43.10.1. Each Air Force installation shall develop local procedures to ensure key personnel and agencies involved in high risk weather activities and operations are notified IAW the installation weather support document. Each installation shall employ a lightning safety program with a two-tiered notification system to minimize worker exposure to lightning hazards. Refer to **Chapter 11**, *Weather Safety*, for adverse weather program guidance.

43.10.2. The supporting AF weather organization shall make initial notification of adverse or mission-limiting weather conditions to predetermined support agencies. **Note:** Adverse or mission-limiting weather conditions include strong surface winds, heavy rain, heavy snow, freezing precipitation and thunderstorms, i.e., frequent lightning, and the potential for damaging winds, heavy rain, hail and tornadoes.

43.10.3. A *Lightning Warning* is in effect whenever any lightning occurs within a five (5) nautical mile radius of predetermined locations and activities. Workers shall cease aircraft LOX servicing whenever a Lightning Warning is in effect. Refer to **Chapter 11** for additional adverse weather guidance.

#### **43.11. Common Cryogenic Liquids, Their Properties and Precautions.**

43.11.1. While LOX and LN<sub>2</sub> are widely used cryogenes, other cryogenes are also used within the Air Force. As with LOX and LN<sub>2</sub>, these cryogenic liquids have boiling points below minus 130° F (minus 90°C) and their use must be properly controlled to prevent any contact with the liquid, container or piping, or exposure to the gases. Common cryogenic liquids include nitrogen, helium, hydrogen, argon, methane, oxygen and carbon monoxide, as listed in **Table 43.4**

43.11.2. Although liquefied carbon dioxide (CO<sub>2</sub>) does not meet the definition for a cryogen, at -57° C it is very cold, can burn exposed skin and shall be treated as a cryogen.

43.11.3. Workers shall read the MSDS and safety precautions for all cryogenes used.

43.11.4. Use of Cryogenic Liquids.

43.11.4.1. Cryogenic liquids are extremely cold, have high liquid-to-vapor expansion ratios and may be flammable, properties that make them dangerous to handle and use.

43.11.4.2. Skin or eye contact with cryogenic liquids, cold equipment and materials used in conjunction with cryogenes, or splashing liquid can cause severe burns, frostbite,

tearing of flesh and eye damage. Vapors from boiling liquids can cause eye damage, freeze skin and produce oxygen deficient environments.

**Table 43.4. Common Cryogenic Liquids and Their Physical Properties.**

Common Cryogenic Liquids and Their Physical Properties							
Cryogenic Liquid:	Methane CH <sub>4</sub>	Oxygen O <sub>2</sub>	Argon Ar	Carbon Monoxide CO	Nitrogen N <sub>2</sub>	Helium He	Hydrogen H <sub>2</sub>
Boiling Point (1 atm) °C (°F)	-161 (-256)	-183 (-297)	-186 (-303)	-192 (-313)	-196 (-321)	-268 (-452)	-253 (-423)
Critical Pressure (psig) <sup>1</sup>	673	736	710	507	492	34	188
Liquid Density g/L	425	1410	1402	1.250	808	125	71
Gas Density(27 °C), g/L	0.72	1.4	1.63	0.968	2.25	0.16	0.082
Liquid-to-Gas Expansion Ratio	650	875	860	680	710	780	865
Type Gas	Flammable	Oxygen <sup>2</sup>	Inert	Flammable	Inert	Inert	Flammable

**Notes:**

<sup>1</sup> = pounds per square inch gauge.

<sup>2</sup> = Although oxygen does not burn, it will support combustion. Oxygen-enriched atmospheres may lead to violent reactions, such as rapid combustion or explosions, with incompatible materials.

43.11.4.3. BE's OEH risk assessment of the cryogenic liquid work processes identify hazards and recommend controls. Refer to paragraph 2.4 and Chapter 14 for additional guidance. Typical PPE for work with cryogenic liquids includes safety goggles, insulated gloves, lab coat or apron, a face shield and leather boots. Gloves should be loose enough to easily toss off in the event spilled cryogen enters the gloves. Supervisors shall contact BE if PPE concerns arise.

43.11.4.3.1. Wear a long sleeve shirt and cuffless pants. Pants should be worn over the tops of boots.

43.11.4.3.2. Wear leather boots without mesh sides or air holes. Non-leather boots may be worn if specifically designed for wear while handling cryogenics.

43.11.4.3.3. Do not wear jewelry or other materials that could trap spilled liquid against the skin.

43.11.4.3.4. Stay out of cryogen vapor pathway.

43.11.4.3.5. Use fume hoods when working with cryogenics.

43.11.4.3.6. Always use tongs when handling objects in liquid.

43.11.4.3.7. Only use materials approved for use with cryogenics. Unapproved materials such as plastic, rubber, wrought iron and carbon steel will become brittle and shatter. (Chemical ensemble vinyl overboots shall not be worn while handling

cryogenics, except when threat of chemical/biological threat exists, as determined by the organization commander.)

43.11.4.3.8. Periodically inspect equipment and remove ice and frost blockages from openings to prevent over pressurization.

43.11.4.3.9. Do not tamper with pressure relief valves. Report any leaky or improperly set relief valves to maintenance personnel or the manufacturer.

43.11.4.3.10. Keep equipment clean without using corrosive cleaning materials that could damage the metal jacket.

#### 43.11.5. Dispensing and Transport of Cryogenic Liquids.

43.11.5.1. Special precautions shall be taken to prevent spills while dispensing or transporting cryogenics and minimize exposure to liquids and vapors. The high liquid to vapor expansion ratio can rapidly displace all oxygen in a room and result in asphyxiation. Personnel using cryogenics shall:

43.11.5.1.1. Wear proper PPE when dispensing or transferring cryogenic liquids.

43.11.5.1.2. Cool the secondary container by adding a little cryogenic liquid first, when obtaining liquid from a large dispensing dewar or cylinder. Dispense slowly to mitigate thermal stress and prevent excess splashing. Do not leave the filling operation unattended to avoid overfilling the container. Do not allow the cryogenic liquid to fall too far before reaching the receiving container.

43.11.5.1.3. Ensure the secondary container is secured when manually pouring liquid into a smaller dewar. Do not overfill, fill to less than 80 percent full to allow room for expansion and use a phase separator, if available, to control the vapor path while pouring.

43.11.5.1.4. Use at least two (2) personnel to transport cryogenic liquids. Use handcarts equipped with brakes to move large dewars and cylinders. **Note:** Avoid traveling in an elevator with a dewar. Spills or elevator failures may be dangerous in this restricted space as oxygen could be displaced if the cylinder failed or leaked. If this is unavoidable, ensure the buddy system is used and have another employee remain outside the elevator during transport.

43.11.5.1.5. Always use care when handling equipment. Damage to dewars could cause loss of vacuum, increased evaporation or leaks.

43.11.5.1.6. Wear PPE and hold the dewar as far away from the face as possible when carrying a dewar. Containers that cannot be easily and safely carried shall be placed on a stable wheeled base designed for the dewar.

43.11.6. Storage of Cryogenic Liquids. Gas from a cryogenic liquid storage unit left open to the atmosphere or a catastrophic failure of a storage unit could create an oxygen deficient atmosphere. To reduce the likelihood of this occurring, users shall ensure:

43.11.6.1. Glass dewars have an exterior coating/cover/plastic mesh to minimize projectiles if an explosion occurs.

43.11.6.2. Dewars are stored in well-ventilated rooms with a minimum of six (6) air changes per hour. If the ventilation rate is unknown, contact BE to evaluate the storage area as the installation of oxygen detection systems and alarms for cryogenic liquid storage areas may be required based on location, ventilation and quantity of material stored.

43.11.6.3. Do not store cryogenic liquids with corrosive or flammable chemicals.

43.11.6.4. Dewars shall be placed so vents and openings are positioned away from personnel and lab equipment.

43.11.6.5. Bulk cryogenic storage and dispensing facilities shall follow the siting process in paragraph 43.3.

43.11.6.6. Bulk cryogenic liquid dispensing areas within buildings must be well ventilated. Consult BE for recommended continuous oxygen monitoring equipment. All new installations shall be designed with an oxygen monitoring system and alarm.

43.11.6.7. Cryogenic liquid dewars are not stored in hallways, unventilated closets, environmental rooms or stairwells.

43.11.7. Special Precautions for Liquid Oxygen and Flammable Cryogenic Liquids. Flammable cryogenic liquids like methane, hydrogen and carbon monoxide are hazardous. While oxygen does not burn, it supports and accelerates combustion rates of other materials and may form explosive mixtures with other combustibles. Prior to using flammable cryogenics and oxygen:

43.11.7.1. The supervisor shall contact BE to assess cryogen engineering and work practice controls.

43.11.7.2. All combustible materials are kept away from flammable liquids and oxygen.

43.11.7.3. "No Smoking" signs are posted, and no sources of ignition are present.

43.11.7.4. Oxygen dewars and equipment are kept very clean as surface contamination can ignite if oxygen leaks from the dewar.

43.11.7.5. Stationary equipment is properly grounded and mobile equipment is properly bonded when dispensing.

43.11.7.6. Valve operation is performed very slowly to prevent ignition of contaminants in the system.

43.11.7.7. Flammable gas venting is independent from other ventilation systems and a nitrogen purge is used when needed.

43.11.8. Emergency Procedures.

43.11.8.1. Periodic equipment inspections, removal of ice blockages and replacement of damaged or old storage units will reduce the probability of catastrophic failure of storage units. Ice blockages that prevent the container from venting properly can cause an explosion hazard. **Note:** Contact the installation FES Flight and BE immediately if ice blockages occur.



43.11.8.2. If a spill occurs, immediately exit the area and contact the installation FES Flight to monitor oxygen levels in the area and determine when it is safe to re-enter.

43.11.8.3. If experiencing symptoms such as lightheadedness, dizziness or confusion, immediately seek fresh air and medical attention.

43.11.8.4. An unconscious employee in a cryogenic liquid storage area shall only be retrieved by personnel using a Self Contained Breathing Apparatus. Once the person is removed to fresh air, provide rescue breathing or CPR until paramedics arrive.

43.11.8.5. If eyes or skin comes in contact with cryogenic liquid or gases, follow first aid procedures, then immediately seek medical attention. Refer to paragraph [43.4.3](#) for additional guidance.

43.11.8.5.1. Immediately remove any contaminated clothing. If clothes are contaminated with oxygen, hydrogen or carbon monoxide, remove clothing, evacuate personnel from the facility and keep contaminated clothing away from ignition sources.

43.11.8.5.2. Do not apply dry heat or rub damaged flesh or eyes.

43.11.8.5.3. Seek treatment at the nearest medical treatment facility.

43.11.8.5.4. Workers shall notify their supervisor of injuries.

**43.12. Personal Protective Equipment (PPE) for LN<sub>2</sub> and LOX Operations.** The following ([Figure 43.3](#)) is a quick reference guide to PPE that may be required for activities and equipment in LN<sub>2</sub> and LOX operations. It is not all inclusive and the omission of an activity or item of equipment does not mean that PPE is not required. The supervisor is ultimately responsible for providing and enforcing the wear of PPE recommended or required by the installation Ground Safety office or BE. Specific PPE for each work area and worker is determined through coordination with the supervisor, unit commander, Ground Safety office and BE. BE is the Office of Primary Responsibility (OPR) and installation authority for determining respiratory protection requirements IAW AFOSH Standard 48-137, *Respiratory Protection Program*. The worker is responsible for the care and proper use of PPE provided. PPE shall be used wherever inhalation, absorption or physical contact injuries may occur. Refer to [Chapter 14, Personal Protective Equipment \(PPE\)](#), and TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, for more details on PPE, recommended usage, national stock numbers (NSNs) and other relevant information. PPE listed below shall be worn in conjunction with head covering, cuff-less trousers, long sleeve shirt, jacket or CMU-3/P coveralls and leather shoes which fit closely around the top with rubber soles and heels.

**Figure 43.3. Personal Protective Equipment (PPE) For LN<sub>2</sub> And LOX Operations.**

<b>Personal Protective Equipment (PPE) For LN<sub>2</sub> And LOX Operations</b>	
<b>Operation</b>	<b>Minimum Required PPE</b>
Operating LN <sub>2</sub> and LOX Generating Plant	Thermal Gloves Eye Protection (goggles) Face Shield Ear Protection (Consult BE's OEH risk assessment)
Cleaning LN <sub>2</sub> and LOX Generating Plant	Eye Protection (goggles) Face Shield Chemical Gloves (Consult BE's OEH risk assessment) Chemical Apron Respirator (Consult BE's OEH risk assessment)
Mixing Chemicals	Eye Protection (goggles) Face Shield Chemical Gloves (Consult BE's OEH risk assessment) Chemical Apron
Moving Chemicals	Eye Protection (goggles) Face Shield Chemical Gloves (Consult BE's OEH risk assessment) Chemical Apron
Storage and Transfer of LOX	Head cover Eye Protection (goggles) Face Shield Gloves (loose fitting), leather, welder's gauntlet cuff (DLA-A-50022) (NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (DLA-A-55213) (NSN 8415-00-964-4760), medium as an insert; or Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673) or equivalent Apron (NSN 8415-00-082-6108) Coveralls, cotton white (mandatory) (NSN 8405-00-037-9274) Cuff-less trousers Long sleeve shirt Jacket (Optional) Shoes, which fit closely around the top, with rubber soles and heels

Storage and Transfer of LN <sub>2</sub>	<p>Head cover</p> <p>Eye Protection (goggles)</p> <p>Face Shield (NSN 4240-00-542-2048)</p> <p>Gloves (loose fitting), leather, welder's gauntlet cuff (Federal Specification KKG486, Type II, NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (MIL G-1057E), medium as an insert; or</p> <p>Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673)</p> <p>Apron (NSN 8415-00-082-6108)</p> <p>Cuff-less trousers</p> <p>Long sleeve shirt</p> <p>Jacket, or</p> <p>Coveralls, cotton white (NSN 8405-00-037-9274)</p> <p>Shoes, which fit closely around the top, with rubber soles and heels</p>
Servicing of Aircraft with LOX (Consult TO 00-25-172)	<p>Head cover</p> <p>Eye Protection (goggles)</p> <p>Face Shield or locally purchased hard hat face shield combination</p> <p>Gloves (loose fitting), leather, welder's gauntlet cuff (DLA-A-50022) (NSN 8415-00-268-7860), medium with gloves, cloth, work, cotton knit (DLA-A-55213) (NSN 8415-00-964-4760), medium as an insert; or</p> <p>Gloves (loose fitting), leather (NSN 8415-00-268-7871) with glove inserts, wool (NSN 8415-00-682-6673) or equivalent</p> <p>Apron (NSN 8415-00-082-6108)</p> <p>Coveralls, cotton white (mandatory) (NSN 8405-00-037-9274)</p> <p>Cuff-less trousers</p> <p>Long sleeve shirt</p> <p>Jacket (Optional)</p> <p>Shoes, which fit closely around the top, with rubber soles and heels</p>

**43.13. Liquid Nitrogen (LN<sub>2</sub>), Oxygen (LOX) and Cryogenics Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to

this checklist to include Command or individual location or shop-unique requirements and/or situations.

43.13.1. Are all high-pressure lines secured with brackets, braces or other devices to prevent whipping from a failed line? Reference [43.2.4](#)

43.13.2. Are painting, welding, cutting and brazing, solvent use and any operation producing toxic or noxious gases or vapors prohibited during LN<sub>2</sub> or LOX production runs? Reference [43.2.5](#)

43.13.3. Are cryogenic facilities sited by minimum separation distances or greater as prescribed by UFC 3-600-01, *Fire Protection Engineering Facilities* and TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*? Reference [43.3.1](#)

43.13.4. Do LN<sub>2</sub> and LOX production facilities and storage locations have permanent signs posted indicating “OXYGEN—NO SMOKING—NO OPEN FLAMES” or an equivalent warning? Reference [43.3.2.2](#)

43.13.5. Are LOX-compatible joint sealers used where spills are likely to occur in LOX handling and storage areas? Reference [43.3.2.4](#)

43.13.6. Is the area around the LN<sub>2</sub> and LOX plant itself made of concrete? Reference [43.3.2.4](#)

43.13.7. Is guidance requested from and provided by BE on hazards, precautions, PPE and ventilation required for working with solvents and chemicals? Reference [43.4.1](#)

43.13.8. Is the proper PPE provided and used by workers handling solvents and chemicals? Reference [43.5.1](#)

43.13.9. Are personnel prohibited from using the same PPE for cryogenic operations as used for chemical protection? Reference [43.5.1](#)

43.13.10. Is PPE always worn when an uninsulated cryogenic surface could be touched? Reference [43.5.2.2](#)

43.13.11. Do workers avoid using cryogenics in small unventilated rooms? Reference [43.5.4.1](#)

43.13.12. Is access to firefighting equipment in LN<sub>2</sub> and LOX facilities clear and unobstructed? Reference [43.6.7](#)

43.13.13. Are preventive measures established and used to ensure LOX does not come in contact with organic materials or flammable substances? Reference [43.6.8](#)

43.13.14. Are floors and drip pans in LOX plants and storage plants maintained in spotless condition? Reference [43.8.1](#)

43.13.15. Are procedures established to verify the correct product is transferred to the correct storage tank or cart? Reference [43.9.1](#)

43.13.16. Are two (2) fully knowledgeable workers within normal voice or eye contact when generating or transferring cryogenic fluids? Reference [43.9.2](#)

43.13.17. Are cryogenic storage and dispensing facilities sited IAW paragraph 43.3?  
Reference 43.11.6.5.

## Chapter 44

### FOOD SERVICE OPERATIONS

#### 44.1. Specific Hazards.

44.1.1. Food services operations present a variety of hazards. Floors must be mopped and cleaned frequently to promote sanitation and prevent wet floors which may cause slips and falls. Spilled grease or other liquids can create dangerous and slippery walking surfaces. Improperly lifting and moving heavy boxes and cases can cause sprains and strains. Refer to [Chapter 2](#), *Human Factors*, and [3](#), *Physical Hazards*, for additional information on human factors and physical hazards.

44.1.2. Equipment used in kitchens for heating, cutting, mixing or grinding food can create hazards. Fats and oils used for cooking are combustible and can scald when hot. Dishwashers present electrical shock and hot water scald hazards. Accumulated grease in hoods and vents is a fire hazard. Broken glasses and dishes with sharp edges must be handled with care to prevent cuts. Deployed, mobile and emergency food service operations present an increased danger of fires and burns from gasoline or other fuels.

44.1.3. Food service personnel can be exposed to several occupational health hazards. Supervisors shall request BE to evaluate any suspected workplace health hazards and recommend the required PPE for the hazards identified. The more common include:

44.1.3.1. Drain cleaners. Drain cleaners and strong caustic solutions are often used for cleaning reusable filters in range, grill and broiler exhaust hoods. Contact may cause skin burns and damage to the eyes. Soaps and detergents can cause skin dermatitis. Soap dust may irritate the throat if inhaled. Ovens and charcoal broilers may generate carbon monoxide if not properly ventilated.

44.1.3.2. Microwave ovens. As ovens age, hinges and catches may loosen and leak microwave radiation. Spilled food may prevent oven doors from closing properly. If the interlock system fails, the oven may not shut off when the door is opened.

44.1.3.3. Ultraviolet (UV) radiation. Low-pressure mercury vapor lamps and black-light lamps emit low-intensity UV radiation, which is harmful to the skin and eyes.

44.1.3.4. High heat levels in kitchens. This can cause heat-related illnesses, so workers shall be aware of heat disorder symptoms and the need for water. Supervisors shall ensure workers drink plenty of water.

#### 44.2. General Requirements.

44.2.1. Worker Training. Supervisors shall ensure all newly assigned workers are trained IAW AFI 91-202. Training shall be provided upon assignment and when there is a change in equipment, procedures or processes, or safety, fire prevention or occupational health requirements. Supervisors shall develop written outlines for personnel training and shall maintain documentation of this training.

44.2.2. Training shall include:

44.2.2.1. Proper lifting techniques.

44.2.2.2. Safe use of cutlery and food processing machinery, handling of hot foods and the danger of falls.

44.2.2.3. Hazardous Communication training IAW AFI 90-821, *Hazard Communication Program*.

44.2.2.4. Hazards of mixing cleaners or chemicals.

### 44.3. Specific Requirements.

44.3.1. Personal Protective Equipment (PPE). All PPE shall be approved by the installation Ground Safety Office and BE. PPE includes respiratory and hearing protective devices; special clothing; protective devices for the eyes, face, head and extremities; and boots, apron, gloves and respirators. Refer to **Chapter 14**, *Personal Protective Equipment (PPE)*, AFI 48-116, *Food Safety Program*, 29 CFR 1910.136, *Occupational Foot Protection*, and 29 CFR 1910.141., *Sanitation*, for additional guidance and information.

44.3.1.1. Personnel working in areas where floors may become wet or greasy shall wear non-slip/skid shoes. Safety-toe footwear shall be worn where needed to prevent foot or toe injuries. Refer to **Chapter 14** and 29 CFR 1910.136, *Occupational Foot Protection*.

44.3.1.2. Supervisors shall provide protective cold weather clothing for workers who frequently enter and exit refrigerators and freezers.

44.3.1.3. Workers shall avoid skin contact with ammonia solutions by wearing protective clothing such as rubber gloves. If skin or eye contact occurs, the affected area shall be washed promptly.

44.3.1.4. **Table 44.1** lists minimal PPE requirements for food services operations. This list is not all-encompassing. Therefore, these requirements shall be locally evaluated by the installation food services manager, Ground Safety office and BE.

### 44.3.2. Housekeeping.

44.3.2.1. All food services areas, to include kitchens, dining rooms, serving lines, passageways, storerooms, disposal rooms and break areas, shall be kept clean, orderly and in a sanitary condition. Loading areas shall be kept clean, free of grease and orderly to prevent congestion. Refer to **Chapter 7**, *Walking Surfaces, Guarding Floors and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, 29 CFR 1910, Subpart D, *Walking-Working Surfaces*, and 1910.141., for additional guidance and information.

44.3.2.2. Dust mops, brooms and wet mops shall be hung vertically on brackets or in storage racks with handles up, heads down.

44.3.2.3. Building or equipment cleaning supplies shall be kept separate from food products and kept locked when not in use. Steel wool used for cleaning shall be stored in metal self-closing containers. Used steel wool shall be disposed of in appropriate trash containers. Only noncombustible sweeping compounds and absorbents shall be used. Used sweeping compounds or absorbents shall be stored in a closed metal container.

44.3.2.4. Clean and dirty rags shall be kept in separate containers with metal lids and permanently labeled or stenciled to identify their contents. Lids shall be self-closing or provided with a solid tight fitting cover and kept closed on the dirty rag container. Refer to 29 CFR 1910.141. for additional guidance.

44.3.2.5. Storage shall not be permitted under stairways, under floors or above ceiling levels of buildings, in corridors or exit passageways or mechanical and boiler rooms unless approved by the installation Fire Emergency Services (FES) Flight. Materials shall not be piled against buildings or in front of doors and exits.

44.3.2.6. Areas behind freezer/refrigeration units, electrically operated units, water heaters or other heat producing devices shall be free of combustible materials. These areas shall be dusted/cleaned regularly to prevent dirt and/or dust buildup.

44.3.3. Dry Storage. Shelves shall be strong enough to support stored items. Store heavy items on lower shelves and lighter items above. Bottom shelves must be at least six (6) inches off the floor to allow for cleaning. A safe ladder shall be provided to reach items on high shelves. Cartons or other combustibles shall be stored at least 18 inches from light bulbs and 18 inches from fire suppression sprinkler system heads.

44.3.4. Pot and Pan Area. Rubber mats or other approved matting shall be used and maintained in safe condition. Workers shall ensure the correct amount of detergent and other cleansing or sanitizing agents are used to wash pots and pans. A waterproof apron and rubber gloves shall be worn by each worker. An adequate drain board or other drying area shall be provided to prevent placing pots and pans on the floor before or after washing. Pot and pan sinks shall be designed so workers can drain sinks without placing their hands in hot water.

44.3.5. Walk-in Refrigerators and Freezers. Storage racks shall be in proper working condition, free from broken or bent shelves and supported on solid legs. Shelves shall be adequately spaced to prevent pinched hands when moving large bulky items for storage. When possible, store heavier items on lower shelves, but always store potentially hazardous foods below foods that are ready to eat to prevent possible cross contamination.

44.3.5.1. Workers shall use care when moving portable racks to avoid hand injuries. Supervisor shall ensure blower fans are properly guarded and adequate aisle space is provided. Proper PPE shall be provided for workers who continuously enter walk-in freezers.

44.3.5.2. A by-pass or other type device shall be installed on the door to permit escape from inside if a worker is locked inside. An internally activated alarm bell shall be provided and tested weekly. This test shall be documented. If the bell is inoperable, it shall be replaced immediately. When a door can be locked from the outside, i.e., with a hasp and padlock, a permanent sign stating, "Determine No One Is Inside Before Locking Door," shall be mounted on the door's exterior. The letters shall be at least three (3) inches high.

44.3.6. Food Preparation Area.

44.3.6.1. Microwave ovens shall be considered occupational use and surveyed IAW AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*. This is



required only when repairs have been made to microwave ovens. Microwave ovens shall be cleaned whenever spills occur and grease shall not be allowed to accumulate.

44.3.6.2. All electrical equipment shall be properly grounded. Electrical equipment shall be inspected annually for safety defects by an installation CE qualified electrician or contract equivalent. Electrical switches shall be located so they can be reached easily in an emergency and so employees do not have to touch metal equipment to reach them. All equipment shall be in safe operating condition and turned off when not in use. Supervisors shall evaluate workers annually on the proper and safe operation of all equipment.

44.3.6.2.1. Movable parts on equipment shall be properly guarded. For example, install blade guards on meat-slicers and wire mesh screening over compressor units or fans. Refer to **Chapter 18**, *Machinery*, for additional guidance. Employees shall use machine guards whenever the machine is operated.

44.3.6.2.2. Workers shall use a pusher when operating meat grinding equipment. Fingers or hands shall never be used to feed or clear meat grinders.

44.3.6.3. Floors shall be adequately maintained and cleaned. Workers shall pick or clean up all dropped or spilled items immediately.

44.3.6.4. Knives and cutting attachments shall be safeguarded and stored in safe enclosures when not in use.

44.3.6.5. Hoods and ducting shall be kept free of grease accumulation. Hood filters over grease vapor producing activities (for example, deep fat fryers and grills) shall be washed at least daily. Hood-filters in other areas shall be washed at least weekly. Ducting shall be cleaned as necessary but at least once every six (6) months. Cleaning of filters and ducts shall be documented IAW local procedures. Cooking shall not be permitted under hoods without properly installed filters or when the fire extinguishing system is not operating. Exhaust hoods shall be vented outside the facility. Refer to NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, for additional guidance.

44.3.6.6. Exhaust fans shall be operating when cooking equipment is in operation.

#### 44.3.7. Serving Area.

44.3.7.1. Safety valves on equipment shall be functional and tested periodically.

44.3.7.2. Hot food tables shall be cleaned after each meal. Serving counters and tables shall be free of broken parts, splinters or metal slivers and burrs.

44.3.7.3. Service ware shall be inspected at least semi-annually, and cracked and heavily scored items discarded. This inspection shall be documented.

44.3.7.4. Tray rails shall be designed to prevent trays from falling off while patrons move through the serving line.

44.3.7.5. Floors and/or ramps shall be dry and free of splinters, protruding nails, loose boards or unnecessary holes and otherwise in safe condition. Floors shall be mopped as necessary, at the end of each meal period, and waxed with nonskid wax as needed. Caution signs shall be used when floors are wet to indicate a possible slipping hazard.

Traffic flow shall be arranged to minimize the danger of customers colliding while carrying trays or obtaining food.

#### 44.3.8. Dining Area.

44.3.8.1. Food dispensers shall be properly grounded. Pictures shall be securely fastened to walls. Drapes, blinds or curtains shall be securely fastened and constructed of fire-resistant materials. Chairs shall be free from splinters, metal burrs and broken or loose parts. Decorations shall be of a flameproof or noncombustible material.

44.3.8.2. Floors shall be continually inspected for spillage and other hazardous situations and cleaned immediately to prevent slipping hazards. Special attention shall be given to the floor adjacent to water, ice cream and milk stations, and salad bars.

44.3.8.3. If trays with used dishes are placed on conveyor units, the edges shall be guarded to keep customers or employees from catching fingers or clothing.

44.3.8.4. If dishes are removed on portable racks or bus trucks, these units shall be in safe operating condition with all wheels or casters working and all shelves firmly fastened.

#### 44.3.9. Dishwashing Area.

44.3.9.1. Floors shall be free of excessive water buildup and spillage. Supplemental flooring shall be properly maintained in safe condition before being used.

44.3.9.2. All electrical units shall be properly grounded. Switches shall be readily accessible and located to permit rapid shutdown in an emergency. Employees shall be able to reach switches without touching metal units such as tables and counters.

44.3.9.3. Employees shall avoid contact with detergents to prevent skin and eye irritation.

44.3.9.4. Supervisors shall instruct employees on the safe collection and disposal of broken glass.

44.3.9.5. The take-off counter dishwashing machine shall be designed to prevent fingers or hands from being caught and injured.

44.3.9.6. Controls located in a passageway shall be recessed or guarded to prevent breakage or accidental starting.

44.3.9.7. Dish racks shall be in safe condition, free of sharp corners that would cause cuts, and kept off the floor to prevent tripping.

44.3.9.8. Dishwashing machines shall have entry and exit curtains or other devices to prevent hot water from spraying outside the machine.

#### 44.3.10. Bakery Area.

44.3.10.1. The frame and electrical components of electrically powered machines shall be grounded, enclosed and/or protected by adequate guards. Rotating parts will be smooth. For example, lubrication fittings and parts which are not flush with the rotating part shall be recessed. Screw conveyors shall be covered. Dead end screw conveyors

shall have an overflow safety gate which operates an electrical limit switch. Sprockets and V-belt drives within reach from passageways and platforms or less than seven (7) feet from the floor shall be enclosed.

44.3.10.2. Manually fed dough breaks shall have top roller protection. An emergency stop bar shall be provided and located so the operator's body will press against it if the operator slips and falls toward the rollers or if the operator's hand gets caught in the rollers. The emergency stop bar shall be checked daily for proper operation.

44.3.10.3. Molder feeding devices shall be designed so the operator's hands cannot be placed into in-running rollers. Molders shall be equipped with stopping devices within reach of the feeder and another one next to the employee taking the dough away.

44.3.10.4. All slicers shall be provided with a mechanical device to push the last loaf through the slicer.

44.3.10.5. When doughnut machines are used, separate flues shall be provided to vent frying section vapors and heat exchanger combustion products. Portable and fixed doughnut fryers shall be installed and used under an approved exhaust hood with an installed fire extinguishing system.

44.3.10.6. Horizontal mixers shall be equipped with safety devices which engage both hands of the operator while the agitator is in motion and when the bowl is open more than one-fifth its total opening. Vertical mixers shall have devices available for moving bowls weighing 60 pounds or more (including contents) into and out of the mixing position.

44.3.10.7. All dump bins shall be of a suitable height to enable the operator to dump flour from bags without undue strain or fatigue. Where the edge of any bin is more than 24 inches above the floor, a bag rest step shall be provided and used. Openings shall be protected by means of bars or grids. If grids are made of mesh, the openings shall not be larger than three (3) inches in length or width. A control device for stopping the dump bin and blender shall be close to the normal operator location.

**44.4. Walking, Working Surfaces, Aisles and Passageways.** [Chapter 7](#), *Walking Surfaces, Guarding Floors and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders*, and 29 CFR 1910, Subpart D, *Walking-Working Surfaces*, provide more information on walking, working surfaces, aisles and passageways.

44.4.1. Supervisors will ensure:

44.4.1.1. Slippery or worn treads and surfaces are replaced or made safe by coating with non-slip surface materials.

44.4.1.2. Loose boards, unsecure treads, protruding nails and torn or worn stair treads are repaired or replaced immediately.

44.4.1.3. Vertical clearance above any stair tread to any overhead obstruction shall be at least seven (7) feet measured from the leading edge of the tread. (29 CFR 1910.24, *Fixed Industrial Stairs*).

44.4.1.4. Outside stairways, entrances, sidewalks, loading docks and ramps are cleared of snow and ice and abrasive materials, such as sand or ash, are readily available and

used during inclement weather. This includes emergency exits and walks leading from them.

44.4.1.5. Prior to opening for service, all exits are checked for proper operation and exit discharges are clear of ice and snow.

44.4.2. Layout. Proper layout, spacing and arrangement of equipment, tables, passageways, aiseways, etc., is essential for orderly operations and to avoid congestion. Consult the installation Ground Safety and Environmental Management offices, BE, CE and (FES) Flight for assistance with layout. Refer to 29 CFR 1910, Subpart D, for additional guidance and information.

44.4.3. Floor surfaces shall be kept clean and in good condition, and free of water, defects and other slippery materials that could endanger workers. Spills shall be immediately cleaned or covered with noncombustible absorbent material. Drip pans shall be used wherever the possibility of spilling or dripping exists. Yellow caution signs with black letters shall be posted to warn patrons and employees of a slipping hazard whenever floors are being cleaned or finishing compounds have been applied.

**44.5. Electrical.** The potential for electrical shock exists in many food services operations. **Chapter 8, *Electrical Safety***, provides more detailed guidance and information on electrical requirements.

44.5.1. Installation/Repair. Only authorized, qualified electricians or appliance repairmen shall install, service or repair electrical equipment or wiring. Defective electrical equipment/cords shall be removed from service.

44.5.2. Receptacles. Electrical receptacles and cover plates shall be securely mounted and free of cracks. Multiple plug adapters can allow overloading electrical circuits and shall not be used. Receptacles shall be located outside wet process areas or protected by a ground fault circuit interrupter (GFCI).

44.5.3. Plugs.

44.5.3.1. Plugs shall be of dead front construction and shall be inserted fully so no part of the prongs is exposed.

44.5.3.2. Supervisors shall frequently check the third/grounding prong safety feature for security, especially on items that are unplugged frequently. The prong shall not be cut off nor will an adapter be used to allow a three-prong plug to fit a two-prong receptacle. This paragraph does not apply to double-insulated equipment or equipment such as clocks, radios, can openers, etc., which are not normally manufactured with a grounding plug.

44.5.3.3. Plugs, whether molded or clamped, shall be firmly attached to the cord to prevent pulling against wire connection points. Clamps shall be nonmetallic.

44.5.4. Flexible/Extension Cords. Also see NFPA 70, *National Electrical Code*.

44.5.4.1. Supervisors shall check cords frequently for signs of fraying, cracking, wear or any damage that could be a sign of possible short-circuiting and for proper size/rating for equipment it services. Defective cords shall be removed from service.

44.5.4.2. Cords shall not be:

- 44.5.4.2.1. Hung over nails, rafters or in a manner that constitutes a safety or fire hazard.
  - 44.5.4.2.2. Taped, stapled or fastened to woodwork or walls.
  - 44.5.4.2.3. Routed through walls, ceilings, floors, doorways, windows or similar openings.
  - 44.5.4.2.4. Attached to building surfaces or concealed in ceilings, walls or floors.
  - 44.5.4.2.5. Placed under rugs, carpets or other combustible materials.
  - 44.5.4.2.6. Walked on nor will equipment be allowed to run over them. If cords must be placed in travel lanes, they shall be protected by molded housing or bridges.
  - 44.5.4.2.7. Kinked, stretched or bent excessively. Such practices will damage internal wire strands.
  - 44.5.4.2.8. Used in wet or damp locations.
  - 44.5.4.2.9. Subjected to current or voltage greater than rated capacity.
  - 44.5.4.2.10. Daisy chained. Refer to **Chapter 8** for additional guidance.
- 44.5.4.3. Cords shall be continuous in length without splices. They shall be kept dry and free from oil or grease. When possible, equipment power cords shall be suspended from overhead in rigid raceways. The plug shall be pulled on rather than the cord to avoid damaging connections when disconnecting cords.
- 44.5.4.4. A grommet, or other means of clamping approved by the NEC, shall be installed where cords pass through equipment housings to prevent abrasion of the cord insulation and to prevent pull or strain put on the connecting point.
- 44.5.5. Extension cords shall not be used in lieu of permanent or fixed wiring. If used, they shall have a single connection. Previously stated rules for cords also apply to extension cords.
- 44.5.6. Equipment connected by flexible cords shall be disconnected when not in use for extended periods of time or at the end of the work shift. **Exception:** Commercial coffee urns hard plumbed to the water service need not be unplugged at the end of the work day, if they are in an occupied/observable space. If the area is unmanned or unoccupied for an extended period of time then the unit shall be disconnected from the electrical service.
- 44.5.7. Circuit breakers, disconnect switches and fuses shall be readily accessible to employees or building management personnel. They shall not be exposed to physical damage nor in the vicinity of ignitable material. Circuit breakers, fuse boxes and disconnect switches shall be legibly marked to indicate what they control and shall clearly indicate whether they are in an open (off) or closed (on) position. Circuit breakers shall not be taped in the “on” position. Breakers that trip frequently indicate possible electrical problems and shall be promptly reported and corrected. Electrical controls shall not be blocked or otherwise obstructed. Workers shall not substitute larger fuses or breakers or use bypass wires. Refer to NFPA 70 for additional information.
- 44.5.8. Guarding of Live Parts. Electrical outlets, switches, junction boxes, etc., shall have cover plates securely installed. Cover plates shall be free of cracks or other defects. All unused openings (knock-out plugs) in switch housings, junction boxes, etc., shall be securely

covered. Rigid conduit shall be securely attached to the box and flexible conduits shall be securely clamped where the conduit enters the box to prevent abrasion to the conduit and strain on the connecting points.

#### 44.5.9. Equipment Grounding.

44.5.9.1. Frames of electrical motors, regardless of voltage, shall be grounded. All covers shall be securely fastened. Motor data plates shall be legible and shall not be painted over.

44.5.9.2. Exposed noncurrent-carrying metal parts of fixed equipment that may become energized under abnormal conditions shall be grounded.

44.5.10. The following is a partial list of cord and plug connected food service equipment (whether fixed, stationary or portable) that shall be grounded, unless double insulated:

44.5.10.1. Refrigerators/freezers.

44.5.10.2. Refrigerated display cases.

44.5.10.3. Dough breaks.

44.5.10.4. Dishwashing machines.

44.5.10.5. Grinders and slicing machines.

44.5.10.6. Metal serving counters where electrical outlets and switches are attached.

44.5.10.7. Deep fat fryers.

44.5.10.8. Portable, hand-held, electric tools.

44.5.10.9. Mixing machines.

44.5.10.10. Wet scrubbing/buffing machines.

44.5.10.11. Water coolers and vending machines with refrigeration units.

44.5.10.12. Cash registers.

44.5.11. Ground-Fault Circuit-Interrupters (GFCI). These devices safeguard personnel from current leakage to ground and are mandatory in: all new food services facilities, facilities undergoing modification in areas subject to wash down and in all areas where excessive water presents an electrical shock hazard. They shall be used within six (6) feet of sinks, basins or other sources of water. Portable GFCIs protect the operator when a non-GFCI circuit is used to power floor scrubbers or buffers. GFCIs are not required for appliances such as freezers or refrigerators. A GFCI breaker installed in the circuit panel can provide GFCI protection for large areas.

44.5.12. Weatherproof Electrical Systems. These systems shall be installed where lamp holders, fixtures or receptacles are used in wet or damp locations, such as perishable storage areas, or refrigerated areas, for both storage and food processing. Such fixtures near steam equipment shall be of vapor proof construction to prevent electrical shock or short circuits caused by moisture. Refer to NFPA 70 for additional information.

44.5.13. Undervoltage Protection. Machines which are not adequately safeguarded to protect the worker during undervoltage situations shall have an undervoltage protective device installed. Undervoltage situations occur when a machine automatically resumes motion after a low voltage situation or power interruption and the operator is exposed to hazardous moving parts. Shop supervisors, with assistance from the installation Ground Safety office and CE, shall identify machines which require this protection and assure that undervoltage protection devices are installed. Refer to **Chapter 8** for additional guidance.

44.5.14. Control switches (on and off) shall be accessible to workers at their normal operating positions to prevent reaching over moving parts of the machine to activate the switch. Control switch stop functions shall be identified by the printed word “STOP” and/or the color red. Positive pressure control switches shall not be wedged for continuous operation. The motor “start” switch shall be protected against accidental/inadvertent operation. Machines, including foot and hand controls, shall be made inoperative before performing maintenance, adjustments or cleaning, unless required by TO or manufacturer’s guidance. Refer to **Chapter 21**, *Hazardous Energy Control (Lockout and Tagout)*, for lockout and tagout requirements. One or more of the following controls shall be used:

44.5.14.1. The power cord shall be unplugged (when equipment is connected by plug and cord).

44.5.14.2. The power source, circuit breaker or start switch shall be locked in the off position when equipment is wired directly to a power source.

44.5.14.3. If existing equipment, circuit breakers or power sources cannot be locked in the off position, danger signs or tags shall be placed on the disconnecting means warning that maintenance is in progress and the disconnecting means shall not be turned on.

44.5.14.4. When equipment is replaced or new construction or a renovation project is planned, include provisions to comply with lockout requirements.

44.5.15. Illumination. Control of light is important to avoid glare and harsh shadows. Soft shadows are usually acceptable, but harsh shadows may obscure hazards or interfere with visibility. Supplementary lighting or additional lighting shall be provided in situations where general lighting is not sufficient. Required illumination ranges from about 5-foot candles for most hallway lighting to 100-foot-candles or more for extremely fine or detailed work. Contact the installation CE if illumination levels are in question. Refer to **Chapter 25**, *Civil Engineering*, paragraph **25.4.3.4**, for information on how to obtain a CE lighting survey.

#### **44.6. Machinery and Equipment, Machine Guarding and Power Transmissions.**

44.6.1. Operating Instructions (OIs). Supervisors shall maintain manufacturer’s manuals for all machinery or equipment under their control or develop local OIs, to include: job safety, maintenance, lubrication and inspection, and identify operator and maintenance technician responsibilities. Refer to **Chapter 18**, *Machinery*, 29 CFR 1910.212, *General Requirements for All Machines*, and 29 CFR 1910.263, *Bakery Equipment*, for additional guidance and information on machinery.

44.6.2. Training. The supervisor, or a designated trainer shall train workers prior to operating machinery or equipment. Training shall include proper operation, safety precautions, cleaning, hazard recognition and emergency shutdown procedures for each piece

of equipment they will operate. Additionally, supervisors shall inform operators of those repairs they are authorized to perform and train them in proper maintenance procedures. Supervisors shall maintain a current list of all personnel qualified to operate and maintain equipment, and periodically evaluate these workers to ensure they are following proper and safe operating procedures. Additionally, this training shall be annotated on the workers' training records.

#### 44.6.3. Safe Operating Practices.

44.6.3.1. No attempt shall be made to clean any part of a machine until all moving parts have come to a complete stop and the power source has been disconnected and marked with a warning sign (cord and plug equipment) or the power disconnecting switch turned off and locked out. Refer to [Chapter 21](#) for lockout and tagout requirements and procedures.

44.6.3.2. Loose fitting clothing, neckties, rings, bracelets, necklaces or other apparel that may become entangled in moving machinery, power transmission apparatus or moving parts shall not be worn.

44.6.3.3. Hair nets or caps shall be worn to keep hair under control and away from moving machinery, power transmission apparatus or moving parts. Refer to [Chapter 14, Personal Protective Equipment \(PPE\)](#), for additional information.

44.6.3.4. Machines shall be used within the rated capacity specified by the machine manufacturer.

44.6.3.5. Machines shall be maintained so they are free of excessive or abnormal vibration while running.

44.6.3.6. Machines shall be completely stopped and the power source disconnected before attempting to clear jammed work or debris.

44.6.3.7. Machines shall not be left unattended with the control switch in the "ON" position. The operator shall remain at the machine until all motion has ceased and any Lockout/Tagout actions needed are complete.

44.6.3.8. The electric equipment shall be unplugged at the outlet or turned off at the circuit breaker/disconnecting switch before washing the equipment or the surrounding area when water could splash on the equipment. Electrical components shall be protected when water or cleaning liquids can enter them.

#### 44.7. Machine Layout.

44.7.1. Machines subject to movement from vibration, rotation or other reasons shall be securely fastened to prevent their movement while operating. Sufficient space for material handling and maintenance shall be provided around each machine. The installation Ground Safety office and CE shall be contacted for assistance on layout problems.

#### 44.7.2. Maintenance and Repair:

44.7.2.1. Supervisors shall ensure all machines are thoroughly inspected at least every 60 days unless the manufacturer's manual, machine use or working environment requires



more frequent inspections. The supervisor shall determine the appropriate inspection schedule when severe operating conditions require more frequent inspections.

44.7.2.2. Operators shall inspect machines prior to the start of each shift, following a new setup, or when operators change to ensure that components are in good working order and guards, interlocks or other protective devices are securely mounted, operating properly and in proper adjustment.

44.7.2.3. Supervisors shall maintain records of inspections and any machine maintenance.

44.7.3. Guarding. Machine guarding shall be provided to protect the operator and other employees in the area from hazards created by the point of operation, in-running nip points, rotating parts, flying chips and power transmission apparatus. Machines shall not be operated unless all guards are in place and operational. Any time guards are removed, the power cord shall be disconnected or the disconnecting means turned off, locked out and tagged. Refer to **Chapter 18** for specific machine guarding requirements.

**44.8. Fire Protection and Prevention.** (Refer to paragraph **6.2.2** for additional guidance.)

44.8.1. Supervisors shall provide food services workers fire prevention training, both initially and annually thereafter. Refer to **Chapter 6, Fire Protection and Prevention**, for additional guidance. Training shall include, as a minimum:

44.8.1.1. How to report a fire by phone (FES Flight's emergency phone number, unit and building identification, nature of the emergency, etc.). Dialing 9-1-1 is the emergency phone number on most Air Force installations. When the nature of the emergency is fire, the operator will connect you to the FES Flight. For installations without this capability, check with the FES Flight for emergency contact numbers in case of a fire emergency.

44.8.1.2. Location of fire alarms within the work area and how to activate them.

44.8.1.3. Location of fire extinguishing equipment and how to operate it.

44.8.1.4. Location of equipment circuit breakers and power disconnects that control their work areas.

44.8.1.5. Location of emergency exits.

44.8.1.6. Evacuation procedures for patrons and workers, to include assisting the physically handicapped.

44.8.1.7. Procedures for extinguishing a grease fire.

44.8.1.8. Workers in facilities with kitchen fire suppression systems shall receive semiannual training on the system from the installation FES Flight as required by **Chapter 6**. This responsibility may be relegated to the supervisor per agreement with the unit commander and FES Flight.

44.8.2. Unit supervision will coordinate with installation FES Flight on the selection, placement and maintaining of fire extinguishing equipment IAW **Chapter 6**. Fire suppression requirements shall be IAW NFPA 10, *Standard for Portable Fire Extinguishers*, NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, and NFPA 96. Supervisors, workers and facility managers shall ensure fire extinguishers:

44.8.2.1. Are in their designated locations, charged, tested, sealed and dated.

44.8.2.2. Have not been tampered with, actuated or discharged, and there are no visible physical defects, corrosion or other conditions that could affect their operation.

44.8.2.3. Are clearly visible, properly identified, labeled for the type of fire they should be used on and immediately accessible.

44.8.3. The following additional fire safety matters affect food services operations:

44.8.3.1. Automatic timing devices shall not be used to turn on electrical appliances unless workers are present in the facility when the appliances are in operation.

44.8.3.2. Space heaters shall not be used without the approval of the installation energy manager. Refer to the installation energy management program. **Note:** In some units, the energy management program is the responsibility of the facility manager.

44.8.3.3. Doors leading to passageways or providing access to rooms shall not be blocked without prior approval of the installation FES Flight. All such doors shall be identified by signs with four-inch block letters indicating "DOOR BLOCKED."

44.8.3.4. At least three feet of clear space shall be maintained around self-closing fire doors.

44.8.4. Fire Hazards.

44.8.4.1. Improperly maintained motors and air compressors.

44.8.4.2. Equipment misuse.

44.8.4.3. Electrical equipment not operating properly, including equipment operating when the facility is closed, i.e., freezers and refrigerators.

44.8.4.4. Cleaning materials treated with chemicals subject to spontaneous combustion shall be stored in closed metal containers, separate from other combustible items and clearly marked to show contents. Cleaning fluids will be non-combustible and nontoxic. **Chapter 22, *Flammables and Combustibles***, and local installation fire regulations shall be followed when storing flammables. Workers shall follow label and MSDS guidance on cleaning chemicals to prevent mixing of chemicals that may produce toxic gases.

44.8.5. Exits and Exit Markings. AF 32-series, CE guidance, NFPA 101, *The Life Safety Code*, and 29 CFR 1910.37, *Means of Egress, General*, provide detailed information on this subject. The installation CE shall comply with these publications.

#### **44.9. Receiving/Loading Dock.**

44.9.1. Lifting Techniques. Employees shall be instructed in proper handling techniques for the equipment and materials received. Supervisors shall periodically evaluate and advise employees on proper lifting techniques. The installation Ground Safety office shall be consulted in the planning stages of new facility design to minimize material handling hazards.

44.9.1.1. Position Feet Correctly. Place feet shoulder width apart for balance, with one foot to the rear of the object and the other foot slightly ahead of the other and to the side of the object.

44.9.1.2. Crouch close to the load. Bend with buttocks resting on the heels of shoes. Stay close to the load to minimize strain on the muscles. Lift with legs and body and keep the back straight.

44.9.1.3. Back Straight. Always keep the back as straight as possible. It may not be possible to keep the back in the vertical plane but avoid arching the back. Bend from the hips and not from the middle of the back.

44.9.1.4. Full Palm Grasp. Pick up materials with a full palm grip. Do not attempt to pick up weights with a fingertip grip. Ensure the load is free of grease or sharp points which could cause injury. Use suitable gloves when necessary.

44.9.1.5. Kinetic Leg Lift. With the arms, slide the object toward the body to give it some motion (kinetic energy). At the same time, lift the object with the legs and bring them back to a vertical position. Keep the object close to the body and avoid twisting while lifting.

44.9.1.6. Setting the Object Down. Use the same method as when lifting, but reverse it to set an object down. Lower the load by bending the legs and squatting with the back straight. Take care when releasing the load to prevent injury to fingers, hands or feet.

44.9.2. Use gloves and safety shoes.

44.9.3. Inspect objects for slivers, sharp edges, rough surfaces or slippery surfaces before attempting to lift.

44.9.4. Keep fingers away from pinch and shear points.

44.9.5. Do not carry a load that obstructs the view of the direction of travel. Make sure the path of travel is clear.

44.9.6. Do not turn at the waist to change direction or to put an object down. Turn the whole body and crouch down to lower the object.

44.9.7. Team-Lifting. Assign additional workers to assist when the load or material is too much for one person to handle safely and mechanical equipment is not practical. Use workers of approximately the same size and train them in team-lifting. If one worker lifts too soon, shifts the load or lowers improperly, either that worker or the worker's partner may be overloaded and strained. Assign one person to give orders to ensure the necessary coordination.

44.9.8. Tools. Adequate tools shall be available and properly stored for opening crates, containers, cartons, etc., (hammer, wire cutter, cardboard carton openers and pliers).

44.9.9. Eave Spouting. Ensure adequate eave spouting over the receiving and dock areas to prevent excessive water build-up or run-off on the loading dock.

44.9.10. Mechanical Material Handling Equipment. Use this equipment whenever loads are too heavy or bulky to be lifted or carried efficiently or safely by hand. Forklifts, hand trucks, rollers, conveyors or cranes (when properly used) simplify materials handling and greatly

reduce the hazards of handling supplies and equipment. Refer to [Chapter 35, Materials Handling Equipment](#), for additional information.

#### 44.10. Trash.

44.10.1. Trash handling and proper disposal is an integral part of the housekeeping process. Combustible waste products shall be removed at the end of each shift or more frequently, if necessary. Adequate trash bins, cans, baskets and other appropriate containers shall be provided to encourage proper waste disposal. Broken glassware shall not be disposed of, or carried in, soft or easily pierced containers. If nonmetallic waste or trash cans are used, they shall be approved by the installation FES Flight. Smoking materials shall be disposed of separately from trash.

44.10.2. Empty cartons and packing materials shall be disposed of promptly. Carton banding shall be disposed when removed. If cartons are nailed shut, the nails shall be removed and disposed of as the carton is opened.

44.10.3. When possible, outdoor trash receptacles shall be located a minimum of ten (10) feet from any building and shall always be kept closed or covered and the area around the receptacle kept clean.

44.10.4. Garbage cans shall be securely covered when not being actually filled or emptied.

44.10.5. Trash and garbage cans shall be leak-proof and adequate in number and size.

44.10.6. If the garbage disposal area is adjacent to or part of the general receiving area, the supervisor shall ensure floors and/or dock areas are clear of refuse and waste.

44.10.7. Garbage containers shall be positioned in a proper rack. Heavy garbage containers shall be moved on dollies to eliminate as much lifting as possible.

44.10.8. Garbage cans shall be washed with hot soapy water and sanitized weekly or more often if required to control odor or vermin.

44.10.9. Janitor/utility closets shall not be used as trash collection points.

**Table 44.1. Minimum Personal Protective Equipment (PPE) for Food Service Operations.**

<b>Minimum Personal Protective Equipment (PPE) for Food Service Operations</b>	
<b>Operation</b>	<b>Minimum Recommended PPE</b>
Receiving and Loading Docks	General purpose leather gloves
	Safety toe shoes
	Non slip rubber overshoes
Dry Storage Area	General purpose leather gloves
	Safety toe shoes
Pot and Pan Area	Rubber gloves
	Rubber apron
	Rubber boots or rubber overshoes over safety toe shoes
Walk-in Refrigerator and Freezers	Thermal gloves
	Bump caps

<b>Minimum Personal Protective Equipment (PPE) for Food Service Operations</b>	
<b>Operation</b>	<b>Minimum Recommended PPE</b>
	Cold environment insulating clothing, four-piece set (hood, jacket, trouser and safety shoe.) (This applies only to those workers who normal duty requires them to enter and exit these units often.)
Food Preparation	Hair nets or caps
Meat Boning, Cutting and Slicing	Metal mesh aprons or heavy butyl aprons
	Safety toe shoes
	Slip resistant shoes
Meat Grinding, Sawing and Pressing	Metal mesh aprons or heavy rubber aprons
	Safety toe shoes
	Slip resistant shoes
	Hair nets or caps
Deep Fat Frying	Thermal gloves (wrist or elbow length)
	Thermal apron (optional)
Baking	Thermal gloves
	Thermal apron
<b>Food Service Area</b>	
Dining Area	Rubber gloves (when removing dishes and cutlery)
Dishwashing Area	Rubber gloves
	Rubber aprons
	Rubber boots or rubber overshoes over safety toe shoes
	Slip resistant shoes
Food and Trash Disposal	General purpose leather gloves
	Abrasion resistant apron

**44.11. Food Service Operations Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

44.11.1. Are all food service workers trained in proper lifting, safe use of cutlery and food processing machinery, handling of hot foods, and the dangers of falls? Reference [44.2.2](#)

44.11.2. Do supervisors ensure safety-toe footwear is worn where there is a reasonable probability of foot or toe injury? Reference [44.3.1.1](#)

44.11.3. Are cleaning supplies kept separate from food products? Reference [44.3.2.3](#).

44.11.4. Are drain plugs designed so pot and pan sinks can be drained without the employee having to place their hands in hot water? Reference [44.3.4](#)

44.11.5. Is a by-pass or other type device installed on doors of walk-in freezers or refrigerated spaces to permit escape from inside if an employee is locked in? Reference [44.3.5.2](#)

- 44.11.6. Are floors mopped as necessary or at the end of each meal period? Reference [44.3.7.5](#)
- 44.11.7. Do supervisors ensure outside stairways, entrances, sidewalks, loading docks and ramps are cleared of snow and ice and that abrasive materials are used during inclement weather? Reference [44.4.1.4](#)
- 44.11.8. Are floor surfaces kept clean and in good condition, free of water, defects and slippery materials? Reference [44.4.3](#)
- 44.11.9. Are defective electrical equipment/cords taken out of service immediately? Reference [44.5.1](#)
- 44.11.10. Are all control switches (on and off) accessible to workers at their normal operating positions so workers do not reach over moving machine parts to activate the switch? Reference [44.5.14](#)
- 44.11.11. Do supervisors maintain manufacturer's manuals or locally developed guidance for all machinery or equipment under their control? Reference [44.6.1](#)
- 44.11.12. Does the supervisor or a designated trainer train personnel prior to allowing them to operate machinery or equipment? Reference [44.6.2](#)
- 44.11.13. Do supervisors ensure all machines are inspected at least every 60 days unless the manufacturer's manual, use or working environment requires more frequent inspections? Reference [44.7.2.1](#)
- 44.11.14. Are all machine guards securely in place and operational? Reference [44.7.3](#)
- 44.11.15. Does the supervisor provide food services personnel fire prevention training initially and annually thereafter? Reference [44.8.1](#)
- 44.11.16. Are doors leading to passageways or providing access to rooms blocked only with approval of the installation FES Flight? Reference [44.8.3.3](#)
- 44.11.17. Does the supervisor instruct employees in proper handling techniques for the equipment and materials received? Reference [44.9.1](#)
- 44.11.18. Does the supervisor assign additional workers to assist when the load or material is too heavy for one person to handle safely and use of mechanical equipment is not practical? Reference [44.9.7](#)
- 44.11.19. Are garbage cans securely covered when not being filled or emptied? Reference [44.10.4](#)
- 44.11.20. Are garbage cans washed with hot soapy water and sanitized weekly, or more often if required to control odor or vermin? Reference [44.10.8](#)

## Chapter 45

### TRAINING SYSTEMS

**45.1. General Information.** This chapter provides guidance on fire protection engineering criteria, fire prevention requirements and housekeeping procedures for the system safety and operational risk management (ORM) of all training devices in AFI 36-2251, *Management of Air Force Training Systems*. Headquarters Air Force Civil Engineer Support Agency (HQ AFCESA) shall determine the fire prevention requirements for trainers not covered in AFI 36-2251. Questions shall be directed to Headquarters Air Force Civil Engineer Support Agency (HQ AFCESA/CEO), 139 Barnes Drive, Suite 1, Tyndall AFB FL 32403-5319. **Note:** This chapter applies to all training systems regardless of the stage of design, development or date of installation.

45.1.1. Hazards. Hazards shall be engineered out, isolated, guarded against or a safer chemical used whenever possible before considering the use of personal protective equipment (PPE). Refer to **Chapter 1**, *Introduction*, paragraph **1.5**, **Chapter 3**, *Physical Hazards*, and **Chapter 14**, *Personal Protective Equipment (PPE)*, for additional guidance.

45.1.2. Human Factors. Functional managers, supervisors and workers shall be aware of human factors that can lead to worker error, injury or adverse effects on their operations. Refer to **Chapter 2**, *Human Factors*, for additional guidance.

45.1.3. Bioenvironmental Engineering (BE) Responsibilities. BE personnel perform occupational and environmental health (OEH) risk assessments of work processes. Supervisors with workplace health hazards questions should contact BE. Refer to paragraph **2.3**, MIL-STD-1686C, *ESD Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)*, and MIL-HDBK-263, *Electrostatic Discharge Control Handbook For Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)*, for additional guidance.

45.1.4. Static Electricity Hazards. Static electricity can damage electrostatic discharge (ESD) sensitive equipment, including computers and equipment associated with training systems. Protective measures, such as grounding, conductive floors and benches, humidity control, antistatic packaging of spare components and other controls shall be used as needed to prevent static electricity damage. Refer to TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance and Test of Electrical Equipment*, for additional guidance.

45.1.5. Fire Protection. Personnel who use training systems shall be protected from conditions which could cause injury or death. Training systems are valuable, critical to mission accomplishment and shall be provided adequate fire protection.

45.1.6. Fire, Injury and Equipment Damage Hazards. Refer to MIL-STD-1472F, *Human Engineering*, for additional guidance on damage to training systems equipment. Training system design and operating procedures shall prevent:

45.1.6.1. Improper fire prevention practices.

45.1.6.2. Inadequate fire detection and/or suppression systems.

45.1.6.3. Inadequately marked or blocked egress routes that prevent escape in a fire or emergency.

45.1.6.4. Contact with energized electrical circuits that results in serious injury or electrocution.

45.1.6.5. Poor housekeeping.

45.1.6.6. Operator error.

45.1.6.7. Faulty design.

45.1.6.8. Lack of training.

## 45.2. General Requirements.

45.2.1. Fire Extinguishers. Portable 1A-10B:C (or greater) fire extinguishers shall be located IAW **Chapter 6**, *Fire Protection and Prevention*, and NFPA 10, *Portable Fire Extinguishers*, in all facility areas such as motion bays, model boards, visual display rooms, computer bays, etc. Additional fire extinguishers may be provided in cockpit and/or other crew stations. Portable carbon dioxide (CO<sup>2</sup>) or non-halon gaseous agent (such as FE-36) fire extinguishers with a minimum rating of 10B:C may be used in areas primarily devoted to delicate and costly electronic equipment.

45.2.2. First Aid. First aid kits for emergency use shall be provided by the unit and approved by base medical services. This item is required for work more than three to four minutes from the nearest medical facility. **Note:** IAW OSHA's letter of interpretation for paragraph 1910.151(b) explains that a first aid kit is required if a medical facility is more than three to four minutes away.

45.2.3. Fire and Emergency Procedures.

45.2.3.1. The training system operator and/or instructor shall provide a fire safety briefing to trainees at the start of each training session. This briefing shall detail signals used for emergency conditions in the training system, specific actions required by trainees and specific actions required by the instructors/operators.

45.2.3.2. Prompt action during a fire will protect personnel and minimize damage. The first level of protection is to alert the instructors/operators for appropriate action, in many cases this simply involves removing power from the problem area. The training system and/or facility fire detection system provides a second level of protection and the facility fire suppression system the final level of protection.

45.2.4. Housekeeping. Good housekeeping is an important element of mishap prevention in training system facilities. Refer to **Chapter 5**, *Housekeeping*, for additional guidance.

45.2.4.1. Combustible materials shall be disposed of in suitable noncombustible containers, conspicuously labeled as to contents and with self-closing lids. These containers shall be emptied when full and at least at the end of each working shift. Contact the installation Environmental Management office for disposal procedures for combustible hazardous waste. Refer to **Chapter 22**, *Flammables and Combustibles*, for additional guidance.



45.2.4.2. Building floors, especially raised floors, shall be kept smooth, clean and free of obstructions and slippery materials.

45.2.4.3. Floor loading capacities shall be identified and posted IAW **Chapter 7, *Walking Surfaces, Guarding Floor and Wall Openings, Fixed Industrial Stairs, and Portable and Fixed Ladders***. These capacities shall not be exceeded.

45.2.4.4. Floors shall not be cleaned with flammable or combustible liquids. Follow the manufacturer's and MSDS guidelines when using cleaning agents for floors and facilities. The installation Environmental Management office, Fire Emergency Services (FES) Flight, Ground Safety office and BE shall determine the hazards associated with their use and prescribe appropriate controls.

45.2.4.5. To prevent buildup of trash and foreign objects, sub-floors under raised floors shall be cleaned periodically, but not less than once every 60 days. If cleaning history shows that a longer period between cleanings is feasible, the Fire Protection Flight may allow extending the time between cleanings. Areas under raised floors shall not be used for storage. Openings in raised floors, including raised training platforms, for electrical cables or other uses shall be protected to preclude collecting debris and to prevent tripping. Sub-floors shall be inspected once each operational day to ensure no flooding or leaking is present, unless the sub-floor area is provided with an automatic water leakage detection system. **Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

45.2.4.6. Utility trenches shall be kept clean of foreign objects and inspected at least every 60 days. If cleaning history shows a longer period between cleanings is feasible, the Fire Protection Flight may allow extending the time between cleanings. **Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

45.2.4.7. Drip pans shall be used to prevent accumulation of hydraulic fluid on floor and/or equipment surfaces. Drip pans shall be cleaned whenever there is excessive buildup of fluids.

### **45.3. Facility Requirements.**

45.3.1. Planning. Proper layout, spacing and arrangement of equipment and machinery are essential and can best be achieved in the planning stages by considering current and future uses of the facility. The installation Ground Safety office, CE, Fire Protection Flight and BE shall coordinate on all plans.

45.3.2. Location. Training systems shall be located in facilities complying with UFC 3-600-01, *Fire Protection Engineering for Facilities*, and ETL 01-18, *Fire Protection Engineering Criteria – Electronic Equipment Installations*. Training systems shall be considered as mission support equipment as defined in ETL 01-18. Facility fire protection shall be as follows:

45.3.2.1. Wheeled Vehicle Egress Assistance Trainers (such as the High Mobility Multipurpose Wheeled Vehicle (HMMWV) Egress Assistance Trainer [HEAT]). These trainers shall be protected by an automatic sprinkler system or automatic fire detection system installed IAW UFC 3-600-01 when located inside a structure having a roof and three or more side walls, including tension membrane/fabric structures.

45.3.2.2. Aircraft Fuselage Trainers (including aircraft loading/unloading trainers, patient transport trainers and other trainers utilizing an aircraft fuselage inside a facility). These units shall be completely protected with an automatic sprinkler system installed IAW UFC 3-600-01, including both inside and outside the fuselage.

45.3.2.3. Aircraft Flight Training Devices and Similar High Value Training Devices.

45.3.2.3.1. The entire facility, including equipment and non-equipment spaces, shall be completely protected by an automatic sprinkler system installed IAW UFC 3-600-01, and maintained IAW requirements in UFC 3-601-02, *Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems*.

45.3.2.3.2. New and relocated aircraft flight training devices or similar high value training devices shall be located in spaces protected by ultra-sensitive smoke detection systems IAW ETL 01-18. Existing facilities housing training devices with internal fire detection and alarm systems do not require ultra-sensitive systems but shall be provided with a standard smoke detection system. **Note:** An ultra-sensitive smoke detection system uses an aspirating air sampling-type smoke detector intended for detection of incipient fires, such as smoldering associated with overheating or low energy release rate fires.

45.3.2.3.3. Training system spaces shall be separated from other spaces and/or occupancies and operationally distinct adjacent equipment spaces in the facility by a minimum of 1-hour fire rated construction, extending from structural floor to structural ceiling and/or roof.

45.3.2.3.4. Raised floor spaces shall be divided in the same manner as the equipment spaces above the area they serve.

45.3.2.3.5. Raised floor spaces shall contain a standard or ultra-sensitive smoke detection system in the same manner as the equipment spaces above the area they serve.

45.3.2.3.6. Raised floor systems shall be constructed of noncombustible materials.

45.3.2.3.7. If training system spaces are served by air handling equipment which also serves any other part of the facility, including an adjacent training system space, automatic smoke and fire dampers shall be provided to shut off the space from the remainder of the facility upon any facility fire alarm indication. Activation of the facility fire detection system shall shut down the air handling system. An air handling system which serves an individual training system does not have to be deactivated for facility fire alarm indications for conditions originating outside the training system space.

45.3.2.3.8. Communications and interconnecting cable and wiring in training system and raised floor spaces shall comply with NFPA 70, *National Electrical Code*, Article 645. Communications and interconnecting cable and wiring in training system spaces and other areas of the facility or other facilities shall comply with NFPA 70, Article 725.

#### 45.3.3. Electrical.

45.3.3.1. Surge protection shall be provided for all incoming power to the training system. New training system facilities shall have surge protection for the entire facility.

45.3.3.2. All power and distribution circuits shall comply with NFPA 70 and UFC 3-520-01, *Interior Electrical Systems*.

45.3.4. Drainage. Drainage shall be provided in utility trenches and motion bays.

45.3.5. Hydraulic Pump Rooms. Hydraulic pump rooms shall be of 1-hour fire rated construction, except rooms which contain more than 250 gallons of hydraulic fluid, which shall be of 2-hour fire rated construction.

45.3.6. Emergency Lighting. Emergency lighting shall be provided IAW ETL 99-4, *Fire Protection Engineering Criteria - Emergency Lighting and Marking of Exits*.

### 45.4. Training Systems Requirements.

45.4.1. General Flammability Requirements. Only fire resistant and non-hazardous (when exposed to fire) materials shall be used in cockpits, seats, shrouds, cable ties, cable coverings and auxiliary insulation for heat, electrical, sound, etc. The flame spread rating for these materials shall not exceed 75 and smoke development shall not exceed 100 when tested IAW American Society for Testing Materials (ASTM) E-84, *Standard Method of Test of Surface Burning Characteristics of Building Materials*. Alternately, materials shall be considered acceptable that meet one of the following: certification under California State Fire Marshall Title 19; listing under Underwriters Laboratories (UL) 94, *Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*; or successful testing under NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, Test Method 1. Materials not meeting one of these requirements may only be used when the training device application is identical to the aircraft/wheeled vehicle configuration and material.

#### 45.4.2. General Hydraulic System Features.

45.4.2.1. Hydraulic pump controls shall be designed to automatically shut down on sudden or excessive flow in the hydraulic lines when the fluid level is low or when excessive hydraulic fluid temperature is sensed.

45.4.2.2. Flexible hoses shall be shielded to prevent leaking hydraulic fluid from spraying on potential ignition sources, trainees and staff personnel. Braided shielding integral to the flexible hoses shall be used whenever the hoses are not located in covered trenches.

45.4.2.3. Upon loss of power or shutdown of the hydraulic pumps, the training device shall automatically return to the rest position within 10 seconds.

45.4.2.3.1. For wheeled vehicle egress assistance trainers, it is permitted to provide a manual hand crank feature, or equivalent method, to enable the instructor/operator to manually rotate the trainer to a position that allows safe egress by the trainees.

45.4.2.3.2. For aircraft fuselage trainers, hydraulically operated doors are not required to be moveable upon loss of power or shutdown of the hydraulic pumps if

exit doors are provided for trainee egress from the trainer. The number of doors and locations shall comply with the requirements in NFPA 101, *The Life Safety Code*.

45.4.2.3.3. For aircraft flight and similar high value training systems, access ramps shall automatically deploy after motion is stopped — even when power is removed.

45.4.2.4. Hydraulic pump controls shall be designed so operation of the facility fire alarm or training system fire alarm system shuts down the pumps. This feature is not required for wheeled vehicle egress assistance trainers.

45.4.3. Emergency Lighting. Emergency lighting shall be provided in all enclosed occupied training spaces IAW NFPA 70, Article 700.

#### **45.5. Requirements of Wheeled Vehicle Egress Assistance Trainers.**

45.5.1. Safety Zone. A safety zone shall be provided to keep observers at a safe distance when the unit is rotating.

45.5.2. Head Strike Hazard. Projections inside the unit shall be padded and loose objects secured that could present a head strike hazard to trainees during unit rollover. Padding shall comply with flammability requirements in paragraph **45.4.1**.

45.5.3. Walkways. Walkways shall be padded where the trainees egress to minimize the potential for injury to personnel should a trainee fall from the vehicle doors. Padding shall comply with flammability requirements in paragraph **45.4.1**.

45.5.4. Fire Extinguisher. A portable fire extinguisher shall be located within immediate vicinity of the instructor/operator.

45.5.5. Power Failure. A means shall be provided to manually-rotate the unit to a safe position for trainee egress in case of loss of power or failure of the powered rotation motor.

45.5.6. Egress Procedures. Procedures shall be established to provide safe emergency occupant egress from the unit, such as when the unit fails to fully rotate to the design rollover position.

45.5.7. Loading and Seating. Approved occupant seating and loading limits shall be posted in the immediate vicinity of the unit. Prohibited seating arrangements shall also be posted, such as any unbalanced seating arrangements that could prevent manual rotation of the unit during an emergency.

45.5.8. Retractor Mechanisms. Trainee shall not be assigned to any location in the trainer (such as the gunner's hatch in the roof of a HEAT unit) that requires completion of manual actions by the trainee or others to pull/move the trainee to a safe position during a rollover operation. Automatic retractor mechanisms (such as gunner's restraint retractors) may be used only after they have been tested to successfully operate during all possible operational modes of the trainer, including failure to fully rotate to the design rollover position.

#### **45.6. Requirements for Aircraft Flight and Similar High Value Training Systems.**

45.6.1. Fire Detection and Alarm Systems.

45.6.1.1. New or relocated training systems do not require an internal fire detection and alarm system when located in spaces protected by ultra-sensitive smoke detection IAW paragraph 45.3.2.3.

45.6.1.2. Existing training systems in spaces protected by a standard smoke detection system shall have an internal fire detection and alarm system. This system shall interconnect all detection and annunciation devices with the various training system components (cabinets, instructor operator station (IOS), cockpit, motion base, etc.). This system shall be either of the dual fixed-temperature type or the ultra-sensitive type.

45.6.1.2.1. Dual fixed-temperature type fire detectors shall be installed in electrical, electronic, hydraulic and computer cabinets. Activation of the first detector, i.e., the one calibrated to the lower activating temperature, shall produce a distinctive audible signal. Activation of the second detector, i.e., the one calibrated to the higher activating temperature, shall activate the facility detection system through the training system fire alarm panel and de-energize the simulator and all peripheral equipment.

45.6.1.2.2. Ultra-sensitive smoke detection systems shall be provided to protect electrical, electronic/and computer cabinets. A minimum two-stage warning capability shall be provided. The first, more sensitive stage shall produce a distinctive audible signal. Activation of the second, less sensitive stage shall activate the facility detection system through the training system fire alarm panel and de-energize the simulator and all peripheral equipment.

45.6.1.2.3. If detection equipment is located in an unoccupied area, i.e., computer rooms, a means shall be provided to positively alert operators at the IOS. If multiple unoccupied computer areas are present, then a means shall be provided to inform the IOS which unoccupied area has the activated alarm.

45.6.1.3. A fire alarm graphic annunciator or display panel, to identify training system fire detection systems signals, shall be installed IAW NFPA 72, *National Fire Alarm and Signaling Code*. Each detection device shall be identified by light emitting diodes, or other readily visible means, in the graphic annunciator or display panel.

45.6.1.4. The fire detection system shall be powered by a dedicated circuit with backup battery power and connected to the facility electrical supply ahead of the training system disconnect switch.

45.6.1.5. The fire detection system shall be capable of operating from both 50 and 60 Hz.

45.6.1.6. The system fire detection and alarm control panel shall be designed to transmit both coded fire and trouble signals to the fire alarm and receiving center or other monitoring service (when not located on a DoD installation) IAW NFPA 72. This may be through the facility fire alarm transmitter or an independent fire alarm transmitter. Contact the installation Fire Protection Flight for fire alarm and receiving equipment requirements.

45.6.1.7. Interface of Facility and Training System Fire Protection Systems.

45.6.1.7.1. Required functions upon activation of the facility fire alarm system (without activation of any suppression system in the facility):

45.6.1.7.1.1. Occupants in the training spaces shall be notified of the alarm

condition through audible (siren, horn, bell, etc.) and visual (strobe) cues. Occupants of the facility (including those in the training spaces) shall exit the facility immediately without delay, following the facility's preexisting emergency evacuation plan.

45.6.1.7.1.2. For training systems meeting the requirements of paragraphs 45.3.2.3 and 45.4, the instructor may place the training system in a standby mode, system freeze or other appropriate condition prior to evacuation.

45.6.1.7.1.3. For existing facilities and training systems awaiting upgrade to comply with paragraphs 45.3.2.3 and 45.4, the training system power source shall shut down. This shutdown may be accompanied by an automatic Emergency Power Off (EPO) or by an automatic, rapid, sequenced shutdown. (Also see paragraph 45.7)

45.6.1.7.2. Required functions upon activation of the facility fire suppression system (without activation of a suppression system in any training system area):

45.6.1.7.2.1. Occupants in the training spaces shall be notified of the alarm condition through audible (siren, horn, bell, etc.) and visual (strobe) cues. Occupants of the facility (including those in the training spaces) shall exit the facility immediately without delay, following the facility's preexisting emergency evacuation plan.

45.6.1.7.2.2. The training system power source shall shut down. This shutdown may be accomplished by an automatic EPO or by an automatic, rapid, sequenced shutdown.

45.6.1.7.3. Required functions upon activation of a training system fire detection system only (without activation of any fire suppression system):

45.6.1.7.3.1. Training staff shall be notified upon activation of the first, less sensitive stage of ultra-sensitive smoke detection systems or upon activation of the first detector in dual fixed-temperature type systems. For existing facilities and training systems awaiting upgrade to comply with paragraphs 45.3.2.3 and 45.4, the training system power source shall EPO upon activation of the first detector. (Also see paragraph 45.7)

45.6.1.7.3.2. The training system shall automatically EPO upon activation of the second, less sensitive stage of ultra-sensitive smoke detection systems or upon activation of the second detector in dual fixed-temperature type systems for training systems meeting the requirements of paragraphs 45.3.2.3 and 45.4.

45.6.1.7.4. Required functions upon activation of a training system fire suppression system — the training system power source shall automatically EPO.

45.6.1.7.5. Training staff shall be provided with means to manually EPO whenever necessary for the safety of the staff, students or the equipment prior to exiting the facility.

45.6.1.7.6. Following an EPO:

45.6.1.7.6.1. The training system fire alarm system shall notify occupants throughout the facility of the alarm condition through audible (siren, horn, bell, etc.) and visual (strobe) cues.

45.6.1.7.6.2. All personnel throughout the facility, including those in training areas, shall exit the facility immediately without delay, following the facility's preexisting emergency evacuation plan.

45.6.2. Fire Stops. All cable trays, utility trenches, etc., that connect to spaces outside training system spaces shall have fire stops installed every 25 feet.

45.6.3. Air Handling Equipment. Training systems served by air handling equipment which also serves any other part of the facility, including any adjacent training system space, shall have automatic smoke and fire dampers to shut off the space from the remainder of the facility on any facility fire alarm indication. Air handling systems dedicated to an individual training system need not be deactivated upon facility fire alarm indications unless originating within the training system.

45.6.4. Specifications for Cable and Wiring.

45.6.4.1. Polyvinyl chloride (PVC) coated wire shall not be used in the cockpit areas of non-commercial-off-the-shelf (COTS) hardware and/or training systems. Plenum rated cable and wiring meeting the requirements of NFPA 70, Article 300.22 shall be used. **Note:** PVC coated wire is allowed in the cockpit areas of COTS hardware and/or training systems per manufacturer's standard or commercial design practices provided the cockpit is not enclosed or, if enclosed, that smoke detectors are installed and the system design vents any smoke or gases to the exterior of the cockpit.

45.6.4.2. Communications and interconnecting cable and wiring between components within the training system space and raised floor space shall comply with NFPA 70, Article 645, and those in the training system space and other areas of the facility or other facilities shall comply with NFPA 70, Article 725.

45.6.4.3. Power and signal cable groups in which heat cannot quickly dissipate shall contain a heat sensor wire or other heat sensing device.

45.6.4.4. Cable and wiring for the training system fire alarm system shall comply with NFPA 70, Article 760.

45.6.5. Power Disconnect Means. A means to disconnect electrical power to the entire training system shall be provided at all IOSs and at other key locations on the training system.

45.6.6. Computer and/or Electronic Cabinets.

45.6.6.1. Self-contained air conditioning systems shall include a product of combustion detector capable of sounding an audible alarm and activating the facility detection system.

45.6.6.2. Cabinets near a motion base water fog and/or spray deluge system shall be water resistant and/or shielded from water discharge. Cabinets near a motion base wet pipe sprinkler system do not require special protection.

45.6.6.3. The acquiring authority may exempt “off-the-shelf” computer and/or electronic devices with internal thermally activated power disconnects from requirements for dual fixed-temperature type thermal fire detectors for computer and/or electronic cabinets.

45.6.7. Instructor Operator Station (IOS).

45.6.7.1. A means to activate the facility fire detection system shall be provided in easy reach of the operators at the IOS. Normally, a standard manual fire alarm station shall be provided on the operator’s console with provision to interconnect to the facility alarm and detection system, and to initiate a training system EPO.

45.6.7.2. Smoke detection devices shall be provided in the IOS when located in an enclosed container and/or space not part of the facility. Activation of this system shall alert the training system occupants and the operators at the IOS.

45.6.7.3. A facility alarm annunciator shall be installed when the IOS is located in an enclosed container and/or space not part of the facility.

45.6.8. Cockpit and/or Other Crew Stations.

45.6.8.1. Single station smoke detection devices shall be provided in cockpits and other enclosed crew stations. Battery powered detectors shall not be used.

45.6.8.2. The cockpit shall be designed to preclude or restrict passage of smoke and gases through the cockpit floor or sides.

45.6.8.3. A means shall be provided to alert cockpit and/or other crew station occupants of a positive activation of the local and facility detection systems.

45.6.8.4. Training station ventilation shall be shut down if the training system fire detection is activated.

45.6.9. Motion Base.

45.6.9.1. The motion system shall return to the rest position within 10 seconds of activation of either the system fire detection system or the facility fire suppression system. Access ramps shall automatically deploy after motion is stopped, even when power is removed.

45.6.9.2. Hydraulically powered motion bases will comply with paragraphs [45.4.2](#) and the following:

45.6.9.2.1. Rate-compensated type thermal fire detection devices shall be provided under each motion platform. These rate-compensated type thermal fire detection devices are not required when all the following conditions are met: the training system is located in a facility fully protected by a wet pipe sprinkler system meeting the requirements of paragraph [45.3.2.3.1](#); flight training devices and associated controls are located in spaces protected by ultra-sensitive smoke detection systems as defined in ETL 01-18 (also see paragraph [45.3.2.3.2](#)); and the cockpit/crew stations located on the motion base fully comply with the cockpit/crew station requirements listed in paragraph [45.6.8](#). Refer to [Figure 45.1](#).



45.6.9.2.2. A wet pipe sprinkler system (sprinkler heads and piping) shall be provided as part of each motion base. This motion base sprinkler system is not required for training systems when all the following conditions are met: the training system is located in a facility fully protected by a wet pipe sprinkler system meeting the requirements of paragraph 45.3.2.3.1; flight training devices and associated controls are located in spaces protected by ultra-sensitive smoke detection systems as defined in ETL 01-18 (also see paragraph 45.3.2.3.2); and the cockpit/crew stations located on the motion base fully comply with the cockpit/crew station requirements listed in paragraph 45.6.8. Illustrations of the motion base sprinkler system are shown in Figure 45.1 through Figure 45.4. The exact position for each sprinkler and number of sprinklers shall be defined for each motion base to ensure complete coverage and prevent interference with each hydraulic actuator's range of motion. The system shall deliver a minimum of 0.35 gallons per minute per square foot of area under the motion base. Normally, sprinkler piping is interconnected with the facility sprinkler system, but a separate system riser with separate flow detection is acceptable.

45.6.9.2.3. A pre-action sprinkler system is permitted for the motion base in lieu of the wet pipe sprinkler system listed in paragraph 45.6.9.2.2 when approved in writing by the MAJCOM Fire Protection office. The rate-compensated type thermal fire detection devices listed in paragraph 45.6.9.2.1 shall be used to activate the pre-action functions of the system. **Note:** Increased procurement, operational and maintenance expenses are associated with the use of pre-action sprinkler systems.

Figure 45.1. Motion Base (Side View).

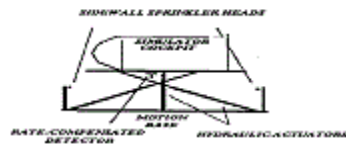
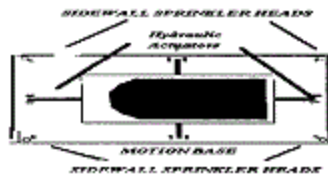
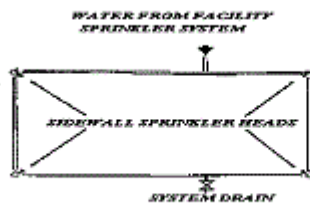


Figure 45.2. Motion Base (Top View).



**Figure 45.3. Sprinkler System Piping (Side View)****Figure 45.4. Sprinkler System Piping (Top View).**

**45.7. Upgrade of Existing Aircraft Flight and Similar High Value Training Systems.** Existing facilities and training systems may continue in use while awaiting upgrade to comply with paragraphs [45.3.2.3](#) and [45.4](#), if they comply with all the following:

45.7.1. Facilities. No Category I or II fire safety deficiencies (FSDs) exist.

45.7.2. Training Systems. It is assumed existing training system deficiencies have been upgraded or are programmed to be upgraded to comply with previous (superseded) editions of AFOSH standards. Training systems currently identified to be upgraded to previous (superseded) editions of AFOSH standards may be upgraded as programmed provided Halon 1301 or other gaseous agents are not part of the upgrade.

45.7.3. Maintenance. All installed fire protection features shall be regularly serviced and maintained in operational condition.

45.7.4. Halon. Existing Halon fire suppression systems shall be placed on manual activation and automatic discharge mechanisms disabled. Existing Halon fire suppression systems shall not be re-serviced following discharge and the training device shall remain operational. Training systems developed with Halon fire suppression systems shall transition to current standards during any major modification.

**45.8. Training Systems Checklist.** This is not an all inclusive checklist. It, like all checklists in this instruction, highlights some critical items contained within this chapter. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, FOAs, DRUs, local safety staffs and supervisors shall add to this checklist to include Command or individual location or shop-unique requirements and/or situations.

- 45.8.1. Does the fire safety briefing provided to trainees at the start of each training session include signals used to indicate an emergency condition and specific actions required by trainees, instructors and operators? Reference [45.2.3.1](#)
- 45.8.2. Are combustible materials disposed of in suitable non-combustible containers, conspicuously labeled as to contents, and with self-closing lids? Reference [45.2.4.1](#)
- 45.8.3. Are building floors kept smooth, clean and free of obstructions and slippery materials? Reference [45.2.4.2](#)
- 45.8.4. Are floor loading capacities identified and posted IAW [Chapter 7](#)? Reference [45.2.4.3](#)
- 45.8.5. Are cleaning materials used consistent with manufacturer's guidelines? Reference [45.2.4.4](#)
- 45.8.6. Are the installation Environmental Management office, FES Flight, Ground Safety office and BE consulted prior to use of cleaning materials? Reference [45.2.4.4](#)
- 45.8.7. Are areas under raised floors cleaned periodically, at least once every 60 days? Reference [45.2.4.5](#)
- 45.8.8. Are sub-floors inspected once per operational day to ensure no flooding or leaking is present, if not provided with an automatic water leakage detection system? Reference [45.2.4.5](#)
- 45.8.9. Are utility trenches kept clean of foreign objects and inspected at least once every 60 days? Reference [45.2.4.6](#)
- 45.8.10. Are drip pans used to prevent accumulation of hydraulic fluid on floor and equipment surfaces? Reference [45.2.4.7](#)
- 45.8.11. Are wheeled vehicle egress assistance trainers provided with a manual hand crank or equivalent method to manually rotate the trainer upon loss of power or shutdown of hydraulic motors? Reference [45.4.2.3.1](#)
- 45.8.12. Are aircraft fuselage trainers provided with an exit door for egress from the trainer in addition to any hydraulically operated loading ramps or doors? Reference [45.4.2.3.2](#)
- 45.8.13. Is emergency lighting provided in all enclosed, occupied training spaces? Reference [45.4.3](#)
- 45.8.14. Is a safety zone provided around the wheeled vehicle egress assistance trainer? Reference [45.5.1](#)
- 45.8.15. Are walkways padded around the wheeled vehicle egress assistance trainer wherever trainees could fall from vehicle doors? Reference [45.5.3](#)
- 45.8.16. Is a portable fire extinguisher located where immediately accessible by the operator of the wheeled vehicle egress assistance trainer? Reference [45.5.4](#)
- 45.8.17. Are occupant seating and loading limits, including prohibited seating arrangements, posted in the immediate vicinity of the wheeled vehicle egress assistance trainer? Reference [45.5.7](#)

45.8.18. Are training staff provided with a means to Emergency Power Off (EPO) the aircraft flight/similar high value training system? Reference [45.6.1.7.5](#)

45.8.19. Is a means within easy reach for the operator provided to activate the facility fire detection system at the IOS for the aircraft flight/similar high value training system? Reference [45.6.7.1](#)

45.8.20. Are smoke detection devices provided in the cockpit and other crew stations for the aircraft flight/similar high value training system? Reference [45.6.8.1](#)

45.8.21. Are cockpit and other crew station occupants alerted when local and facility detection systems are actuated for the aircraft flight/similar high value training system? Reference [45.6.8.3](#)

## Chapter 46

### PROCESS SAFETY MANAGEMENT (PSM)

**46.1. General Information.** This chapter applies to all highly hazardous chemical operations, as outlined in 29 CFR 1910.119., *Process Safety Management of Highly Hazardous Chemicals*. It implements 29 CFR 1910.119. requirements to prevent or minimize consequences of catastrophic releases of toxic, reactive, flammable or explosive chemicals. See website: [http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=9760](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9760). This chapter ensures attention and emphasis are given to OSHA requirements and provides implementation guidance. It also ensures adequate information is gathered for highly hazardous chemical operations, that process hazard analyses are performed and an appropriate PSM program is in place.

#### 46.2. Application.

46.2.1. The criteria in 29 CFR 1910.119. shall be used in its entirety for program implementation and application unless otherwise specified in this chapter. This chapter applies to all chemicals listed in 29 CFR 1910.119., Appendix A, *List of Highly Hazardous Chemicals, Toxics, and Reactives*, whether the chemical is in a mixture or a by-product of a chemical process and/or reaction. This chapter also applies to explosives and pyrotechnics defined and discussed in AFMAN 91-201, *Explosives Safety Standards*. In addition, this chapter applies to chemicals of equivalent hazard potential used within the Air Force, but not identified in 29 CFR 1910.119., Appendix A.

46.2.2. For purposes of this chapter, similar processes in separate locations and/or geographic areas, i.e., geographically separated buildings, shall not be considered a single process if the separation distance is sufficient to prohibit interaction and the processes are not physically interconnected.

#### 46.3. Responsibilities.

46.3.1. Installation Ground Safety (SEG). With assistance from the ground safety staff, the Chief of Ground Safety shall:

46.3.1.1. Serve as the focal point for implementing this chapter.

46.3.1.2. Coordinate installation PSM program and ensure PSM requirements are followed.

46.3.1.3. Assess installation operations and advise AFSEC/SEG (through MAJCOM safety channels) of number and type of operations that fall under this chapter.

46.3.1.4. Lead installation Process Safety Management Program (PSMP) Team, which shall include representatives from the installation Ground Safety office, BE, Hazardous Material Pharmacy (HMP) Program OPR, CE, Environmental Management office, Fire Emergency Services (FES) Flight, Readiness Flights and all highly hazardous chemical users as defined in 29 CFR 1910.119.

46.3.1.5. Ensure copies (or the location source) of OSHA-required PSM documentation are maintained for OSHA review for the life of the process.

46.3.1.6. Ensure each process hazard analysis is updated and revalidated by PSMP Team at least every five (5) years, after completion of initial process hazard analysis (PHA), to assure process hazard analysis is consistent with current process. **Note:** Organizations with specialized safety staffs may assign above responsibilities to another safety staff discipline.

46.3.2. Installation Bioenvironmental Engineering (BE) shall:

46.3.2.1. Provide technical advice and support to users of the chemicals, as outlined in 29 CFR 1910.119(d)(1).

46.3.2.2. Help determine range of possible health effects if controls fail, as outlined in 29 CFR 1910(e)(3).

46.3.2.3. Review process hazard analyses for technical accuracy of health effects and viability of health control measures.

46.3.2.4. Provide permanent membership to installation PSMP Team.

46.3.3. Installation Logistics Representative shall:

46.3.3.1. As the OPR for the HMP, provide PSMP Team information on chemicals present on the installation.

46.3.3.2. Provide permanent membership to the installation PSMP Team.

46.3.4. Installation Civil Engineering (CE).

46.3.4.1. Civil Engineering Environmental (CEV) shall:

46.3.4.1.1. Provide advice and information on corollary and associated environmental requirements, primarily derived from EPA Chemical Accidental Release Prevention (CARP) program requirements.

46.3.4.1.2. Provide permanent membership to the installation PSMP Team.

46.3.4.2. Fire Emergency Services Flight (CEF) shall:

46.3.4.2.1. Provide technical advice on fire hazards of chemicals, as outlined in 29 CFR 1910.119(d)(1).

46.3.4.2.2. Assist with determining range of possible fire effects if controls fail, as outlined in 29 CFR 1910.119(e)(3).

46.3.4.2.3. Review PHAs to determine technical accuracy of fire effects and technical viability of recommendations for fire control measures.

46.3.4.3. Readiness Flight (CEX) shall:

46.3.4.3.1. Ensure the emergency action plan for processes covered by this chapter meet the requirements of 29 CFR 1910.119(n).

46.3.4.3.2. Provide technical advice on emergency response, containment and cleanup to the PHA team.

46.3.4.3.3. Review PHAs to determine technical accuracy of emergency response plans and to include these considerations in emergency action plans.

46.3.5. Users of Highly Hazardous Chemicals shall:

46.3.5.1. Follow criteria of 29 CFR 1910.119.

46.3.5.2. Identify any chemicals thought to be hazardous but are not listed in 29 CFR 1910.119, Appendix A, to the PSMP team to determine if they should be considered under the PSM program.

46.3.5.3. Review written worker participation plan developed by PSMP team.

46.3.5.4. Obtain process safety information as outlined in 29 CFR 1910.119(d).

46.3.5.5. Develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information.

46.3.5.6. Review operating procedures as often as necessary to assure they reflect current operating practice, including changes in process chemicals, technology and equipment, and changes to facilities. The user shall certify to the PSMP Team annually that these operating procedures are current and accurate.

46.3.5.7. Update each PHA at least every five (5) years, after completion of initial PHA, to assure PHA is consistent with current process. Provide copy to PSMP Team for revalidation. **Note 1:** Provisions of hazard analyses must be brought to the attention of and followed by equipment maintainers performing any required maintenance, repair or replacement of equipment used for processes falling under this chapter. Workers shall also be advised of and follow guidance in 29 CFR 1910.119(j). **Note 2:** Supervisors of user organizations shall ensure that requirements for specific job tasks, as outlined in 29 CFR 1910.119(g), are conducted and documented for initial and refresher job task training. **Note 3:** Training required by this chapter is normal job skills training and/or operator equipment training, but does include PSM knowledge training.

46.3.6. The Installation Process Safety Management (PSMP) team consists of members from installation Ground Safety office, BE, HMP Program OPR, Environmental Management office, FES Flight, Readiness Flights and all highly hazardous chemical users, as defined in 29 CFR 1910.119. This team shall:

46.3.6.1. Develop and coordinate installation plan for worker participation.

46.3.6.2. Meet as necessary to ensure specific requirements of 29 CFR 1910.119. are met.

46.3.6.3. Track the status of discrepancies found during audits and report progress to the installation ESOH Council at least every 12 months.

46.3.6.4. Participate in pre-startup safety review with the process operator. Refer to 29 CFR 1910.119(i) for additional guidance.

46.3.6.5. Assess whether or not any chemical identified by user as possibly hazardous should be included in PSM program.

46.3.6.6. Conduct compliance audits each year using checklist in OSHA Compliance Program Letter 2-2.45, Appendix A, *PSM Audit Guidelines*. Audits may be done by a single member or members of the PSMP Team. **Note 1:** The PSMP team is not

necessarily the same team that performs process PHA in 29 CFR 1910.119(e). PHAs may be performed by internal staff members, by contractor or a combination of both. **Note 2:** The PSMP team leadership organization may be any one of the permanent members, at the discretion of the Installation and/or Wing Commander.

#### **46.4. Associated and Corollary Guidance Documents.**

46.4.1. Where practical, hazard analyses required by AFI 10-2501, *Air Force Emergency Management Program, Planning and Operations*, shall be combined with those required by PSM, and any industrial process analyses conducted under Section 313 of Emergency Planning and Community Right-To-Know-Act (EPCRA).

46.4.2. Some PSM program requirements are addressed directly or indirectly by existing Air Force publications. Thus, a review of other AF guidance may reveal some PSM requirements have been partially or fully completed. In that case, centralization of completed tasks into one reference source (project document) shall satisfy the requirements. **Note:** The PSM standard and EPA Chemical Accidental Release Prevention (CARP) program have some similar process requirements. The CARP program is outlined in 40 CFR, Part 68, *Chemical Accident Prevention Provisions*.

GREGORY A. FEEST  
Major General, USAF  
Chief of Safety



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

- AF Form 3, *Hazard Abatement Plan*, 1 October 1986
- AF Form 103, *Base Civil Engineering Work Clearance Request*, 11 March 2003
- AF Form 171, *Request for Driver's Training and Addition to U.S. Government Drivers License*, 15 March 2011
- AF Form 332, *Base Civil Engineer Work Request*, 1 January 1991
- AF Form 469, *Duty Limiting Condition Report*, 25 October 2007
- AF Form 483, *Certificate of Competency*, 1 February 1985
- AF Form 592, *USAF Hot Work Permit*
- AF Form 623, *Individual Training Record Folder*, 1 October 1996
- AF Form 971, *Supervisor's Employee Brief*, 1 October 1986
- AF Form 979, *Danger Tag*, 1 July 1990
- AF Form 980, *Caution Tag*, 1 July 1990
- AF Form 981, *Out of Order Tag*, 1 February 1981
- AF Form 982, *Danger Tag: Do Not Start*, 1 July 1990
- AF Form 983, *Danger – Equipment Lockout*
- AF Form 1024, *Confined Spaces Entry Permit*
- AF Form 1098, *Special Task Certification and Recurring Training*, 1 April 1985
- AF Form 1118, *Notice of Hazard*, 1 January 1982
- AF Form 1313, *Driver Record*, 1 May 1985
- AF Form 1492, *Warning Tag*, 1 October 1991
- AF Form 1800, *Operator's Inspection Guide and Trouble Report*, 1 April 2010
- AF IMT 55, *Employee Safety and Health Record*, 5 August 2011
- AFH 32-1084, *Facilities Requirements*, 1 September 1996
- AFI 10-2501, *Air Force Emergency Management Program, Planning and Operations*, 24 January 2007
- AFI 11-202V1, *Aircrew Training*, 22 November 2010
- AFI 11-218, *Aircraft Operations and Movement on the Ground*, 28 October 2011
- AFI 13-213, *Airfield Driving*, 1 June 2011
- AFI 21-101, *Aircraft and Equipment Maintenance Management*, 26 July 2010
- AFI 21-202V1, *Missile Maintenance Management*, 4 November 2009

AFI 23-204, *Organizational Fuel Tanks*, 24 June 2009

AFI 23-302, *Vehicle Management*, 29 October 2007

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AFI 31-204, *Air Force Motor Vehicle Traffic Supervision*, 14 July 2000

AFI 32-1042, *Standards for Marking Airfields*, 27 October 2005

AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arresting Systems*, 4 April 2003

AFI 32-1064, *Electrical Safe Practices*, 25 May 2006

AFI 32-1065, *Grounding Systems*, 1 October 1998

AFI 32-1066, *Backflow Prevention Program*, 8 October 2007

AFI 32-1067, *Water Systems*, 25 March 1994

AFI 32-2001, *Fire Emergency Services Program*, 9 September 2008

AFI 32-6002, *Family Housing Planning, Programming, Design, and Construction*, 15 January 2008

AFI 32-7040, *Air Quality Compliance and Resource Management*, 27 August 2007

AFI 32-7041, *Water Quality Compliance*, 20 December 2003

AFI 32-7042, *Waste Management*, 15 April 2009

AFI 32-7080, *Pollution Prevention Program*, 12 May 1994

AFI 32-7086, *Hazardous Materials Management*, 1 November 2004

AFI 36-2251, *Management of Air Force Training Systems*, 5 June 2009

AFI 36-2903, *Dress and Personal Appearance of Air Force Personnel*, 18 July 2011

AFI 40-201, *Managing Radioactive Materials in the US Air Force*, 16 March 2011

AFI 48-145, *Occupational and Environmental Health Program*, 15 September 2011

AFI 48-148, *Ionizing Radiation Protection*, 21 September 2011

AFI 90-821, *Hazard Communication*, 20 March 2005

AFI 90-901, *Operational Risk Management*, 1 April 2000

AFI 91-202, *The US Air Force Mishap Prevention Program*, 5 August 2011

AFI 91-204, *Safety Investigations and Reports*, 24 September 2008

AFI 91-207, *The US Air Force Traffic Safety Program*, 27 October 2011

AFJMAN 23-210, *Joint Service Manual (JSM) for Storage and Materials Handling*, 12 April 1994

AFJMAN 23-227(IP), *Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders*, 16 June 2000

AFMAN 23-110, *AF Supply Manual*, 1 April 2009

AFMAN 24-306(IP), *Manual for the Wheeled Operator*, 1 July 2009

AFMAN 32-1094, *Criteria for Air Force Precision Measurement Equipment Laboratory Design and Construction*, 1 November 1998

AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, 4 October 2011

AFMAN 48-153, *Health Risk Assessment*, 28 March 2007

AFMAN 48-154, *Occupational and Environmental Health Site Assessment*, 28 March 2007

AFMAN 48-155, *Occupational and Environmental Health Exposure Controls*, 1 October 2008

AFMAN 91-201, *Explosives Safety Standards*, 12 January 2011

AFOOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, 1 August 1997

AFOOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*, 30 June 2006

AFOOSH Standard 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories*, 1 March 1994

AFOOSH Standard 48-137, *Respiratory Protection Program*, 10 February 2005

AFOOSH Standard 48-139, *Laser Radiation Protection Program*, 10 December 1999

AFPAM 48-151, *Thermal Injury*, 18 November 2002

AFPAM 90-902, *Operational Risk Management (ORM) Guidelines and Tools*, 14 December 2000

AFPAM 91-210, *Contract Safety*, 14 February 1994

AFPAM 91-216, *USAF Safety Deployment and Contingency Pamphlet*, 9 August 2001

AFPD 91-2, *Safety Programs*, 28 September 1993

AFTO Form 95, *Significant Historical Data*, 17 June 2002

AFTO Form 244, *Industrial/Support Equipment Record*, 13 January 2011

AFTO Form 350, *Repairable Item Tag*, 1 January 1993

AFVA 11-240, *Airport Signs and Markings*

AFVA 13-221, *Control Tower Light Signals*

AFVA 48-101, **CAUTION—HAZARDOUS NOISE AREA—MAY CAUSE HEARING LOSS—HEARING PROTECTION REQUIRED**

AFVA 48-103, **CAUTION—HEARING PROTECTION MUST BE WORN WHEN THIS EQUIPMENT IS IN OPERATION LABEL**

AFVA 48-104, **CAUTION—HEARING PROTECTION MUST BE WORN WHEN THIS EQUIPMENT IS IN OPERATION LABEL**

AFVA 48-150, **CAUTION—HEARING PROTECTION MUST BE WORN WHEN THIS EQUIPMENT IS IN OPERATION**

AFVA 91-303, **DANGER—DO NOT ENERGIZE—PERSON WORKING ON ANTENNA**

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

AFVA 91-305, *DANGER—INTERLOCKS DISABLED*

AFVA 91-306, *DANGER—HIGH VOLTAGE*

DD Form 1577-2, *Unserviceable (Reparable) Tag Materiel*

DoD 4145.19-R-1, *Storage and Materials Handling*, 15 September 1979

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ETL 01-18, *Fire Protection Engineering Criteria – Electronic Equipment Installations*, 24 October 2001

ETL 07-3, *Jet Engine Thrust Standoff Requirements for Airfield Asphalt Edge Pavements*, 14 February 2007

ETL 96-5, *Hangar Concrete Floor Reflective Coating Criteria*, 26 August 1996

ETL 99-4, *Fire Protection Engineering Criteria - Emergency Lighting and Marking of Exits*, 9 November 1999

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(MNCL) MIL-DTL-15562G, *Matting or Sheet, Floor Covering Insulating for High Voltage Application*

MIL-STD-101B, *Color Code for Pipeline for Compressed Gas Cylinders*, 3 December 1970

MIL-STD-161, *Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels*, 25 August 2005

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Standard Form (SF) 182, *Authorization, Agreement and Certification of Training*, December 2006

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TO 00-25-223, *Integrated Pressure Systems and Components (Portable and Installed)*, 1 June 1991

TO 00-25-232 *Control and Use of Insulating Matting for High-Voltage Application*, 28 February 1997

TO 00-25-234 *General Shop Practice Requirements for the Repair, Maintenance and Test of Electrical Equipment*, 1 August 1988

TO 00-25-245 *Operations Instruction - Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, 1 September 2006

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- TO 00-85-20, *Engine Shipping Instructions*, 15 October 2003
- TO 00-105E-9, *Aerospace Emergency Rescue and Mishap Response Information (Emergency Services)*, 1 February 2006
- TO 00-110N-3, *Requisition, Handling, Storage and Identification of Radioactive Material*
- TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells*, 22 December 2009
- TO 1-1-688, *Use of Electronic Equipment in Hazardous Areas*
- TO 1-1-691, *Cleaning and Corrosion Prevention and Control, Aerospace and Non-Aerospace Equipment*, 2 November 2009
- TO 4T-1-3, *Inspection, Maintenance Instruction – Storage and Disposition of Aircraft Tires and Inner Tubes*
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- TO 14P3-1-131, *OPN and Maintenance Instruction with IPB – Aircrew Chem-Defense Ensemble*
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- TO 32-1-2, *Use of Hand Tools (International Business Machines)*
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- TO 33D2-10-60-1, *Operation and Maintenance Instruction with IPB –Cryogenic Sampler Model #FCS2001*
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- TO 35E8-2-5-1, *Operation and Maintenance Aircraft Arresting System Mod BAK-12/E32A*

- TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenance*, 20 July 2007
- TO 36C-1-4, *Dielectric Testing of Insulated Aerial Manlift Devices*
- TO 36C-1-5, *Sixty Rules on Safety—Operators of Power Cranes and Excavators*, 1970
- TO 36G1-2-9-1, *Oxygen/Nitrogen Generating Plant, Model J665*
- TO 36G1-2-9-11, *Operation and Service Instruction—Oxygen, Nitrogen Generating Plant, Type I-A/E26A-8, II-A/E26A-20, Model D LON-150(M)*
- TO 36G1-2-9-21, *Operation and Service Instruction—Oxygen and Nitrogen Generating and Charging Plant, 1.5 Ton Per Day, Type A/E 26A-8 Model J79122 1.5 TD*
- TO 36G1-2-11-1, *Operation and Service Instruction—Oxygen and Nitrogen Generating and Charging Plant, 5 Ton Per Day, Model J79123, 5 TD*
- TO 36G1-3-8-1, *Operation and Service Instruction—Generating Plant, Oxygen and Nitrogen, Model DLON-500(M), -500(M)-2*
- TO 36M-1-141, *Operator and Operation Instruction—Material Handling Equipment System Components of 463L*
- TO 36M2-3-35-11S, *Operation and Operator Maintenance Instructions, Truck, Aircraft Cargo Loading/Unloading 60,000 Pound Capacity*
- TO 36M2-3-45-1, *Halvorsen 25K Aircraft Cargo Loaders*
- TO 36Y31-1-1, *Removal of Rust and Sediment from Fuel and Oil Servicing Truck and Trailer Tanks and Application of Coating, Interior, Fuel and Water Resistant*
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### ***Abbreviations and Acronyms***

**AAAH**C—Accreditation Association for Ambulatory Health Care

**AC**—Alternating Current

**ACO**—Administrative Contracting Office or Officer

**AED**—Automated External Defibrillator

**AETC**—Air Education and Training Command

**AFCE**SA—Air Force Civil Engineer Support Agency

**AFCI**—Arc-fault Circuit Interrupters

**AFHCP**—Air Force Hazard Communication Program

**AFI**—Air Force Instruction

**AFJI**—Air Force Joint Instruction

**AFMAN**—Air Force Manual

**AFMC**—Air Force Materiel Command

**AFMOA**—Air Force Medical Operations Agency  
**AFOSH**—Air Force Occupational Safety and Health  
**AFPD**—Air Force Policy Directive  
**AFRC**—Air Force Reserve Command  
**AFSEC**—Air Force Safety Center  
**AFTO**—Air Force Technical Order  
**AFVA**—Air Force Visual Aid  
**AGE**—Aerospace Ground Equipment  
**ALARA**—As Low As Reasonably Achievable  
**ANG**—Air National Guard  
**ANSI**—American National Standards Institute  
**ASHRAE**—American Society of Heating, Refrigerating and Air-Conditioning Engineers  
**ASME**—American Society of Mechanical Engineers  
**ASTM**—American Society for Testing Materials  
**ATPV**—Arc Thermal Performance Value  
**BCE**—Base Civil Engineer  
**BE**—Bioenvironmental Engineering  
**BTU**—British Thermal Unit  
**BX**—Base Exchange  
**C**—Celsius  
**CBT**—Computer-based Training  
**CE**—Civil Engineering  
**CEF**—Civil Engineering Fire Protection  
**CFR**—Code of Federal Regulations  
**CGA**—Compressed Gas Association  
**cm**—Centimeter  
**COF**—Coefficient of Friction  
**CPR**—Cardiopulmonary Resuscitation  
**CRT**—Cathode Ray Tube  
**CO<sub>2</sub>**—Carbon Dioxide  
**CSPT**—Confined Spaces Program Team  
**dB**—Decibels

**DBMS**—Director of Medical Service

**DC**—Direct Current

**DoD**—Department of Defense

**DOT**—Department of Transportation

**DRU**—Direct Reporting Unit

**EAID**—Equipment Authorized Inventory Data

**EH**—Electrical Hazard

**EOD**—Explosive Ordnance Disposal

**EPO**—Emergency Power Off

**ESOHC**—Environmental, Safety and Occupational Health Council

**ESOHCAMP**—Environmental, Safety and Occupational Health Compliance Assessment Program

**ETL**—Engineering Technical Letter

**F**— Fahrenheit

**FC**—Fiber Core

**FES**—Fire Emergency Services

**FHA**—Flash Hazard Analysis

**FMRC**—Factory Mutual Research Corporation

**FOA**—Field Operating Agency

**FOD**—Foreign Object Damage

**FSC**—Fuels Service Center

**GFCI**—Ground Fault Circuit Interrupter

**GSA**—General Services Administration

**HAZMAT**—Hazardous Material

**HEAT**—HMMWV Egress Assistance Trainer

**HMMWV**—High Mobility Multipurpose Wheeled Vehicle

**HQ**—Headquarters

**HSV**—Hydrant Servicing Vehicle

**HVAC**—Heating, Ventilation and Air Conditioning

**ICBM**—Intercontinental Ballistic Missile

**IDLH**—Immediately Dangerous to Life and Health

**IOS**—Instructor Operator Station

**IPS**—Improved Plow Steel  
**ITM**—Inspection, Test and Maintenance  
**IWRC**—Independent Wire Rope Core  
**JSA**—Job Safety Analysis  
**JSM**—Joint Service Manual  
**kV**—Kilovolt  
**kW**—Kilowatt  
**LEL**—Lower Explosive Limits  
**LFL**—Lower Flammable Limit  
**LN2**—Liquid Nitrogen  
**LOTO**—Lockout/Tagout  
**LOX**—Liquid Oxygen  
**LP**—Liquefied Petroleum  
**MAJCOM**—Major Command  
**MAQ**—Maximum Allowable Quantity  
**MDS**—Mission Design Series  
**MEP**—Master Entry Plan  
**MIL-HDBK**—Military Handbook  
**MIL-SPEC**—Military Specification  
**MIL-STD**—Military Standard  
**MFH**—Military Family Housing  
**MHE**—Material Handling Equipment  
**MNCL**—Master Nuclear Certification List  
**MPH**—Miles Per Hour  
**MSDS**—Material Safety Data Sheet  
**MTF**—Medical Treatment Facility  
**MTP**—Maximum Tire Pressure  
**MUTCD**—Manual on Uniform Traffic Control Devices  
**NATO**—North Atlantic Treaty Organization  
**NCS**—National Consensus Standard  
**NDI**—Non-Destructive Inspection  
**NEC**—National Electrical Code

**NFPA**—National Fire Protection Association  
**NIOSH**—National Institute for Occupational Safety and Health  
**nm**—Nautical Mile  
**NMAB**—National Materials Advisory Board  
**NRTL**—Nationally Recognized Testing Laboratory  
**NSC**—National Safety Council  
**NSF**—National Sanitation Foundation  
**NSN**—National Stock Number  
**OAP**—Oil Analysis Program  
**OEEL**—Occupational and Environmental Exposure Limit  
**OI**—Operating Instruction  
**OH**—Occupational Health  
**OJT**—On-The-Job-Training  
**OPR**—Office of Primary Responsibility  
**ORM**—Operational Risk Management  
**OSH**—Occupational Safety and Health  
**OSHA**—Occupational Safety and Health Administration  
**PDO**—Publishing Distribution Office  
**PFAS**—Personal Fall Arrest System  
**PH**—Public Health  
**PMEL**—Precision Measurement Equipment Laboratory  
**POL**—Petroleum, Oils and Lubricants  
**PPE**—Personal Protective Equipment  
**PR**—Permit-required  
**psi**—Pounds per Square Inch  
**psia**—Pounds per Square Inch Absolute  
**psig**—Pounds per Square Inch Gauge  
**RAC**—Risk Assessment Code  
**RADIAC**—Radiation Detection, Identification and Computation  
**REM**—Roentgen Equivalent Man  
**RF**—Radio Frequency  
**RPIE**—Real Property Installed Equipment

**RSO**—Radiation Safety Officer  
**SABC**—Self-Aid Buddy Care  
**SAE**—Society of Automotive Engineers  
**SAV**—Staff Assistance Visit  
**SCBA**—Self-Contained Breathing Apparatus  
**SEG**—Ground Safety  
**SG**—Surgeon General  
**SOW**—Statement of Work  
**SSEA**—System Safety Engineering Analysis  
**TMDE**—Testing, Measurement, Diagnostic and Evaluation  
**TLD**—Thermoluminescent Dosimeter  
**TOA**—Table of Allowance  
**TO**—Technical Order  
**UFC**—Unified Facilities Criteria  
**UL**—Underwriters Laboratories  
**UN**—United Nations  
**USAFSAM**—US Air Force School of Aerospace Medicine  
**USAF**—United States Air Force  
**US**—United States  
**UV**—Ultraviolet  
**VDT**—Video Display Terminal  
**VCNCO**—Vehicle Control Non-Commissioned Officer  
**VCO**—Vehicle Control Officer  
**VMO**—Vehicle Maintenance Officer  
**www**—World-Wide Web  
**XIPS**—Extra Improved Plow Steel

### *Terms*

**463L Equipment**—Specialized material handling equipment designed for on- and off-loading cargo from aircraft. It includes specially constructed pallet conveyor platforms.

**Abrasive Wheel**—A cutting tool made of abrasive grains held together by organic or inorganic bonding materials.

**Automated External Defibrillator**—A device that analyzes the heart's rhythm and, if necessary, tells the user to deliver a shock to a victim of sudden cardiac arrest. This shock, called defibrillation, may help the heart to re-establish an effective rhythm of its own.

**Actuator**—A manually operated device used to initiate controls or operator action. An actuator includes, but is not limited to, a push button, toggle switch, foot pedal, hand lever or a hand set timer.

**Administrative or Regulatory Authority**—Governmental agency or the employer in the absence of governmental jurisdiction.

**Aerial Device**—Any vehicle-mounted device, telescoping or articulating or both, that is used to elevate personnel to job sites above ground. These devices include extendable boom platforms, vertical towers or a combination of the above.

**Aerial Ladder**—An aerial device consisting of a single or multiple-section extendable ladder.

**Affected worker**—A worker whose duties require him/her to work in the vicinity of or operate a machine or equipment on which servicing or maintenance is being performed.

**Aisleway**—An established path for powered material handling equipment (or foot traffic) used inside a facility, such as aisleways in a warehouse.

**Anchorage**—See Fixed Anchorage.

**Angle Indicator (Boom)**—An accessory that measures the angle of the boom to the horizontal.

**Anti-Repeat or One Stroke Only**—A system or device that may be part of the clutch and/or brake control mechanism and limits the press to a single stroke when the tripping control is held in an operational position.

**Appointed**—Assigned specific responsibilities by the supervisor or the authorized user agency.

**Approved**—Listed and approved by Underwriters Laboratories Inc., Factory and Mutual Engineering Corporation, The Bureau of Mines, National Institute for Occupational Safety and Health, American National Standards Institute, National Fire Protection Association or other nationally recognized agencies that list, approve, test or develop specifications for equipment to meet fire protection, health or safety requirements.

**Approved Portable Fire Extinguishers**—Extinguishers procured to a military specification for specific Air Force needs, or approved by a nationally recognized agency such as Underwriters Laboratories Inc., Factory Mutual Laboratory, Bureau of Mines, Department of Interior, Department of Transportation (DOT) or US Coast Guard.

**Articulating Boom Platform**—An aerial device with two (2) or more hinged boom sections.

**Assembly Facilities**—Facilities or portions of facilities used for gathering together 50 or more persons for such purposes as deliberations, worship, entertainment, eating, drinking, amusement or awaiting transportation.

**Atmospheric Monitoring**—The quantitative analysis of a confined space environment to identify a potentially hazardous atmosphere.



**Attendant**—A trained individual stationed outside one or more confined spaces who monitors authorized entrants and performs attendant's duties assigned in the permit space program.

**Authorized Worker**—A worker who locks or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment.

**Automatic Fire Detection System**—A system that employs heat, smoke and flame detectors, or a combination of these, to detect, announce and report the presence of fire. The system includes features to manually actuate the system and transmit the alarm to the FES Flight.

**Fire Suppression System**—A system that automatically or manually discharges fire extinguishing agent to suppress a fire.

**Auxiliary Hoist**—A supplemental hoisting unit of lighter load capacity and usually higher speeds than provided by the main hoist.

**Backrest Extension (Forklift)**—A device extending vertically from the fork carriage to keep cargo from falling rearward.

**Bearer**—A horizontal part of a scaffold on which the platform rests and which may be held in place by ledgers.

**Belt Conveyor**—An endless fabric, rubber, plastic, leather or metal belt operating over suitable drive, tail end and bend terminals and over belt idlers or slider bed for handling bulk materials, packages or objects placed directly upon the belt.

**Belt Idler**—A roller or series of rollers that support the belt of a belt conveyor.

**Blacklight**—Light in the near ultraviolet spectrum, e.g. light having wave lengths of 3200A to 4200A (Angstrom Units), and that is used to stimulate fluorescence in various dyes.

**Blanking or Blinding**—The absolute closure of a pipe, line or duct, by fastening across it a solid plate or cap capable of withstanding the maximum upstream pressure with no leakage beyond the plate or cap.

**Bloodborne Pathogens**—Bloodborne pathogens are pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, Hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

**Body and/or Hand protection**—Any glove, finger guard, arm protector, apron, bib or garment designed to protect the body, arms, hands or fingers from contamination or injury due to absorption or physical contact.

**Body Harness**—A harness secured about the wearer so fall arrest forces are distributed over the thighs, buttocks, chest and shoulders, or any combination thereof. Includes provisions for attaching a lanyard centered in the back near shoulder level or above the head.

**Bonding**—The interconnecting of metal raceways, equipment cabinets, shields, etc., to the facility equipment system to eliminate electrical potential of individual pieces of equipment relative to each other.

**Boom Angle**—The angle between the longitudinal centerline of the boom and the horizontal. The boom longitudinal centerline is a straight line between the boom foot pin (heel pin) centerline and the boom point sheave pin centerline.

**Boom (Crane)**—A member, fixed or telescoping, hinged to the rotating superstructure and used to support the hoisting tackle.

**Boom Hoist**—A hydraulic or mechanical hoist drum and rope reeving system used to raise and lower the boom. The rope system may be all live reeving or a combination of live reeving and pendants.

**Boom Stop**—A device used to limit the angle of the boom at the highest position.

**Brace**—A tie that holds one scaffold part in a fixed place with respect to another part.

**Braided Wire Rope**—A wire rope formed by plaiting (braiding) component wire strands.

**Brake**—A friction device for slowing down a conveyor component, bringing conveyor equipment to a controlled stop, holding traveling or traversing equipment in a selected location, preventing reverse travel and controlling over-speed due to the action of gravity.

– *Brake, Drag.* A brake that provides retarding force without external control.

– *Brake, Holding.* A brake that automatically prevents motion when power is off.

– *Brake, Travel.* A brake that retards or stops motion in a horizontal direction.

**Bridge**—That part of a crane consisting of girders, trucks, end ties, footwalks and drive mechanism that carries the trolley or trolleys.

**Bridge Plate**—A plate, usually of metal and having a rated load capacity, used to span the space between freight cars or trucks and the loading platform. Also known as a dockboard.

**Breakthrough Time**—The time required for a specific chemical to permeate through a particular brand of protective clothing or equipment.

**Buddy System**—Two people, each responsible for each other's safety, are present in a hazardous situation. There are two (2) types of buddy systems. One involves both persons subjected to the same hazard at the same time, and each assures the other's well-being and assists if a mishap occurs. The other system is where one person is exposed to the hazard while the other is not and acts as an observer.

**Bumper (Buffer)**—An energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel or when two (2) moving cranes or trolleys come in contact.

### **Cab**

– The operator's compartment attached to the crane or monorail carrier in which the operator may ride and from which the motions of the crane or monorail equipment may be controlled.

– A housing that covers the rotating superstructure machinery or operator's station.

**Cable Laid Wire Rope**—A wire rope composed of six (6) wire ropes wrapped around a fiber or wire rope core.

**Cab-Operated**—Crane or monorail equipment, the motions of which are controlled from an operator's cab.

**Calibration or Recalibration**—A laboratory or bench-top resetting of alarm points, spans and zeros according to manufacturer's specifications.

**Capable of being locked out**—An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, has a locking mechanism built into it or if lockout can be achieved without the need to dismantle, rebuild or replace the energy isolating device or permanently alter its energy control capability.

**Carbon Dioxide Fire Suppression System**—An automatic or manually activated fire suppression system that uses carbon dioxide (a colorless, odorless, electrically nonconductive gas) as its extinguishing agent.

**Cardiopulmonary Resuscitation (CPR)**—A procedure to support and maintain breathing and circulation for a person who has stopped breathing (respiratory arrest) and/or whose heart has stopped (cardiac arrest).

**Carrying Methods**—Following are descriptions of various types of carrying methods:

– *Neck Carry Method.* In this method, the material is carried on the back of the neck and shoulders with both arms lifted to shoulder height and the hands grasping the sides or top of the load.

– *Shoulder Carry Method.* The load rests on one shoulder with the near arm helping to support the weight and the other arm brought across the body to steady the load.

– *Side Hand Carry Method.* This is simply the suitcase method and can be used only where the load may be grasped by a handle or the equivalent.

– *Tray Carry Method.* The material is carried in front of the abdomen with both hands placed under the bottom surface and the body serving as the balancer.

– *Two Person Carry Method.* A load is carried by two (2) people who use oral signals to coordinate their movements. They decide on appropriate emergency signals to be given if the grasp of either person should slip. They walk in step to coordinate their movements.

– *Under-Arm Carry Method.* The material is carried under one arm with the other arm brought across in front of the body to steady and balance the load. Also called Side Under-Arm Carry Method.

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

**Chain**—A series of links pivotally joined together for conveying or transmitting motion or power. General classes of chain are detachable, pintle, combination, roller, rivetless, coil, inverted tooth and bar link chains.

– *Chain, Roller Link.* A chain consisting of a series of stamped steel plates fastened with pins, bushings and rollers giving articulation in only one plane.

– *Chain, Welded Link.* A chain consisting of a series of interwoven links formed and welded from round bar stock.

**Chemical Protective Clothing**—Chemical protective clothing is intended to protect the worker from contact with chemicals. It may include items such as: hoods, face shields, chemical goggles, jackets, coats, aprons, bib overalls, coveralls, splash suits, boots, shoe covers and full-body encapsulating suits.

**Chuck**—A clamp that holds a tool or material being worked in or on a machine.

**Class I Solvents**—Liquids having a flash point below 100°F (37.8°C).

**Class II Solvents**—Liquids having a flash point at or above 100°F (38°C) and below 140°F (60°C).

**Class IIIA Solvents**—Liquids having a flash point at or above 140°F (60°C) and below 200°F (93.4°C).

**Class IIIB Solvents**—Liquids having a flash point at or above 200°F (93.4°C).

**Class IV Solvents**—Liquids classified as nonflammable.

**Class A Fire**—Fire involving ordinary combustible materials such as wood, cloth, paper, rubber and many plastics.

**Class B Fire**—Fire involving flammable liquids, grease and gases.

**Class C Fire**—Fire involving energized electrical equipment.

**Class D Fire**—Fire involving combustible metals such as magnesium, titanium, zirconium, sodium and potassium.

**Climbing Ladder**—A separate or built-in ladder with rungs spaced at equal distance and attached to a scaffold or platform so people can climb and descend.

**Clutch**—A device used to connect and disconnect a driving and driven part of a mechanism that, when connected, transmits rotary motion from the driving part to the driven member.

**Coaming (Toeboard)**—Raised sides on a platform installed to prevent tools and small items from falling off.

**Coating**—An elastomer or other suitable material used to impart physical, electrical or other desired properties when applied to a sling or sling component.

**Combination Unit (Emergency Shower and Eyewash)**—A unit combining a shower with an eye and face wash, or eyewash with a drench hose, or both.

**Combustible Liquid**—A liquid having a flashpoint at or above 100° F (37.80° C). Combustible liquids shall be divided into two classes as follows:

– Class II liquids have a flashpoint at or above 100°F (37.8° C) and below 140° F (60° C), except any mixture having components with flashpoints of 200° F (93.3° C) or higher, the volume of which makes up 99 percent or more of the total volume of the mixture.

– Class III liquids have flash points at or above 140° F (60° C) and are subdivided into two subclasses:

-- Class IIIA liquids have flashpoints at or above 140° F (60° C) and below 200° F (93.3° C), except any mixture having components with flashpoints of 200° F (93.3° C) or higher, the total volume of which makes up 99 percent or more of the total volume of the mixture.

-- Class IIIB liquids have flashpoints at or above 200°F (93.3° C).

**Commercial Cooking Facilities**—Facilities such as clubs, dining halls, snackbars, cafeterias and other places of assembly where the facility or a portion of it is devoted to the preparation of food served to the public.

**Competent Person**—Competent person is an individual who, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, is designated by the unit commander, unit representative or supervisor and has authority to take appropriate actions.

**Compressed Gas**—Any gas or mixture of gasses in a container having a pressure exceeding 40 psia at 70° F (21.1° C), or a pressure exceeding 104 psia at 130° F (54.4° C), or any liquid having an absolute vapor pressure exceeding 40 psia at 100° F (37.8° C).

**Conductor**—A substance or device that readily conducts heat, electricity, sound, etc. Definitions of specific conductors follow:

- *Conductors, Bridge.* The electrical conductors located along the bridge structure of a crane to provide power to the trolley.
- *Conductors, Enclosed.* Bar or wire used to transmit electricity, enclosed to minimize the possibility of accidental contact with the conductor.
- *Conductors, Open.* Bar or wire not enclosed, used to transmit electrical current and provide power (frequently used with the crane or monorail carrier).
- *Conductors, Runway (Main).* The electrical conductors located along a crane runway to provide power to the crane.

**Confined Space**—A space large enough and configured so a worker can bodily enter and perform assigned work; has limited or restricted means for entry or exit (for example: tanks, vessels, silos, storage bins, hoppers, vaults, manholes and pits); and is not designed for continuous human occupancy.

**Confined Space Program Team (CSPT)**—A group of professionals, consisting of representatives from installation Ground Safety office, FES Flight and BE, working together for the purposes of organizing and controlling the installation confined space program. Commanders, functional managers or their representatives are members of the team when their particular organizations are involved.

**Control**—The system governing the starting, stopping, direction of motion, acceleration, speed, retardation and function of the moving member in a predetermined manner.

**Control Braking**—A method of controlling motor speed when in an overhauling condition, i.e., as in a crane motor.

**Control Voltage**—The voltage passing through the operator's push-button station or the controller and the control circuits.

**Controller**—An electric or mechanical device or assembly of devices for starting, stopping, accelerating or decelerating a system, or which serves to govern in some predetermined manner the power delivered to the system.

**Controller, Spring Return**—A controller that when released will return automatically to a neutral or off position.

**Coolant**—Oil or other fluid that draws off heat by circulating through a machine or by bathing a mechanical part, such as oil that is applied to a metal cutting operation to dissipate the heat.

**Corrective Lens**—A lens manufactured to the wearer's individual corrective prescription.

**Corrosive**—Any substance that burns, injuriously irritates or destructively attacks metal, organic tissues or other materials.

**Countertorque**—A method of control by which the power to the motor is reversed to develop torque in the opposite direction. Also used to slow or stop motion.

**Counterweight**—A weight used to balance or counter a load. Examples are:

- Additional weight attached to the rear of the forklift to provide better weight distribution.
- Weight used to supplement the weight of a crane to provide stability for lifting working loads.

**Coupler**—A device for locking together the parts of a tubular metal scaffold.

**Crane**—Any machine for lifting and lowering of a load and moving it horizontally, in which the lifting device is an integral part of the machine.

- *Crane, Cantilever Gantry.* A gantry or semi-gantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.
- *Crane, Crawler.* A crane consisting of a rotating superstructure with power plant, operating machinery and boom, mounted on a base, equipped with crawler treads for travel.
- *Crane, Floor-Operated.* A crane which is controlled by an operator on the floor or an independent platform by using a pendant or nonconductive rope.
- *Crane, Gantry.* A crane similar to an overhead crane except the bridge for carrying the trolley or trolleys is rigidly supported on two (2) or more legs running on fixed rails or other runway.
- *Crane, Overhead.* A crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed runway structure.
- *Crane, Remote-Operated.* A crane controlled by an operator not in a cab or pulpit. It is controlled by any method other than pendant or rope control (for example: radio, voice, remote hydraulic control, etc.).
- *Crane, Storage Bridge.* A gantry type crane of long span usually used for bulk storage of material; the bridge girders or trusses are rigidly or non-rigidly supported on one or more legs. It may have one or more fixed or hinged cantilever ends.
- *Crane, Underhung.* A traveling bridge on two (2) or more runway tracks on which hoists and carriers may travel for the purpose of lifting, transporting and lowering loads. It is suspended under its runway tracks system, the trolley of which operates on the bottom flange of the track.
- *Crane, Wall.* A crane having a jib with or without trolley and supported from a side wall or line of columns of a building. It is a traveling type and operates on a runway attached to the side wall or columns.

**Critical Load**—Materials that if damaged or destroyed during a lift would present an unrecoverable loss or unacceptable risk. Air Force materials will be designated as critical loads for purposes of lifting or hoisting by an appropriate Program Manager or the functional manager

at the facility where the lift will occur. Items for consideration in making a critical load determination include, but are not limited to:

- Personnel injury or significant adverse health impact.
- Damage resulting in serious economic consequences (nonavailability of necessary funds to repair or replace the item).
- Damage resulting in unacceptable delay to schedule (mission impairment) or other destructive programmatic impact, e.g., loss of vital data.
- Undetectable damage that would jeopardize future operations or safety of a facility.
- Damage that may occur without exceptional care in handling because of close-tolerance installation, high susceptibility to damage or other unusual characteristic.
- Damage that would result in significant release of hazardous materials.
- Damage that may occur because the item, although noncritical, must be lifted above a critical item, e.g., loads of any sort in close proximity to a nuclear component or near concentrations of hazardous materials.

**Critical Pressure**—The vapor pressure of a liquid at the critical temperature.

**Critical Temperature**—The temperature above which a gas cannot be liquefied by pressure alone.

**Crossover**—A connecting track with an interlock mechanism on both ends mounted between two interlocking cranes used to transfer a carrier from one bridge to the other.

**Cryogen**—A cryogenic liquid boils at temperatures below  $-160^{\circ}\text{C}$  ( $-256^{\circ}\text{F}$ ) and is used as a refrigerant. As used in this standard, normally refers to LN2 or LOX.

**Cryogenics**—The science of refrigeration, with reference to methods for producing very low temperatures.

**Cryotainer**—A double-walled, insulated container (tank) for storage of a cryogenic fluid.

**Cylinder**—Generally a compressed gas container having a maximum water capacity of 1,000 lbs. (453.6 kg.). This is approximately the equivalent of 120 gallons (454.2 L).

**Daily or Prior-to-Use Inspection**—A visual inspection of equipment performed once each day prior to initial use. If the equipment is not used on a daily basis, this inspection is performed prior to each use and is not required on those days the equipment is not used. The use of additional items such as ladders, personnel lifts or special tools or disassembly of lifting equipment is not required by this standard for this inspection. **Note:** The daily or prior to use inspection is not an Operational Test.

**Deceleration Device**—Any mechanism, such as rope-grab, rip-stitch lanyard or specifically woven lanyard, that serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limits the energy imposed on a worker during fall arrest.

**Deceleration Distance**—The vertical distance between the user's fall arrest attachment at the onset of fall arrest forces during a fall, and after the fall arrest attachment comes to a complete stop.

**Derrick**—An apparatus consisting of a mast or equivalent member held at its upper end by guys or braces, with or without a boom, for use with hoisting mechanism and operating ropes.

**Designated Person**—Selected or assigned by the supervisor or the unit's representative as qualified to perform specific duties.

**Design Working Load**—The maximum intended load, being the total of all loads including the weight of the workers, materials, equipment and platform.

**Die**—Tooling used in a press for cutting and forming material. Upper and lower dies make a complete set.

**Dielectric Boom Shield**—An insulating device installed on booms to provide electrocution protection to operators and load handlers.

**Dog**—A device for gripping or holding material or a machine component in place.

**Dolly**—A low mobile platform that rolls on casters, used for transporting heavy loads.

**Double Block and Bleed**—The closure or isolation of a confined space from a line, duct or pipe by locking or tagging two (2) closed in-line valves and locking or tagging open to the outside atmosphere a drain or bleed in the line between the two (2) closed valves.

**Drive**—An assembly of the necessary structural, mechanical and electrical parts which provides the motive power for a conveyor, monorail, crane, etc.

**Dropline**—A vertical line attached to a fixed anchorage to which a lanyard is attached.

**Drop Section**—A mechanism which will permit a section of track to be lowered out of alignment with a stationary track.

### **Drum**

– A cylindrical or polygonal rim type of wheel around which cable, chain, belt or other linkage may be wrapped. A drum may be driven or driving. The face may be smooth, grooved, fluted or flanged;

– A cylindrical or bilged shipping container having straight sides and flat or bumped ends, designed for storage and shipment as an unsupported outer package that may be shipped without boxing or crating.

**Dry Cleaning**—The process of removing dirt, grease, paints and other stains from such items as wearing apparel, textiles, fabrics and rugs by the use of non-aqueous liquids (solvents, non-water based).

**Dry or Wet Chemical Fire Suppression System**—An automatic or manually activated fire suppression system normally installed over cooking equipment and dipping vats.

**Dual Phase Processing**—A process in which a dry-cleaning operation precedes or follows a laundering operation in the same equipment.

**Electrical Worker Personal Protective Devices**—Equipment designed to protect against electrical shock while working on electrically energized circuits. May include rubber insulating matting, blankets, line hose, gloves, sleeves, rain gear, footwear, safety belts, lanyards and lifelines, arc flash protective clothing and special hand tools.

**Emergency Shower Head**—A high-volume spray head specially designed for use on an emergency shower.



**Emergency Shower**—A unit that cascades water over a worker's entire body to remove hazardous chemicals splashed or sprayed on the worker.

**Energized**—A circuit electrically connected to a source of potential difference or an electrical charge. Can also include mechanical, hydraulic and pneumatic pressure differences.

**Energy Isolating Device**—A physical device that prevents transmission or release of energy including, but not limited to: a manually operated electrical circuit breaker, disconnect switch, slide gate, slip blind, line valve, blocks and similar devices with a visible indication of the position of the device. Push buttons, selector switches and other control circuit type devices are not energy isolating devices.

**Entrant**—Any employee who is trained and authorized to enter a confined space.

**Entry**—Any action by which a person passes through an opening into a permit-required confined space. Entry includes work activities in the space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the confined space.

**Entry Permit**—The written authorization for entry under defined conditions into a confined space for a stated purpose during a specified time. The entry permit becomes the written record of circumstances surrounding each entry operation. See paragraph 23.4.1.2 for entry permit retention instructions.

**Entry Permit System**—The system for issuing entry permits and ensuring safe entry into and work within confined spaces.

**Entry Supervisor**—The person responsible for determining if acceptable entry conditions are present at a permit space where entry is planned.

**Equalizer**—A device that compensates for unequal length or stretch of a rope.

**Equipment Ground**—Connection to ground from one or more of the non-current carrying metal parts of apparatus or equipment.

**Equivalent**—An alternative design or feature which will give an equal degree or factor of safety.

**Exit Access**—Exit access that is a portion of a means of egress that leads to an exit.

**Extendible Boom Platform**—An aerial device (except ladders) with a telescopic or extendible boom. Telescopic derricks with personnel platform attachments are considered extendible boom platforms when used with a personnel platform.

**Extension Ladder**—A non-self-supporting portable ladder, adjustable in length, with two (2) or more sections traveling in guides or brackets arranged to permit length adjustment. Its size is designated by the sum of the lengths of the sections measured along the side rails.

**Eye and Face Protectors**—This equipment includes spectacles and goggles (with and without corrective lenses), face shields and hoods.

**Eye and Face Wash Unit**—A unit used to irrigate and flush both the face and eyes.

**Eye Hazard Area or Task**—A location or task where liquids, vapors, dust, particles, light, heat or other situations exist that require eye protective devices and extra precautions by personnel. Examples of eye hazards are splashes or mists from fuels, corrosive or toxic chemicals or other

liquids; particles of metals from grinding, cutting or welding; dusts; and harmful levels of light from welding, ultraviolet, laser or other sources.

**Eyewash Bottle**—A squeeze type or plunger-actuated bottle that supplements permanent units, portable units or both.

**Eyewash Unit**—A unit used to irrigate and flush the eyes only.

**Face Shield**—A protective device worn in front of the eyes, covering a portion of, or all of, the face.

**Facility Ground**—A grounding system of 10 ohms or less that the entire third wire ground system, metal raceways, conduits, generators, transformers and other equipment within the facility are connected to.

**Fail-Safe**—A provision designed to automatically stop or safely control any motion if a malfunction occurs.

**Feather Board**—An angular board with multiple parallel saw cuts used as a side and top hold-down to prevent kickbacks and keep hands away from moving blades and cutters.

**Field Check**—A method of checking an instrument for a proper response in the field. It is a pass or fail functional check of the instrument.

**Fence (Woodworking Machinery)**—A device installed for the purpose of acting as a stop and guide for sawing materials. Also called a rip fence.

**Filler Piece**—A narrow strip of wood with cleats on both ends that permits ripping of narrow material on circular saws without removal of a guard.

**Fire Area**—Any area of a building that is enclosed by fire-resistant partitions.

**Fire Hydrant**—A valved outlet connected to a water distribution system designed to permit the transfer of water from the water distribution system to a fire fighting vehicle or hose streams.

**Fire Protection**—Sprinkler systems and other fire fighting or fire protection equipment or systems.

**Fire Protection Authority**—The senior individual assigned responsibility for managing the installation fire prevention and protection program or their authorized representative.

**Fire Suppression System**—A system which automatically or manually discharges fire extinguishing agent to suppress a fire.

**Fixed Anchorage**—A secure point of attachment, not part of the work surface, for droplines, lifelines or lanyards. An approved fixed anchorage shall be capable of supporting a minimum deadweight of 5,000 pounds (per person).

**Flammable Liquid**—A liquid having a flashpoint below 100° F (37.80° C) closed cup test and having a vapor pressure not exceeding 40 pounds psi at 100° F (37.80° C). Flammable liquids are categorized as Class 1 liquids and are further subdivided as follows:

- Class 1A have a flashpoint below 73° F (22.8° C) and boiling points below 100° F (37.8° C).
- Class 1B have flashpoints below 73° F (22.8° C) and boiling points at or above 100° F (37.8° C).

– Class 1C have flashpoints at or above 73°F (22.8° C) and below 100°F (37.8° C).

**Flange**—A collar, disk or plate used to hold an abrasive wheel in position on a rotating shaft.

**Flashpoint**—The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

**Flight line**—Any area or facility including aprons, hardstands and ramps on or in which aircraft may be parked, stored, service or maintained.

**Flight line Fire Extinguisher**—A wheeled portable fire extinguisher provided for the protection of aircraft. Included are various sizes of Halon 1211, carbon dioxide and dry chemical extinguishers.

**Floor**—The interior walking surface upon which machinery, aisles and passageways are located. This does not include platforms, walkways or catwalks.

**Floor Hole**—An opening measuring less than 12 inches but no more than 1 inch in its least dimension in any floor, platform, pavement or yard, through which materials but not persons may fall, such as a belt hole, pipe opening or slot opening.

**Floor Opening**—An opening measuring 12 inches or more in its least dimension in any floor, platform, pavement or yard, through which persons may fall; such as a hatchway, stair or ladder opening, pit or large manhole. Floor openings occupied by elevators, dumb waiters, conveyors, machinery or containers are excluded from this subpart.

**Foot Protector**—A product designed to protect the foot from injury due to moderate impact; abrasions; cuts; burns; corrosive, caustic or toxic materials; freezing; absorption; or dampness.

**Footwalk**—A walkway with handrail, attached to a crane bridge or trolley for access purposes.

**Fork Extensions**—Steel extensions that fit over the forks to extend the reach of the forklift. The use of extensions extends the reach but reduces the capacity of the forklift.

**Fork Height**—The vertical distance from the ground to the forklift load carrying surface adjacent to the heel of the forks with the mast vertical and forks extended.

**Free Fall Distance**—The vertical displacement of the fall arrest attachment point on the employee's body harness between onset of the fall and just before the system begins to apply force to arrest the fall.

**Functional Manager**—The senior operating official at all levels exercising managerial control of an activity or operation. This individual usually can acquire and commit resources for the abatement of occupational safety and health hazards. Functional managers are designated by MAJCOM, DRU, FOA or installment commanders.

**Gauge Pressure**—The pressure above or below local atmospheric pressure. Therefore, absolute pressure minus local atmospheric pressure equals gauge pressure. Gauge pressure is commonly designated by the abbreviation **psig**.

**Goggle**—A device that protects the eyes and eye sockets. They have contour-shaped eyecups or full facial contact, glass or plastic lenses and are held in place by a headband or other suitable means.

**Graphics**—Elements (words, emblems, colors, symbols and other visual devices) of a sign or tag used to convey a warning, caution, danger or serve as a notice of an existing or potential hazard.

**Grounding Stick**—A device used to ground electronic circuits and bleed off voltage or static electricity.

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

**Guardrail**—A protective railing built along exposed sides of stairs and platforms designed to prevent people or objects falling into an open space or stairwell. The top part of a guardrail can serve as a handrail.

**Halon 1301 Fire Suppression System**—An automatic or manually activated fire suppression system using Halon 1301 (a colorless, odorless, electrically non-conductive gaseous agent).

**Hand Chain Wheel**—A wheel with formed pockets on its periphery to allow torque to be transmitted to the hoist when a force is applied to the hand chain.

**Hand-Held Drench Hose**—A flexible hose connected to a water supply and used to irrigate and flush eyes, face and body areas.

**Handrail**—Single bar, pipe or wood rail supported on brackets attached to a wall or partition to provide a handhold for people using stairs to keep them from falling or tripping.

**Hazard Identification**—For the purpose of this standard, hazard identification refers to signs or tags that warn, caution or inform personnel of a hazardous situation.

**Hazardous Atmosphere**—An atmosphere presenting a potential for death, disablement, injury or acute illness from one or more of the following causes: a flammable gas, vapor or mist in excess of 10 percent of its lower explosive limit (LEL) or lower flammable limit (LFL); an airborne combustible dust at a concentration that meets or exceeds its LEL or LFL; atmospheric oxygen concentration below 19.5 percent or above 23.5 percent; an atmospheric concentration of any chemical substance greater than the occupational and environmental exposure limit (OEEL), which is capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to its health effects.

**Hazardous Material**—A substance that is explosive, flammable, poisonous, corrosive, oxidizing, irritating or otherwise harmful and may cause personal injury or harm.

**Head Protection**—A device worn to provide protection to workers when there is the potential for injury to the head from impact and penetration from flying, falling or stationary objects or limited electrical shock, heat or burn. Protection includes a suitable chinstrap and harness to secure the helmet to the head.

**High-Lift Platform Truck**—A truck equipped with a load platform, intended primarily for transporting and tiering loaded skid platforms.

**High-Lift Truck**—A truck designed to permit stacking material in tiers. Types in this category are high-lift fork truck, high-lift ram truck, high-lift boom truck, high-lift clamp truck and high-lift platform truck.

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

**Hitch**—A sling configuration whereby the sling is fastened to an object or load, either directly or around it.

– *Basket Hitch.* A sling configuration where the sling is passed under the load and has both ends, end attachments, eyes or handles on the hook or single master link.

– *Choker Hitch.* A sling configuration with one end of the sling passing under the load and through an end attachment, handle or eye on the other end of the sling. Used for turning an object.

– *Vertical Hitch.* A method of supporting a load by a single vertical part or leg of the sling.

**Hoist**—Includes only those components furnished by the hoist manufacturer, such as drums tackle, prime movers, limiting device, mounting bases, etc. When hoists are mounted as integral parts of more complex lifting equipment, they become component parts of that equipment. They are subject to the safety standards and inspection intervals established for the end item.

**Hoist Chain**—The load bearing chain in a hoist.

**Hook, Latch Type**—A safety hook incorporating a device to bridge the hook throat opening and that requires manual movement to release the load from the hook.

**Immediately Dangerous to Life or Health (IDLH)**—Any condition that poses an immediate or delayed threat to life, that would cause immediate or delayed adverse health effects or that would interfere with a worker's ability to escape unaided from a permit-required space.

**Inclined Ladder or "Ship's" Ladder**—A stairway installed at an angle greater than 50 degrees. All stairway criteria, except the angle of rise, applies to inclined ladders.

**Inerting**—Rendering the atmosphere of a confined space non-flammable, non-explosive or otherwise chemically non-reactive by displacing or diluting the original atmosphere with steam or a gas that is non-reactive with respect to the contents of the space. Nitrogen is a common inerting gas. **Note:** This procedure creates an IDLH oxygen-deficient atmosphere.

**In-Running Nip Point**—A hazardous condition created by moving or rotating objects that move toward each other.

**Insulated Aerial Device**—An aerial device designed for work near energized electrical lines and apparatus.

**Insulated Fuse Puller**—A non-conductive device used to remove fuses from circuit boxes.

**Interlock**—A device that prevents operation of the control that starts a machine in motion until a condition is met, such as the guard being in place.

**Intrinsically Safe**—As applied to equipment and wiring, equipment and wiring that are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture.

**Ionizing Radiation/Ionized Radiation**—Electromagnetic or particulate radiation, which may cause ionization and damage within the cells or tissues of the body, and that has sufficient energy

to produce direct ionization in passage through a substance. Examples of ionizing radiation are X-rays, gamma rays, alpha particles and beta particles.

**Irritant**—Substances that when blown or splashed onto the body or in the eyes will not normally cause lasting or permanent damage, but will definitely irritate the skin or eyes.

**Isolation**—Positively preventing any unwanted form of energy (or other agent with a serious potential for hazard) from contacting a worker or operation through the use of blanking, double block and bleed or lockout and/or tagout.

**Job Safety Analysis (JSA)**—Procedure used by supervisors and workers to assess the hazards associated with a work procedure and determine the safest, most efficient means of accomplishing a given task. Specific documentation is required. The prescribing directives for conducting JSAs are AFI 91-202 and 29 CFR 1910.132.

**Kickback**—The tendency of blades and cutters to force material being cut or milled up and back toward the operator.

**Ladder Stand**—A mobile fixed size, self-supporting ladder made up of a wide flat tread ladder in the form of stairs. The ladder stand may include handrails.

**Lanyard**—A flexible line used to secure a wearer of a body harness to a dropline, lifeline or fixed anchorage.

**Lay**—The linear distance for one strand to go completely around a rope.

**Ledger (Stringer)**—A horizontal part on a scaffold that extends from post to post that supports the bearer forming a tie between the posts.

**Lifeline**—A flexible line for connection to an anchorage connector at one end to hang vertically (vertical lifeline), or for connection to anchorages or anchorage connectors at both ends to span horizontally (horizontal lifeline).

**Lift Section**—A mechanism that will lift a section of crane trolley track out of alignment with a stationary track.

**Limiting Device**—A mechanical or electrical device designed to limit motion.

**Limit Switch**—A switch that is operated by some part of the hoist or equipment to limit travel of lifting option to prevent hoist or equipment damage.

**Linebreaking**—The intentional opening in a confined space of a pipe, line or duct that is or has been carrying flammable, corrosive or toxic material, inert gas or any fluid at a pressure or temperature that is capable of causing injury.

**Liquefaction**—The process of refrigerating a gas to a temperature below its critical temperature so that liquid can be formed at some suitable pressure also below the critical pressure.

**Liquid Cylinder**—A pressurized double-walled and insulated container used to hold cryogenic liquefied gas or refrigerated liquefied gas.

**Liquid Nitrogen Fire Suppression System**—An automatic or manually activated fire suppression system using LN<sub>2</sub>, which displaces oxygen to extinguish a fire.

**Load Block (Lower)**—The assembly of hook or shackle, swivel, sheaves, pins, bearings and frame suspended by the hoisting ropes or chains.

**Load Block (Upper)**—The assembly of hook or shackle, swivel, sheaves, pins and frame suspended from the boom point.

**Load Rating**—A rating in pounds established by the manufacturer as the maximum safe working load for an individual hoist, crane or related lifting equipment.

**Load Test**—Also called rated load test. A 100-percent to 125-percent test of the rated capacity (working load limit), as determined by type of equipment and designated by the manufacturer.

See individual chapters for applicable equipment-specific test procedures.

**Load (Working)**—The external load, in pounds applied to the crane, including the weight of load-attaching equipment such as load blocks, shackles, slings and ropes.

**Lockout and/or Tagout Program**—A program consisting of energy control procedures, staff training and periodic inspections established before a staff member performs any servicing or maintenance on a machine or equipment where the unexpected energizing, start-up or release of stored energy could occur and cause injury. Prior to service, the machine or equipment shall be isolated from the energy source and rendered inoperative.

**Lockout Device**—A device that utilizes a lock and key to hold an energy isolating device in the safe position for the purpose of protecting personnel.

**Low-Lift Truck**—A truck designed to raise a load sufficiently to permit horizontal movement. Examples are the low-lift platform truck and the pallet truck.

**Lower Explosive Limit (LEL)**—The lowest concentration of flammable or combustible vapor, which can be ignited by a spark or flame (also referred to as “Lower Flammable Limit [LFL]” in industry).

**Man-Rated**—A crane specifically configured or designed and built for raising and lowering personnel in work cages or baskets, having a positive controlled powered lowering system, upper limit switch and dead-man controls.

**Master Entry Plan (MEP)**—A written document, which must be reviewed annually by the CSPT, that authorizes entry supervisors to issue entry permits. This document defines acceptable entry conditions for routine recurring entries into like spaces.

**Material Safety Data Sheet (MSDS)**—Electronic, written or printed information on hazardous material prepared IAW 29 CFR 1910.1200.

**Maximum Intended Load**—The total weight of all loads including the weight of workers, materials and scaffolding.

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

**Midrail**—A rail approximately midway between the guardrail and platform and secured to the uprights erected along the exposed sides and ends of platforms.

**Military-Unique (Workplaces, Operations, Equipment and Systems)**—DoD military and civilian operations and workplaces that are unique to the national defense mission. This includes combat and operation, testing and maintenance of military-unique equipment and systems such

as military weapons, military-unique aircraft, missiles, early warning systems, military space systems, ordnance and tactical vehicles. It also includes operations such as peacekeeping missions; field maneuvers; combat training; military flight and missile operations; military-unique research; development, test and evaluation activities; and actions required under national defense contingency conditions.

**Mishap Prevention Sign**—A visual display made of some durable material (metal, wood, rigid plastic) intended to caution, warn or provide information.

**Mishap Prevention Tag**—A visual display, intended to caution or warn, made of materials that will withstand the environmental conditions expected in the workplace and are securely attached in an appropriate manner to ensure visibility, as close to the machine or equipment as possible.

**Mobile Scaffold (Tower)**—A light, medium or heavy duty scaffold that is mounted on casters or wheels.

**Mobile Unit**—A combination of an aerial device, its vehicle and related equipment.

**Mobile Work Platform**—A scaffold that provides a work level, one or more frames high, on casters or wheels, with bracing across or diagonally from the platform to the posts.

**Motorized Hand Truck**—A truck designed to be controlled by a walking operator.

**Multiple-Spray Shower Unit**—A unit using more than a single head and delivering water from more than one direction.

**Musculoskeletal-Disorder**—Refers to conditions that involve the nerves, tendons, muscles and supporting structures of the body.

**Non-ionizing Radiation**—Electromagnetic radiation that does not have sufficient energy to produce direct radiation when passing through a substance. Examples include radiofrequency (RF) radiation, visible light, infrared and ultraviolet.

**Nonmilitary-Unique (Workplaces and Operations)**—DoD military and civilian workplaces and operations that are comparable generally to those of the private sector. Examples include facilities involved and work performed in the repair and overhaul of weapons, aircraft or vehicles (except for equipment trials); construction; supply services; civil engineer or public works; medical services; and office work.

**Non-Permit Confined Space**—A space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazards capable of causing death or serious physical harm.

**Nose, Nosing**—The portion of a tread projecting beyond the face and the riser immediately below.

**Notice of Hazard**—A written warning of a condition, procedure or practice that constitutes an occupational hazard. As used in the context of this standard, Notice of Hazard refers to **AF Form 1118, Notice of Hazard**.

**Nuclear-Certified Equipment**—Hoists and related lifting equipment approved for use with nuclear weapons as listed in TO 00-110N-16, *Equipment Authorized for Use with Nuclear Weapons*. The Air Force single point of contact for nuclear certification of lifting equipment is



HQ AFSEC/SEWE. This office establishes the equipment as certified and ensures the equipment is listed in the MNCL (<https://www.mil.nwd.kirtland.af.mil.mncl>).

**Occupational and Environmental Exposure Limit (OEEL)**—The most appropriate limit adopted from established recognized standards including, but not limited to, those in AFI and AFOSH Standards, the latest edition of the TLV® Booklet published annually by the American Conference of Governmental Industrial Hygienists, 29 CFR 1910.1000 Tables Z-1, Z-2 and Z-3, and 40 CFR 141. OEELs are limits of exposure established to protect personnel from hazardous OEH threat exposures. OEELs apply to OEH threat exposures for individuals and/or similarly exposed groups of individuals.

**Occupational Exposure to Ionizing Radiation**—An exposure incurred as a result of an individual's employment or duties. Occupational exposure does not include exposure to ionizing radiation for medical diagnosis or therapy.

**Open Riser**—The air space between the treads of stairs.

**Operational Test**—A test of mechanical and electrical controls, limit switches and safety devices through the complete operational range without a load.

**Operator's Station**—Location at which actuators are placed for the purpose of starting, stopping, reversing or otherwise controlling the conveyor or system of conveyors during normal operation.

**Order (Stock) Picker Truck, High Lift**—A high-lift truck with operator's station attached to the forks. The station and forks move as a unit. The truck is intended for manual stock selection but may be capable of self-loading or tiering.

**Organizational Rescue Team**—A group of two (2) or more personnel typically designated and trained by an organization to perform rescues from confined spaces within that organization.

**Outriggers**—Extendible or fixed metal arms, attached to the mounting base, which rest on supports at the outer ends.

**Overload Device**—A mechanical or electrical device designed to disconnect the driven equipment from the motive power in the event of an overload on the conveyor.

**Oxygen-Deficient Atmosphere**—An atmosphere containing less than 19.5 percent oxygen by volume.

**Oxygen-Enriched Atmosphere**—An atmosphere containing more than 23.5 percent oxygen by volume.

**Pallet**—A low portable platform of wood, metal, or fiberboard used to stack, move, store and transport supplies as a unit.

**Parked Vehicle (flight line)**—To put or leave a vehicle for a period of time in a certain location.

**Pawl (Dog)**—A device for positively holding the mechanism, drum, etc., against undesired rotation.

**Pendant Station**—Controls suspended from the hoist for operating the unit from the floor or portable "plug-in" pendant controls.

**Peripheral Guard**—Commonly referred to as a tongue guard. This adjustable guard is installed on machines (grinding machine) where the operator is in front of the grinding surface during the operation.

**Permit-Required Confined Space**—A confined space that has one or more of the following characteristics: contains or has a potential to contain a hazardous atmosphere; contains a material that has the potential for engulfing the entrant; has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section; or contains any other recognized serious safety or health hazard. **Note:** Also see [Table 23.1](#).

**Permit-Required Confined Space Program**—The overall written program an organization develops for controlling and protecting workers from permit space hazards and for regulating entries into permit spaces.

**Personal Fall Arrest System**—An assembly of components and subsystems used to arrest a person in a fall from a working height.

**Phase Change**—The passing of a substance from one phase (state) to another (liquid to gas, solid to liquid, etc.).

**Physical Hazard and Obstruction**—Specific hazards of such nature that failure to identify them may lead to accidental injury to workers or property damage.

**Pinch Point**—Any point other than the point of operation where it is possible for a person's body or clothing to be caught between moving parts.

**Piping Systems**—Any pipes or conduit used for conveying gases, liquids or semi-liquids, except those carrying solids in air or gas.

**Pitch**—The angle at which the fixed ladder is inclined against a structure or piece of equipment.

**Plano**—A lens that does not incorporate correction.

**Platform**—A walking or working surface elevated above the surrounding floor or ground (such as a balcony or landing) or a personnel carrying device (basket or bucket), which is a component of a mobile unit.

**Point of Operation**—The areas of a machine where cutting, shearing, forming, assembling, etc., takes place.

**Portable Fire Extinguishers**—Manually operated, hand-held or wheeled extinguishers containing a fire extinguishing agent with a means to discharge the agent and direct it onto a fire.

**Position Belt**—Belt fit around the worker's waist and attached to a lanyard (usually in the back) which is then attached to an anchor.

**Powder-Actuated Tools**—Tools, such as ramsets, where cartridge-type explosives are the source of power.

**Power Taps**—Power strips designed for low-powered loads that are relocatable multiple extensions of a branch circuit to supply laboratory equipment, industrial workshops, and to provide outlet receptacles for computers, audio and video equipment and other equipment. Power taps are not designed for high powered loads such as coffee makers, space heaters, refrigerators

and microwave ovens, which can easily exceed the recommended ampere ratings on many power strips.

**Pressure Regulator**—A pressure and/or temperature activated device used to prevent the pressure from rising above a predetermined maximum, thereby preventing rupture of a normally charged cylinder when subjected to a standard fire test.

**Primary Warning Color**—This color appears as a circular band on piping systems and identifies a material which is classified by its primary hazard.

**Prohibited Condition**—Any set of conditions in a permit space where the hazard potential exceeds the limits authorized by the entry permit.

**Proof Test**—A nondestructive tension test performed by the manufacturer or qualified person to verify construction and workmanship of a lifting device. See individual chapters for applicable equipment-specific test procedures.

**Proximity Warning Device**—A device installed on booms that alerts or warns the operator when the boom is in proximity to energized electric power lines.

**Pulpit Operated**—A crane or unit operated from a fixed operator station not attached to the unit.

**Push-button Station**—An electrical control device consisting of push-button operated contacts in an enclosure used by the operator for control of the powered motions of the crane, hoist and other auxiliary equipment.

**Push Block**—A block of wood having a handle and shoulder at the rear end that is used for pushing short lengths of material over revolving cutters.

**Push Stick**—A strip of wood with a notch cut into one end that is used to push short lengths of material through saws or other cutting operations.

**Qualified Person**—A person who by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience, successfully demonstrated the ability to solve/resolve problems relating to the subject matter, the work or the project.

**Radiation Protection Survey**—An evaluation of potential radiation hazards associated with the use of industrial x-ray and gamma ray equipment under specified conditions. When appropriate, such evaluation includes inspection of equipment, examination of its location with reference to controlled and uncontrolled areas in the immediate environment and measurement of exposure levels arising from operation of the equipment.

**Rail Clamp**—An attachment or device for clamping movable equipment to the rail to hold it in a fixed location.

**Rail Stop**—A stop mounted at the ends of conveyor rails to limit the travel of traversing machinery.

**Rated Line Voltage**—The manufacturer's recommended safe working line voltage.

**Rated Load**—Sometimes called rated capacity or working load limit. The maximum working load, as designated by the manufacturer, for which a crane, individual hoist or related hoisting equipment is designed and built. **Note:** HQ AFSEC/SEW establishes rated load for nuclear-certified hoists.

**Rated Load Test**—Also called load test. A 100-percent to 125-percent test of the rated capacity (working load limit), as determined by type of equipment and designated by the manufacturer. See individual chapters for applicable equipment-specific test procedures.

**Reach Truck**—A self-loading truck, generally high-lift, having load-engaging means mounted so it can be extended horizontally forward. This permits a load to be picked up and deposited in the extended position and transported in the retracted position.

**Real Property Installed Equipment**—Installed equipment attached to and made part of buildings and structures (such as heating systems), but not movable equipment (such as plant equipment).

**Reciprocating Conveyor**—Any conveyor that progressively advances material by a back and forth motion of its conveying medium. It may be equipped with hinged flights or tilting dogs or pushers.

**Red Ball**—A situation requiring a sense of urgency and priority actions on the flight line intended to prevent late aircraft takeoffs and ground aborts.

**Reeving**—A system in which a rope or chain travels around drums, sheaves or sprockets.

**rem**—A measure of the dosage of ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose from 1 roentgen (r) of X-rays (1 millirem (mrem) = 0.001 rem).

**Remote Control**—A control station or any system of controls in which the actuator is situated in a remote location and is not mechanically attached to the device being controlled.

**Retrieval Line**—A line or rope secured at one end to a worker's full harness or wristlets, with the other end secured to a lifting or other retrieval device. The retrieval line shall be used to remove an unconscious entrant from a confined space.

**Rise**—The vertical distance from the top of a tread to the top of the next higher tread.

**Riser**—The upright part of a step at the back of a lower tread and near the leading edge of the next higher tread.

**Rope Grab**—A deceleration device that travels on a lifeline and automatically engages the lifeline and locks so as to arrest a fall. A rope grab usually employs the principle of inertial locking, cam or lever locking or both.

**Runner (Scaffolding)**—The lengthwise horizontal bracing or bearing members.

**Runway**—The track and supports (rails, beams, girders, brackets and framework) system upon which the crane or trolley travels.

**Runway (Catwalk)**—A passageway for persons, elevated above the floor or ground level, such as a foot walk along shafting or a walkway between buildings. It is sometimes called a catwalk.

**Safety Climbing Device (Ladder)**—A device, other than a cage, designed to limit falling distance. It may incorporate such features as belts, friction brakes or sliding attachments.

**Safety Device**—A mechanism or an arrangement used to prevent an unsafe condition, preventing continuation of an unsafe condition, warning of an unsafe condition or limiting or eliminating unsafe effects of a possible condition.

**Safety Observer**—A worker trained in CPR and qualified to operate the equipment in use. Responsible for placing equipment in safe/neutral mode and administer immediate assistance to a technician in the event of an emergency. The safety observer may be the supervisor.

**Scaffold**—Any temporary raised platform and all the necessary vertical, diagonal and horizontal parts used for supporting workers and materials or both. Also known as a Scaffold Tower.

**Secondary Warning Color**—This color appears as arrows (or triangles) on piping systems and identifies a material with a second hazard distinctly different from that indicated by its primary color.

**Sectional Ladder**—A non-self supporting portable ladder, nonadjustable in length, consisting of two (2) or more sections constructed so it functions as a single ladder. Its size is designated by the overall length of the assembled sections.

**Seizing**—The cord, tape or wire wrapped around a rope to prevent it from unraveling when it is cut in two.

**Self-Contained Emergency Shower or Eyewash Unit**—A unit that must be refilled or replaced after use and may be portable or fastened to a supporting structure.

**Self-Retracting Lifeline and/or Lanyard**—A deceleration device which contains a drum-wound line which may be slowly extracted from, or retracted onto, the drum under slight tension during normal worker movement and that, after onset of a fall, automatically locks the drum and arrests the fall.

**Selvage Edge**—The finished edge of synthetic webbing designed to prevent unraveling.

**Service, Normal**—That service that involves operation of cranes and hoists with randomly distributed loads within the rated load limit, or with uniform loads less than 65 percent of rated load, for no more than 15 percent of the time of a single work shift for manually operated cranes and hoists, and 25 percent of the time of a single work shift for electric- or air-powered cranes and hoists.

**Service, Heavy**—That service that involves operation of cranes and hoists within the rated load limit that exceeds normal service.

**Service, Severe**—That service that involves normal or heavy service of cranes and hoists with abnormal environmental conditions, such as excessively high or low ambient temperatures, exposure to adverse weather, corrosive fumes, dust-laden or moisture-laden atmospheres and hazardous locations.

**Shall**—Indicates a mandatory requirement.

**Shear Point**—The immediate area where two (2) or more machine elements are in close contact, creating a shearing action.

**Sheave**—A grooved wheel or pulley used with a rope to change direction and point of application of a pulling force.

– *Sheave, Non-running.* A sheave used to equalize tension in two (2) parts of the rope. Because of its slight movement, it is not termed a running sheave.

– *Sheave, Running.* A sheave that rotates as the load block is raised or lowered.

**Shelf Life**—Period of time that a product or chemical can be stored before use and still be used for its designed purpose.

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

**Side Loader**—A truck, generally a high-lift, having a load engaging means mounted so it can be extended laterally to permit a load to be picked up and deposited in the extended position and transported in the retracted position.

**Sideshield**—A device of metal or plastic (or both) or other material, hinged or fixed firmly to the spectacle to protect the eye from side exposure.

**Single Ladder**—A freestanding portable ladder, nonadjustable in length, consisting of but one section. Its size is designated by the overall length of the siderail.

**Snagging**—Grinding that removes relatively large amounts of material without regard to close tolerances or surface finish requirements.

**Span-Gas Test**—Test required to allow atmospheric monitoring equipment to adjust its sensors and/or to check alarms against a known concentration of gases, accomplished daily or prior to each use.

**Spectacle, Safety**—A device patterned after conventional type spectacle eyewear but of more substantial construction. They may be equipped with sideshields. The lenses can be plano- or corrective-protective. They may be made of clear or absorptive filter glass or plastic. Also called Safety Glasses.

**Spindle**—A rotating or fixed shaft-like member mounted in bearings and connected to the drive mechanism. A device for holding the work piece or a cutting tool is mounted on one or both ends.

**Spreader**—A curved piece of steel mounted behind a saw blade that prevents internal stresses within wood from clamping down on the saw blade.

**Sprocket**—A wheel with suitably shaped and spaced cogs or teeth to engage with the links of a chain.

**Sprocket, Load**—The hoist component that transmits motion to the load chain. Component is sometimes called load wheel, load sheave or chain wheel.

**Stairs**—A series of steps and landings with three or more risers. Stairs may lead users from one level or floor to another, to platforms, pits, boiler rooms or crossovers, or around machinery, tanks and other equipment.

**Standby Crane**—A crane not in regular service but that is used occasionally or intermittently as required.

**Standing (Guy) Rope**—A supporting rope that maintains a constant distance between the points of attachment to the two (2) components connected by the rope.

**Standpipe and Hose System**—An arrangement of piping, valves, hose connections and allied equipment installed in a facility so water can be discharged through a hose and nozzle for immediate fire fighting by trained fire fighters or building occupants.

**Stay-Open Valve**—A valve that will remain in the open position and continue to deliver water until manually closed (as part of an emergency shower or eyewash unit).

**Step**—The crosspiece of a ladder on which a person may step, also called a rung or a cleat. Also means a combination of risers or treads that may be part of a stair.

**Stroboscopic Effect**—The potential for fluorescent lighting to create the appearance that moving, rotating or vibrating objects are stationary.

**Stop**—A device to limit travel of a trolley or crane bridge or moving part of other equipment. This device normally is attached to a fixed structure and does not have energy absorbing ability.

**Stop Switch, Emergency**—A manually or automatically operated switch to cut off electric power independently of the regular operating controls.

**Straddle Lift Truck**—A general class of lift truck designed for picking up and hauling loads between its outrigger arms.

**Strand Laid Endless Sling-Mechanical Joint**—A wire rope sling made endless from one length of rope with the ends jointed by one or more metallic fittings.

**Strand Laid Grommet-Hand Tucked**—An endless wire rope sling made from one length of strand wrapped six times around a core formed by hand-tucking the ends of the strand inside the six wraps.

**Strand Laid Rope**—A wire rope made with strands (usually six or eight) wrapped around a fiber core, wire strand core or independent wire rope core (IWRC).

**Stripper**—A device that aids the load chain in leaving the load sprocket.

**Superstructure**—The rotating upper frame structure of a crane or other machine and the operating machinery mounted thereon.

**Suspension Belt**—Design of simple or compound straps that may be secured about the wearer's body, usually at the waist or buttocks, as an independent work support. These are commonly referred to as saddle belts or tree trimmer's belts. Suspension belts do not provide fall protection and are not designed for use as a personal fall arrest system.

**Swing**—Rotation of the crane or other machine superstructure for movement of loads in a horizontal direction about the axis of rotation.

## **Switch**

- A control device for making, breaking or changing connections in an electric circuit.
- Any device for connecting two (2) or more continuous package conveyor lines.
- A mechanism that transfers a trolley, carrier or truck from one track to another at a converging or diverging section.

**Switch, Limit**—A switch operated by some part or motion of a power-driven machine or equipment to alter power to the machine. The purpose is generally to limit the travel of a machine or equipment component.

**Switch, Main**—A switch controlling the entire power supplied to a system.

**Switch, Track**—A device with a section of track that can be moved to permit passage of a carrier from an incoming track to one of various outgoing tracks.

**Symbol**—A letter, picture, figure or other character or mark (or a combination thereof) used to identify a hazard.

**System Safety Engineering Analysis**—Evaluates and approves new operations previously prohibited due to the perceived risks. A team of engineers (AFMC) conducts actual demonstrations and analysis of the operation to validate overall risk assessment and recommend actions. Past examples include hot pit refueling, integrated combat turn around (ICT) and concurrent servicing.

**Tag Line**—A rope or cable used to prevent a load from swinging or rotating.

**Tagout Device**—A mishap prevention tag that is capable of being securely attached and that, to protect personnel, forbids operation of an energy isolating device and identifies the applying individual or authority who has control of the procedure.

**Tail Stock**—The adjustable or sliding heads of lathes.

**Test load**—The specific load applied in performance of the load test.

**Thermoluminescent dosimeter (TLD)**—A type of dosimeter that uses powdered or solid phosphor materials (e.g., Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub>, LiF, CaSO<sub>4</sub>) to record radiation exposures. When heated, the phosphor emits light proportional to the amount of radiation energy absorbed. This type of dosimeter consists of a card and a holder (badge).

**Tiering**—The process of placing one load on or above another.

**Toeboard**—A barrier, secured along the sides and ends of a platform, to prevent material falling from the scaffold platform.

**Tongue Guard**—See peripheral Guard.

**Toxic Material**—A material that causes an adverse physiological response in the human body.

**Track Opener**—Sections of monorail track arranged to lift or swing out of the line of track to make an opening through which a door may pass.

**Traffic Area**—Any area designed or designated for routine traffic, i.e., streets/roads, parking lots, driveways, flight line, aircraft taxiways, aircraft aprons and aircraft ramps.

**Training**—The process of making an individual proficient through instruction and hands-on practice in the operation, equipment or processes expected to be used in performing assigned duties.

**Tread Plate**—A plate of suitable size fitted between conveyor rollers to permit persons to use as a working or walking surface or safety guard.

**Tread Width**—The horizontal distance from the front to the back of tread including nosing.

**Tread**—The horizontal part of a step.

**Trolley**



- An assembly of wheels, bearings and brackets used for supporting and moving suspended loads or for carrying load connecting and conveying elements such as chain, cable or other linkage.
- The unit carrying the hoist mechanism that travels on overhead bridge rails.
- A frame on which a pair of load carrying wheels is mounted.

**Trolley Conveyor**—A series of trolleys supported from or within an overhead track and connected by endless propelling means such as chain, cable or other linkage with loads usually suspended from the trolleys.

### **Truck**

- An assembly that supports another unit in either a fixed or adjustable position and that provides mobility.
- A wheeled vehicle that can be detached from a conveying medium (usually chain) and pushed by hand.

**Truck Crane**—A crane consisting of a rotating superstructure with power plant, operating machinery and boom mounted on an automotive truck equipped with a power plant for travel. Some variations use a single engine in the truck which also powers the superstructure, or a single engine in the superstructure which also powers the truck.

**Tube and Coupler Scaffold**—A scaffold that is made up of tubing used as posts, bearers, braces, ties, runners, base supporting posts and uprights that serve to join the various members. This type of scaffold is normally used in fixed locations.

**Tubular Welded Frame Scaffold**—A sectional, panel or frame metal scaffold mainly built of prefabricated welded sections. This scaffold consists of posts and bearers with connecting parts and is braced with diagonal or cross braces.

**Tubular Welded Sectional Folding Scaffold**—A sectional, folding metal scaffold either designed as a ladder frame or inside stairway. It is built of prefabricated welded sections, which consist of end frames, platform frame, inside inclined stairway frame and braces or hinged connected diagonal and horizontal braces. It can be folded into a flat package when the scaffold is not in use.

**Turntable**—A track device with a movable liner frame containing a straight section of track which can be rotated with a load carrier on it to align the section of track with other tracks for the transfer of carriers from one track to another.

**Two-Blocking**—When the lower load block comes in contact with the upper load block or boom point can cause lifting cable to break and drop load.

**Unattended Vehicle**—An unattended vehicle is a vehicle, running or not, that the operator is not physically in or in a reasonable vicinity of the vehicle and could not exercise or gain control over.

**Valve Protection Cap**—A rigid removable cover provided for cylinder/container valve protection during handling, transportation and storage.

**Vehicle**—Any carrier that is not manually propelled.

**Vertical Reciprocating Conveyor**—A reciprocating power or gravity actuated unit that receives only inanimate objects on a track, roller conveyor or power conveyor forming the bed of the carrier and transmits these inanimate objects vertically from one elevation to another.

**Vertical Tower**—An aerial device designed to elevate a platform on a vertical axis.

**Warehouse Tractor or Tug**—An industrial vehicle designed to draw one or more non-powered trailers.

**Welding, Cutting and Brazing Permit (AF Form 592)**—The written authorization to perform “hot work” operations such as riveting, welding, cutting, burning or heating that could provide a source of ignition.

**Wheel, Buffing**—A wheel made of disks of felt, linen or canvas. The cutting surface is coated with rouge, tripoli or other mildly abrasive substances.

**Wheel, Inorganic**—A wheel bonded by inorganic material such as clay, glass, porcelain, sodium silicate, magnesium oxychloride or metal. Those bonded with ceramic materials are referred to as vitrified bonded wheels.

**Wheel, Organic**—A wheel bonded by an organic material such as resin, rubber, shellac or other similar bonding agent.

**Wheel, Polishing**—A wheel made of wood covered with leather or disks of canvas or similar material stitched together with a coat of emery or other abrasive glued to the wheel.

**Wheel, Reinforced**—A type of organic wheel that has webbing, fabric or filament that provides resistance to complete breakage if the wheel becomes cracked or damaged.

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

**Wire Brush**—A wheel made of varying protruding wires of different thickness, all attached to a central core.

**Wire Rope**—A rope composed of steel wires, strands and a core. The individual wires are cold drawn to predetermined size and breaking loads according to use. They are then helically laid or formed around the core, which may be sisal or synthetic fiber, a metallic strand or an independent wire rope. The size, number and arrangement of wires; and the number of strands, the lay and the type of core in a rope are determined by the service for which the rope is to be used.

**Work Level**—A raised platform, used for supporting workers and their materials, made up of the necessary vertical, horizontal and diagonal braces, guardrails and ladder for access to the work platform.

**Written Permit-Required Confined Space Program**—The overall written program the organization develops for controlling, and where appropriate, for protecting workers from permit space hazards and for regulating entries into permit spaces. It establishes procedures for all permit-required confined spaces within an organization.

## Attachment 2

### MINIMUM MANDATORY REQUIREMENTS FOR AERIAL LIFT TRAINING AND TRAINING PLANS

**Note:** While these requirements relate to aerial lifts, a similar level of detail is required when developing training plans and training personnel on other powered or potentially hazardous equipment.

**A2.1.** All training will be accomplished by a qualified instructor with knowledge and experience on all lifts for which he/she is conducting training and has been trained as an instructor.

**A2.2.** Training (model specific) will be documented on an AF IMT 55, *Employee Safety and Health Record*, or an equivalent authorized computerized information management system.

**A2.3.** Aerial lift training plans will include, as a minimum, the following requirements:

A2.3.1. Model specific classroom and proficiency training covering all machine functions, including, but not limited to, the following (if so equipped): self leveling platform, oscillating and extendible/retractable axles, travel alarm, motion alarm, beacon, tilt alarm, soft alarm, horn, boom limit switch, variable speed control knob (all speeds), drive enable switch, foot switch (deadman switch) emergency stop button, rated workload, unrestricted rated workload, stick booms vs. articulating boom, etc.

A2.3.2. The purpose, use and location of all manuals (ANSI Standards, Operator Safety Manual, Manufacturer's Operator Manual and Technical Order, if applicable).

A2.3.3. Purpose and function of all controls (platform and ground controls).

A2.3.4. All safety devices, alarms, limit switches and operating characteristics specific to the lift (how they work, what they do, when to use them, how to inspect them to ensure they are working properly and the hazards and consequences of by-passing or ignoring safety devices).

A2.3.5. Hazardous location requirements, if applicable.

A2.3.6. Pre-start inspection of the lift.

A2.3.7. Recognition of hazards associated with operation of the lift.

A2.3.8. Responsibilities associated with problems or malfunctions affecting operation of the lift, including documentation of deficiencies and process for removing lift from service.

A2.3.9. Factors affecting lift stability.

A2.3.10. Workplace/site inspection (look for hazards like uneven floors or drop offs, floor and overhead obstructions, etc.).

A2.3.11. The purpose of placards and decals (what they are and what they mean).

A2.3.12. Safety rules applicable to the task (such as overhead obstructions, electrical lines, working around other equipment, etc.).

A2.3.13. The use of outriggers, stabilizers or oscillating or retractable/extendible axles (how they work, what they do, when to use them and how to inspect them to ensure they are working properly).

A2.3.14. Use of removable railings, guards and attachments, including how to ensure they are properly secured when in use

A2.3.15. Fuel system, if applicable.

A2.3.16. Battery and charging requirements, if applicable.

A2.3.17. Safety harness and type of lanyard required for use with the lift and appropriate attachment point location(s).

A2.3.18. Spotter's responsibilities (emergency controls, procedures, and PPE requirements) .

A2.3.19. Any other items affecting safe operation of the lift.

A2.3.20. Hands on training covering all items above and actual lift operation under the direction of a qualified instructor. The trainee shall operate the aerial lift for a sufficient period of time to demonstrate proficiency with that specific model.

A2.3.21. A written test will be administered by a qualified instructor to ensure the trainee understands all aspects of the aerial lift's operation. Passing score will be 85% correct.

**A2.4.** Additional requirements for aerial lifts:

A2.4.1. Operator training will be documented for each specific model of lift a worker/supervisor is authorized to operate. A detailed lesson plan will be maintained within the organization receiving the training for each lift model that will be taught, including classes taught by contractors.

A2.4.2. Operators will be familiar with the TO(s) and/or manufacturer's manual(s) for the lift being operated and know where they are stored on the lift.

A2.4.3. Supervisor will only permit qualified and authorized personnel to operate or work from aerial lifts.

A2.4.4. Problems or malfunctions that affect safe operation of the aerial lift will be repaired prior using the lift.

A2.4.5. Only instructors or supervisors who are qualified to operate aerial lifts can task certify workers on aerial lifts, and only for aerial lifts that they are qualified to operate.

A2.4.6. Each aerial lift will have an AF Form 1800, *Operator's Inspection Guide and Trouble Report* with pertinent manufacturers inspection/test information added. The AF Form 1800 shall be used to inspect/test the aerial lift prior to lift operation. Coordinate the AF Form 1800 with the installation Ground Safety office.

A2.4.7. All inspections will be documented and maintained for at least one year, or as required by applicable TO or other guidance.

**A2.5.** All aerial lift operators will have an AF Form 483, *Certificate of Competency*, or equivalent document, which identifies all lifts they are authorized to operate. The AF Form 483 (or equivalent document) will be signed by a qualified instructor or a qualified supervisor as defined in paragraph 4e above.