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This manual implements Department of the Air Force Policy Directive (DAFPD) 91-2, *Safety Programs,* and is consistent with parts of Title 29 Code of Federal Regulations (CFR), Chapter XVII, *Occupation Safety and Health Administration (OSHA), Department of Labor (DoL).* This manual defines the Air Force's minimum safety, fire protection and occupational health standards, including additional requirements not addressed by the OSHA standards. This publication applies to all civilian employees and uniformed members of the Regular Air Force, Air Force Reserve (AFR), the Air National Guard (ANG), the United States Space Force (USSF), the Civil Air Patrol when conducting missions as the official Air Force Auxiliary, and those with a contractually obligation to abide by the terms of Department of the Air Force (DAF) publications. This publication requires the collection and/or maintenance of information protected by the Privacy Act of 1974 authorized by Department of Defense Directive (DoDD) 5400.11, *DoD Privacy Program.* The applicable System of Records Notice (SORNs) F024 AF IL C, *Motor Vehicle Operator's Records,* and F031 AF SP L, *Traffic Accident and Violation Reports,* are available at **https://pclt.defense.gov/DIRECTORATES/Privacy-and-Civil-Liberties-Directorate/Privacy/SORNs**. Ensure all records generated as a result of processes prescribed in this publication adhere to AFI 33-322, *Records Management and Information Governance Program,* and are disposed in accordance with (IAW) Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the DAF Form 847, *Recommendation for Change of Product;* route DAF Forms 847 from the field through the appropriate functional chain of command. Refer to Department of the Air Force

Instruction (DAFI) 91-202, *The Department of the Air Force (DAF) Mishap Prevention Program,* for guidance on submitting requests for exemptions to requirements of this publication. Report conflicts in guidance between this publication, federal standards or other DAF directives through Major Command (MAJCOM), Field Command (FLDCOM), Direct Reporting Unit (DRU) or Field Operating Agency (FOA) occupational safety offices to Headquarters Air Force (HAF) Safety Center, Occupational Safety Division, Standards and Policy Branch (HQ AFSEC/SEGS), 9700 G Avenue SE, Kirtland AFB NM 87117-5670. This manual may be supplemented at any level, but to ensure standardization, any organization supplementing this manual must send the implementing publication to AFSEC, Occupational Safety Division (AFSEC/SEG) for review and coordination before publishing. The authorities to waive wing/delta/unit-level requirements in this publication are identified with a Tier ("T-0, T-1, T-2, T-3") number following the compliance statement. See Department of the Air Force Manual (DAFMAN) 90-161, *Publishing Processes and Procedures*, for a description of the authorities associated with the Tier waiver approval authority. For non-tiered compliance items, the requestor's commander is the approval authority. Submit requests for waivers through the chain of command to the appropriate Tier/Waiver approval authority, or alternately, to HQ AFSEC/SEG for waivers/exemptions to non-tiered compliance items. The requested office must send a copy of all approved waivers to the OPR of the Higher Headquarters publication being waived (see DAFI 90-160, *Publications and Forms Management,* paragraph 1.5.3.2) within 30 days of approval. Sending an email to the waived publication OPR that includes a completed DAF Form 679, *Department of the Air Force Publication Compliance Item Waiver Request/Approval,* or equivalent, will suffice. Requirements in this publication are mandatory, unless otherwise indicated. Not included are safety, fire prevention and occupational health requirements addressed in specific equipment technical orders (TOs). Compliance with the attachments in this publication is mandatory. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the DAF.

SUMMARY OF CHANGES

This document is substantially revised and must be completely reviewed. Major changes include adding the applicability to the USSF and clarifying and reinforcing requirements for Process Safety Management, which is now its own standalone chapter, **Chapter 33,** *Process Safety Management (PSM) of Highly Hazardous Chemicals*. Additionally, it includes creating a new **Chapter 34**, *Additive Manufacturing Safety,* for 3D printing, major changes to **Chapter 12,** *Material Handling Equipment (MHE),* regarding inspection criteria for material handling equipment, implementing required changes to confined space requirements recommended and mandated by the Air Force Audit Agency.

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Chapter 1

INTRODUCTION

1.1. Objective.

1.1.1. OSHA safety guidance published in the DoL 29 CFR series provides employees with a safe and healthy workplace. OSHA dictates what must be accomplished in the workplace, but in some cases, not necessarily how it will be accomplished, or by whom. Refer to AFSEC Occupational Safety SharePoint® site for Introduction to OSHA Standards training information located at **https://usaf.dps.mil/teams/AFSEC-SEG/SEGS%20Public/Forms/AllItems.aspx?as=json&FolderCTID=0x012000D03CA3064AB0BB4CA2705F0FFC828818&id=%2Fteams%2FAFSEC-SEG%2FSEGS%20Public%FOSHA**.

1.1.2. Commanders are responsible for the safety of their facilities and personnel, including the correction of all identified hazards and deficiencies in their workplaces. This publication compliments DAFI 91-202 and assigns responsibilities to individuals or functions to help commanders manage their safety and health program, ensuring they comply with OSHA, Department of Defense (DoD), and DAF guidance. This publication provides uniform guidance, which safety staffs and commanders may supplement when additional or more stringent safety, fire prevention and health criteria are required.

1.1.3. MAJCOMs/FLDCOMs may have more stringent or restrictive requirements than those contained in this publication or other DAF Occupational Safety and Health (OSH) publications/standards. Therefore, all requests for interpretations or clarifications concerning these publications must be forwarded through the servicing MAJCOM/FLDCOM/DRU/FOA safety, health, and/or civil engineering organization, as applicable. **Note**: With respect to references in this manual to medical treatment facilities, pursuant to 10 United States Code (USC) § 1073c, the Defense Health Agency, a combat support agency, will be responsible for their administration and management; the details of these responsibilities are still being worked and finalized. **(T-0)**

1.2. Roles and Responsibilities.

1.2.1. All HAF elements will ensure policies and procedures are consistent with the guidance of this manual.

1.2.2. Headquarters, Air Force Safety Center (AFSEC) will:

1.2.2.1. Formulate and disseminate policy. Clarify roles, responsibilities, and guidance applicable to all areas of safety.

1.2.2.2. Act as coordination authority for safety waivers associated with Tier1 and above wing/delta-level requirements in this manual.

1.2.3. MAJCOMs, FLDCOMs, DRUs and FOAs will provide program oversight and supplement safety and health guidance, as necessary, ensuring safety training is available to subordinate organizations.

1.2.4. Commanders and Functional Managers will:

1.2.4.1. Ensure applicable occupational safety and health (OSH) guidance for workplace and operations is available to all personnel.

1.2.4.2. Enforce and promote compliance with occupational safety, fire prevention and health program requirements in their areas of responsibility.

1.2.4.3. Provide a safe and healthy workplace via a monthly spot-inspection program.

1.2.4.4. Provide employees with training in job safety, fire prevention and health, as required by:

1.2.4.4.1. OSHA directives.

1.2.4.4.2. DAFOSH directives.

1.2.4.4.3. DAFIs, DAFMANs, and associated publications.

1.2.5. Supervisor. Supervisors will require employees to notify them in advance if they have a medical condition or are taking medications that could interfere with their safe performance of assigned duties. Supervisors will ensure employees are trained, using manufacturer's instructions or lesson plans, prior to the operation of any type of equipment or accomplishing assigned tasks. Supervisors will routinely evaluate employees on the proper and safe operation of all equipment and associated personal protective equipment (PPE). Unsafe behaviors will be corrected on the spot. Supervisors will provide such instruction at the time of initial assignment and all required refresher training. If guidance is not available, supervisors will accomplish a job hazard analysis (JHA) to determine safe procedures. Additional supervisor responsibilities can be found in DAFI 91-202.

1.2.5.1. Conduct pre-task safety briefings where the task(s) present higher mishap risks, e.g., use of aerial lifts or when conducting new tasks. Refer to DAFPAM 90-803, *Risk Management (RM) Guidelines and Tools,* for specific risk management tools.

1.2.5.2. Pre-task safety briefings should include:

1.2.5.2.1. Hazards to be aware of and how to protect employees.

1.2.5.2.2. Review of work assignments and answering employees' questions concerning the work, hazards, and controls.

1.2.5.2.3. Provide clarification on why the task must be completed and the work methods that must be used.

1.2.6. DAF personnel (military and civilian) will:

1.2.6.1. Comply with OSH guidance.

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

1.2.6.3. Promptly report injuries and illnesses IAW DAFI 91-204, *Safety Investigations and Reports,* and DAFMAN 91-224, *Ground Safety Investigation and Reports*.

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

1.2.6.5. Only operate machines and equipment with functional safety devices.

1.2.6.6. Notify supervisors in advance if they have a medical condition or are taking medications that could interfere with their safe performance of assigned duties.

1.3. Waivers, Exemptions and Letters of Interpretation.

1.3.1. The affected work center will process a request for waiver or exemption when it is impossible to meet OSH guidance due to operational needs, mission impact, or technical reasons. **(T-1)** When requesting a waiver or exemption, the work center leadership must identify and implement interim control measures to reduce the degree of risk associated with the hazard to protect personnel, equipment and/or property. **(T-1)** The process for requesting a waiver IAW DAFMAN 90-161 or exemption is provided in DAFI 91-202.

1.3.2. DAF letters of interpretation (LOIs) are written in response to OSH-related inquiries submitted by DAF personnel or organizations regarding specific aspects of the terminology in this manual or with OSHA standards and applicable adopted national consensus safety guidance. AFSEC/SEG is responsible for responding to and providing clarification to meet the operational needs of the DAF. LOIs provide this response and are intended to clarify the application of established standards, policy, or procedure, but they may not, in themselves, establish or revise DAF policy or procedure. The LOI specifically cites the source policy or procedure document being interpreted and includes the time duration of the LOI.

1.4. How to Use This Document.

1.4.1. This publication incorporates appropriate parts of the 29 CFR §§ 1910 and 1926 standards that relate to DAF operations. References to other DAF publications and national consensus standards are provided as appropriate. DAF activities must comply with OSHA requirements at all times. Use of the military-unique exemption will be applied IAW Department of Defense Instruction (DoDI) 6055.01, *DoD Safety and Occupational Health (SOH) Program,* and DAFI 91-202. **(T-0)**

1.4.2. This publication is intended for use by all DAF personnel. It provides OSH requirements that will provide equal or greater protection than applicable federal regulatory standards. The information in this publication is for the protection of employees, DAF property and equipment, and to ensure compliance with Federal law. **Note**: This publication may contain criteria not fully compatible with host-nation safety criteria. In case of conflict, safety offices will facilitate coordinated concerns through their chain of command for resolution. **(T-1)**

1.5. Applying Standards. DAF personnel must comply with all applicable safety guidance during DAF operations. **(T-1)** Where there is conflicting guidance, use the guidance that provides the most protection for the employee until conflict resolution is attained.

1.5.1. Compliance.

1.5.1.1. This standard contains both horizontal and vertical fire, safety, and health standards/requirements within the various chapters. Horizontal standards/requirements apply across all industries/activities, whereas, vertical standards/requirements apply to a specific industry/activity, e.g., construction or telecommunications. Vertical standards will be followed to protect employees from hazards identified in specific industries/operations over horizontal standards. **(T-0)** Where the vertical standard does not cover a hazard, then the horizontal standard will be applied to protect personnel. **(T-0) Example:** In 29 CFR 1910.252, *Welding, Cutting, Brazing,* there are specific confined space requirements

(vertical standard) that must be addressed prior to using the requirements in 29 CFR 1910.146, *Permit-Required Confined Spaces* (horizontal standard). However, the welding standard does not cover certain requirements found in the Permit-Required Confined Space standard, such as the permit process, training of personnel, etc. that would require following the Permit-Required Confined Space standard, as applicable. Contact your occupational safety office if assistance is needed with vertical/horizontal standards.

1.5.1.2. When OSH guidance or other established safety criteria does not cover a situation, use non-DAF standards to include, but not limited to, national consensus standards, professional safety and health standards, and other Federal agency standards.

1.5.2. OSHA Requirements. DAF safety officials cannot grant exemptions to OSHA standards, only the DoL has the authority to grant exemptions to OSHA standards. Refer to DAFI 91-202 for additional guidance.

1.5.3. National Consensus Standards. National consensus standards referenced in this document have been adopted, in whole or in part, for DAF use and list the standard, part/document number, part/document title, and date of standard, as applicable, e.g., American Society of Mechanical Engineers (ASME) B30.9, *Slings,* and National Fire Protection Association (NFPA) 70, *National Electrical Code.* Personnel needing access to American National Standards Institute (ANSI) and/or other national consensus standards can contact the occupational safety office for guidance and assistance. Consensus standards are identified for awareness/information unless needed to complete a specific task.

1.5.4. Joint Base Safety Standard Compliance. DAF personnel at Joint Bases will follow safety requirements outlined in the approved support agreement(s) developed IAW DoDI 4000.19, *Support Agreements,* and AFI 25-201, *Intra-Service, Intra-Agency, and Inter-Agency Support Agreements Procedures.* **(T-1)** When there is conflicting guidance, use the guidance that provides the most protection. Further conflicts in safety program requirements will first be coordinated through senior leadership at the local level for resolution. **(T-1)** If resolution at the local level cannot be obtained, the organization will refer conflicts to AFSEC/SEG through the appropriate MAJCOM/FLDCOM/FOA/DRU safety office for cross-service resolution. **(T-1)**

1.6. Job Hazard Analysis (JHA). JHAs are conducted on all work processes, where appropriate, to identify potential fire, safety, or health hazards, determine appropriate training and PPE, and include preventative measures in procedures to mitigate the hazards. Refer to DAFI 91-202 for additional guidance.

1.7. Documentation. This publication specifies the use of Air Force Technical Order (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 the use of automated systems for tracking these activities, requiring specific paper forms may impede the use of more efficient automated processes. Therefore, the 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 if they contain the same information called for by the designated form. Electronic signatures or other unique personal identifiers (not initials) are acceptable. While this publication offers an optional alternative to paper forms, MAJCOMs, FLDCOMs, Numbered Air Forces (NAFs), local procedures, Technical Orders (TOs), and other

DAF guidance may continue to require the use of these forms. Check the prescribing directive(s) before discontinuing use of any forms.

1.8. First Aid and Cardiopulmonary Resuscitation (CPR) Training. Initial first aid/CPR training will be accomplished prior to assigning an individual duties where first aid/CPR are requirements of the position. **(T-1)** All employees requiring CPR training will receive refresher training before their current CPR certification expires. **(T-1)** Organizational/shop CPR instructors may be trained by the local medical group or trained directly by the American Red Cross, American Heart Association, or a Military Treatment Facility (MTF) approved source. CPR instructors will, in turn, train organizational personnel. **(T-1)** MTF Commanders determine the MTFs ability to support CPR training and will notify the units when/if they can no longer provide training. **(T-1)** Where training is no longer provided by the host medical facility, contact the host Public Access Defibrillator (PAD) Program Coordinator for assistance in locating training providers. The CPR instructor will ensure training includes PAD training IAW AFI 44-177, *Public Access Defibrillator Program.* **(T-1)** Tactical Combat Casualty Care (TCCC) IAW DoDI 1322.24, *Medical Readiness Training,* may be used to fulfill first aid training requirements; however, it does not cover CPR. Employees performing duties with risk of severe cuts, burns or electrocution, or perform duties in remote locations away from emergency responders will have a plan for immediate medical response pending definitive transfer and care. **(T-0) (Note**: Remote location is defined as emergency care that is more than three to four minutes from the workplace.) Refer to DHA 6000.03, *Life Support Training Certification Requirements and Guidance,* for additional requirements.

1.9. Bloodborne Pathogen Training. Any person with routine duties where tasks and procedures involve reasonably anticipated exposure to blood or other potentially infectious materials (e.g., individual responsible for rendering medical assistance as part of their duties) must be trained and enrolled in the Bloodborne Pathogen Program IAW 29 CFR § 1910.1030, *Bloodborne Pathogen,* and AFI 44-108, *Infection Prevention and Control Program.* **(T-0)** A person may be required to receive separate first responder training outside of bloodborne pathogen, e.g., First Aid, CPR, TCCC. For workplaces with employees that meet this job description, supervisors will establish a written exposure control plan and conduct training IAW 29 CFR § 1910.1030. **(T-0)**

Chapter 2

GENERAL WORK PROCEDURES

2.1. General Information. This chapter provides general work procedures for a safe and healthy workplace, to include the wearing of jewelry, workplace safety, ergonomics, and housekeeping. The supervisor will ensure the job safety training outline (JSTO) evaluates and identifies PPE requirements IAW DAFI 91-202. **(T-1)** All facilities will comply with DoD standards, UFC 3-600-01, *Fire Protection Engineering for Facilities,* DAF guidance and NFPA 101, *Life Safety Code.* **(T-0)**

2.2. Hazards. Physical hazards are the most common workplace hazards. Hazards can include working from heights; slips, trips and falls; falling objects; spills; faulty equipment; and noise hazards. Other examples of workplace hazards include:

2.2.1. Radiation. Ionizing and non-ionizing are the two basic types of radiation. 29 CFR § 1910.1096, *Ionizing Radiation,* and AFMAN 48-148, *Ionizing Radiation Protection,* list requirements for working in an area with ionizing radiation. Non-ionizing radiation includes most radio frequency energy sources, light sources and lasers. Protection levels and requirements are outlined in AFI 48-139, *Laser and Optical Radiation Protection Program,* and AFI 48-109, *Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program.*

2.2.2. Noise. Hazardous noise levels can cause hearing loss and/or prevent hearing of warning signals. Hazardous noise issues are common to industrial and outside work areas such as flightlines and maintenance areas but should be uncommon in administrative work areas. Concerns with workplace noise levels should be evaluated. Installation Bioenvironmental Engineering (BE), or joint base equivalent, conducts occupational environmental health risk assessments (HRAs), then recommends appropriate controls using the hierarchy of controls methodology. Refer to AFI 48-127, *Occupational Noise and Hearing Conservation Program,* and 29 CFR § 1910.95, *Hearing Conservation Program,* for additional guidance.

2.2.3. Thermal Exposure. Refer to DAFI 48-151, *Thermal Stress Program*, for guidance and information on thermal injuries and their prevention/treatment. Any thermal illness requiring more than first aid is investigated and recorded in the AFSAS by Public Health Flight Commander or equivalent IAW DAFI 48-151.

2.2.4. Inhalation. Inhalation of hazardous materials can cause acute (irritation, allergic reaction and/or damage the lungs and respiratory tract) and/or chronic (permanent damage, disease, and cancer) health effects. Inhalation hazards need to be evaluated by installation BE to determine if respiratory protection is required. Refer to 29 CFR § 1910.134, *Respiratory Protection,* and AFI 48-137, *Respiratory Protection Program*, for guidance and information.

2.2.5. Chemical. Chemical hazards may exist in everyday products such as cleaning supplies, pesticides, and paints. It may also include vapors and fumes from welding and brazing, solvents, flammable, and combustible liquids. Refer to 29 CFR § 1910.1200, *Hazard Communication,* AFI 90-821, *Hazard Communication (HAZCOM) Program,* and **Chapter 22,** *Flammables and Combustibles,* of this publication.

2.3. Jewelry. Jewelry, such as rings, watches, bracelets, and necklaces, that presents a potential for catching, snagging, pulling, or tearing will be evaluated, controlled and restricted from wear if it presents a hazard to the employee or operation. **(T-1)**

2.3.1. Finger Rings. Personnel engaged in work in industrial areas, performing maintenance on aircraft, vehicles, equipment or machinery will not wear rings of any material type. **(T-0)** Personnel will comply with established safety precautions to prevent personal injury. **(T-0)** Rings will not be worn while performing the following activities (this list is not all-inclusive):

2.3.1.1. Climbing, ascending, or descending, activities where personnel could fall or jump from elevated surfaces. **(T-0)** This includes personnel working on elevated surfaces, e.g., ladders, scaffolds, platforms, roofs, or high reach vehicles, e.g., refuelers, wreckers, sweepers, dump trucks and stake bed trucks.

2.3.1.2. Materials handling operations, e.g., warehousing, parts handling, operating equipment, packing and crating, and attaching/detaching equipment to tow vehicles. **(T-0)**

2.3.1.3. Any type of work where personnel 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. **(T-0)**

2.3.1.4. Performing work or inspection on or near energized electrical parts where contact could result in injury or damage to equipment. **(T-0)** Articles such as jewelry, earrings, rings, hair fasteners, bracelets, key chains, or metallic ID (dog) tags with metal chains will also be removed and metal framed eyeglasses will be secured by a band or cord to prevent them from falling into energized electrical circuits or machinery. **(T-0) Note**: This prohibition includes conductive jewelry, e.g., necklaces, bracelets, watches, etc. These items will permit inadvertent electrical current transfer to the employee.

2.3.1.5. Performing maintenance or inspections on aircraft or ground support equipment, including civil engineering-type or transportation-type maintenance where such activity could result in injury. **(T-0)**

2.3.1.6. Performing work on or around high temperature equipment where contact with these surfaces could result in injury. **(T-0)**

2.3.2. Eyewear. Metal eyeglasses will be secured by a band or cord to prevent them from falling into energized electrical circuits or moving industrial machinery. **(T-1) Note**: It‘s best practice to wear nonmetallic eyeglasses and neck lanyards (e.g., ID cardholders) with a breakaway safety band, lanyard or cord to prevent them from falling into energized electrical circuits or moving industrial machinery.

2.3.3. Medic-Alert. Personnel that require identification for medical issues are permitted to don non-dangling/non-hazardous medical alert items, e.g., clasps, medical cards in hard hats, identification badge holders, to warn co-workers of potential medical issues. Supervisors will ensure such items do not create hazards during employees’ assigned tasks. **(T-0)**

2.3.4. These restrictions do not apply to administrative and support personnel assigned office duties or visiting these areas but not performing industrial work.

2.4. Housekeeping.

2.4.1. Floors and Walking Surfaces. Keep areas, in and around facilities, 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. This includes sidewalks, parking lots etc. Facility managers will promptly report potholes and uneven surfaces to installation Civil Engineering (CE). **(T-0)**

2.4.1.1. Facility managers will ensure the removal of snow and ice from all facilities walkways, sidewalks, handicap ramps and work areas expediently where they may create a hazard or interfere with the work. **(T-0)** If ice cannot be readily removed, sand or other approved materials will be applied. **(T-1)** Snow and icicles above walkways will be removed by the unit or a work request will be submitted for areas that cannot be reached. **(T-1)** Walkways that are located under rooftops with icicles and accumulation of snow, should be cordoned off until the hazard can be removed.

2.4.1.2. The supervisor will ensure telephone and electrical cords are placed where they do not pose tripping hazards. If placement in foot-traffic areas is unavoidable, cords and cables will be properly protected by molded housing, bridges or other covers approved for such use to prevent tripping. **(T-0)**

2.4.1.3. Briefcases, wastebaskets, etc., will be placed under desks, against a wall or otherwise out of the way. **(T-1)**

2.4.1.4. 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. **(T-1)**

2.4.1.5. 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 safety observer at the door if a step stool or ladder must be placed in a doorway. **(T-1)**

2.4.2. Hazardous Materials and Waste. Refer to DAFMAN 32-7002, *Environmental Compliance and Pollution Prevention,* for approved hazardous waste disposal procedures and guidance. Safety Data Sheets (SDSs) are required for each hazardous chemical, IAW AFI 90-821. The SDS can assist with the proper handling of the waste prior to being removed for disposal, especially for waste generated as a result of unused and/or expired hazardous chemicals. The supervisor will ensure use or storage of flammable liquids will be kept to a minimum and not exceed the maximum allowable quantities specified in **Chapter 22. (T-1)**

2.4.3. Packing Supplies and Recycled Materials. Non-soiled excelsior (fine wood shavings), straw, shredded paper, recyclable cardboard, recyclable paper, and other packing/recyclable materials will be stored in an isolated fire-resistant area and/or container. **(T-0)** Small supplies of packing materials, which are kept in shops for immediate use, will be stored in metal or noncombustible covered containers. **(T-1)** Remove hazardous material markings and/or placards from empty packaging. Remove protruding nails, brads and staples from crates, cases, packing boxes, casks, boards and lumber to prevent personnel injury.

2.4.4. Electric Buffing Machines. Supervisors will ensure electric buffing machines are equipped with under-voltage/over-voltage sensing and cutoff controls. **(T-1)**

2.4.5. Stacking Materials. Refer to Air Force Joint Manual (AFJMAN) 23-210, *Joint Service Manual (JSM) For Storage and Materials Handling,* for guidance on stacking materials. When

materials are stacked to a height less than 15 feet, maintain an 18-inch clearance below ceiling sprinkler deflectors. If the stack is over 15 feet in height, increase the clearance to 36 inches (when only joists, rafters, beams and roof trusses exist, without a ceiling constructed below, a 36 inch clearance will also be required). **(T-1)** Position all stacks of materials to ensure an 18-inch clearance around light or heating fixtures or follow the manufacturer's instructions, regardless of height. **(T-1)**

2.4.6. Storage of materials will not create a hazard. **(T-0)** Bags, containers, bundles, etc., stored in tiers will be stacked, blocked, interlocked, and limited in height so they are stable and secure against sliding or collapse. **(T-1)**

2.4.7. Lighting Fixtures. The supervisor will ensure tubular light fixtures (fluorescent/light-emitting diode) will have shields or other protective devices installed to keep the tubes from falling out of the fixture and from accidental contact. **(T-1)**

2.4.8. Waste disposal containers in food handling environments will be equipped with disposable liner material and emptied not less frequently than once each working day, unless unused. Containers will be maintained in a clean and sanitary condition and sanitized at least once a month. **(T-1)** All other waste containers will be cleaned, as needed. **(T-1)** Exterior garbage cans will be securely covered when not actually being filled or emptied. **(T-1)**

2.4.9. General Safe Practices. All areas, shops, yards, buildings, and mobile equipment facilities/areas will be maintained in a clean and orderly condition. **(T-0)** Supervisors and employees are responsible for good housekeeping in or around the work area they are supervising or working.

2.4.9.1. Do not place equipment or material where it creates a hazard for employees or visitors, by falling, being a trip hazard or causing the collapse of structures. **(T-0)**

2.4.9.2. Keep aisles and passageways clear of tripping hazards. **(T-0)**

2.4.9.3. Ensure moisture accumulation from heating, ventilation and air conditioning (HVAC) units or other water sources are cleaned up immediately to prevent mold. **(T-0)** Submit work orders to installation CE, as appropriate. **(T-1)**

2.4.9.4. Remove nails from loose lumber or turn the points down. **(T-0)**

2.4.9.5. Properly store tools and supplies. **(T-0)**

2.4.9.6. Do not block or obstruct disconnect switches, distribution panels, and alarm supply boxes preventing ready access. **(T-0)**

2.4.9.7. Stack wire reels with strips of wood between reels. **(T-0)**

2.4.9.8. Keep noncombustible materials neat and plainly marked, and in designated cabinets. **(T-1)**

2.4.9.9. Storage Racks/Shelving. The load size and rating of storage racks/shelving will be determined by the manufacturer's specifications. **(T-1)** Structural engineers or a certified testing agency will evaluate load size and rating for storage rack shelving units where manufacturer's specifications are not available or fail to specify the load size and rating. **(T-1)** The load size and rating will be posted on the storage racks/shelving unit. **(T-1) Exception:** Shelving used in administrative areas for lightweight office items needed for administrative work e.g., examples include books, small stocks of paper and

paper products, and other lightweight items used in office settings. Employees will report any damage to racks at the time of incident, specifically damage due to mechanical equipment. **(T-1)** Repair defective storage racks in a timely manner. All damage and repairs will be documented appropriately. **(T-1)**

2.4.9.9.1. Inspections of storage racks/shelving units will follow the manufacturer's instructions. **(T-1)**

2.4.9.9.2. Inspection will be conducted frequently to ensure preventative maintenance is completed and damage identified. **(T-1)** Inspections will include all manufacturer identified storage racks/shelving components. **(T-1)**

2.4.9.9.3. Inspections will be documented on AFTO Form 95 or MAJCOM/FLDCOM or locally devised automated systems. **(T-1)**

2.4.9.9.4. Racks/shelving identified as damaged will be tagged with AF Form 979, *Danger Tag,* or AF Form 981, *Out of Order Tag,* until repairs are completed. **(T-1)** Remove items from racks/shelving and tag or sign "do not use" to prevent damage or injury until the rack/shelving is repaired.

2.4.9.10. Compressed Air. Compressed air will not be used for cleaning purposes except where it is reduced to less than 30 psi, and only with effective chip guarding and PPE. **(T-0)** Follow TO, manufacturer's instruction or local procedures as applicable. Ensure the nozzle discharge tip is a diffuser type. Compressed air will not be used to blow chips or other debris from an employee's body or clothing. Screens, barriers, or protective cones attached to air nozzles will be used to prevent flying chips and particles from striking the eyes and skin of the operator. **(T-0)** Compressed air used for tools and equipment will follow TO, manufacturer's instruction or local procedures, as applicable. **(T-1) Note**: Facility compressed air or air used from an air compressor should not be used on electrical equipment as it could allow small metal chips or air condensation to accumulate causing equipment malfunction. Canned compressed air should only be used on electrical components.

2.4.9.11. Machinery and equipment will be kept clean of excess grease, oil, and excessive dust. **(T-1)** Pressure gauges and visual displays will be kept clean, visible, and serviceable. **(T-1)** Drip pans and wheeled or stationary containers will be cleaned and emptied at the end of each shift. **(T-2)**

2.4.9.12. All work surfaces and floors will be kept free of any visible accumulation of dust, liquid or any other foreign particles, as practicable. **(T-0)**

2.5. Office Safety.

2.5.1. General Office Equipment.

2.5.1.1. Chairs.

2.5.1.1.1. The supervisor or designated representative will inspect chairs regularly for broken casters or other defects. **(T-3)** New or replacement caster chairs will have at least five legs. **(T-1) Note**: Five or more legged caster chairs are more stable and ergonomically sound than four-legged caster chairs.

2.5.1.1.2. Do not stand on a chair to change a light bulb, retrieve overhead items or when hanging pictures/decorations, etc. Use stepstools or ladders to access anything above shoulder level.

2.5.1.1.3. Do not tilt back, lean sideways or reach behind to lift objects while seated in a chair.

2.5.1.2. File Cabinets.

2.5.1.2.1. Store heavy material in bottom drawers and load cabinets from the bottom up.

2.5.1.2.2. Close drawers when not in use.

2.5.1.2.3. Do not climb on open file drawers.

2.5.1.3. Office Shelving/Bookcases. Store the heaviest objects/books on lower-level shelves.

2.5.2. Electrical Equipment.

2.5.2.1. Appliance, electrical equipment and other office machines will comply with 29 CFR 1910.334, *Use of Equipment.* **(T-0)**

2.5.2.2. Keep access to fuse or circuit breaker boxes or electrical controls clear and unobstructed with panel doors closed to prevent electrical flashover if a malfunction occurs. Refer to NFPA 70, *National Electrical Code,* for additional guidance on fuse and circuit breakers in the office area.

2.5.2.3. Modular office furniture electrical systems are normally designed only to provide power to office equipment, e.g., personal computers, monitors, and printers. Refer to 29 CFR § 1910, Subpart S, *Electrical,* for additional guidance. Use of appliances for personal convenience, such as refrigerators, coffee makers, microwave ovens, will be requested through the facility manager prior to use to ensure the electrical system can safely accommodate the additional load. **(T-2)** Facility managers will contact their installation CE when assistance is needed. **(T-2)**

2.5.3. Items that could present hazards, such as knives or razors, will not be left unprotected in desk drawers, storage cabinets, on top of counters or desktops. **(T-1)**

2.5.4. Lighting. Consult the installation CE facility design section when specific guidance on lighting is required. Fluorescent light bulbs contain toxic materials and will be managed IAW local hazardous waste disposal criteria. **(T-0)** Supervisors will ensure any stroboscopic effect with moving machinery is eliminated when using fluorescent lighting fixtures. **(T-1)** Work area lighting will be installed to eliminate glare and harsh shadows. **(T-1)** Supplementary or additional lighting will be provided where general lighting is not sufficient. **(T-1)**

2.5.5. HVAC systems will be maintained and inspected by a trained HVAC system technician. Filters will be changed as needed, but minimum of once per year. **(T-1)** Do not cover air vents or obstruct air flow from registers. **(T-1)** Do not place furniture, equipment, or materials where they interfere with air movement or thermostats. **(T-1)**

2.5.6. Elevators.

2.5.6.1. A certified inspector will inspect elevators annually. **(T-0)** Elevator inspection certification will be posted in the cab of the elevator in view of all passengers or retained by the building manager and a permanent sign posted in the cab that identifies the location of the elevator certification. **(T-0)**

2.5.6.2. Elevators will stop level with the floor when the doors open to prevent a tripping hazard. **(T-0)** Report elevator malfunctions immediately to the unit facility manager. Employees will not try to stop elevators by placing a hand or foot in closing doors. **(T-0)** Employees will not use elevators during emergency evacuation. **(T-0)**

2.5.6.3. Where an elevator or escalator is operating unsafely or has visible damage, do not use it until inspected by a certified inspector. **(T-1)** UFC 3-490-06, *Elevators,* ASME A17.1, *Safety Code for Elevators and Escalators,* and ASME A17.2, *Guide for Inspection of Elevators, Escalators and Moving Walk,* provides additional information.

2.5.7. Facility floors, especially raised floors, will be kept smooth, clean and free of obstructions and slippery materials. **(T-0)**

2.5.8. Raised floor spaces will be divided in the same manner as the equipment spaces above the area they serve. **(T-0)**

2.5.9. Raised Floors of Aircraft Flight Training Devices, Similar High Value Training Devices and ADPE Facilities. Raised floor spaces will contain a standard or ultra-sensitive smoke detection system as required by UFC 3-600-01. **(T-0)**

2.5.10. Raised floor systems will be constructed of noncombustible materials. **(T-0)**

2.5.11. Floors will not be cleaned with flammable or combustible liquids. **(T-0)** Follow the manufacturers instruction and SDS guidelines when using cleaning agents for floors and facilities.

2.5.12. Sub-floors will 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; and clean out trash or dirt accumulation, as needed. **(T-1) Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

2.5.13. Utility trenches will be kept clean of foreign objects and inspected at least every 60 days. **(T-1)** If cleaning history shows a longer period between cleanings is feasible, the Fire and Emergency Services (F&ES) Flight may allow extending the time between cleanings.

2.6. Ergonomics. Ergonomics attempt to fit the job to the person, rather than forcing the person to fit the job. Adapting the job to the employee helps reduce stress and eliminates many potential injuries and disorders from overuse of muscles, poor posture, and repetitive motion. Ergonomic hazards may include improperly adjusted workstations and/or chairs, poor posture, frequent lifting, vibration, repetitive motion, or awkward movement. Contact the installation BE office for questions relating to ergonomics or to have an ergonomic assessment completed. Refer to OSHA website: **https://www.osha.gov/SLTC/ergonomics/controlhazards.html** the USAFSAM ESOH Service Center**:** **https:/hpws.afrl.af.mil/dhp/OE/ESOHSC/pages/index.cfm?id=646** for additional guidance.

2.7. Roll-up Doors. Roll-up doors will be maintained in good operating condition with door tracks free of debris and obstructions to allow smooth operation. **(T-1)** Operators will conduct a visual inspection of door path and trackway and correct any discrepancies before operating door.

(T-1) Roll-up doors will also receive an annual inspection per manufacturer instructions. **(T-1)** Individuals will remain clear of door path while door is in motion. **(T-1)**

2.7.1. Operators ensure auxiliary service roll-up doors, to include tow vehicle exit doors, meet the following requirements:

2.7.1.1. Be able to open a minimum of 8 feet or 70 percent of maximum opening height, whichever is greater. **(T-1)**

2.7.1.2. Powered roll-up doors equipped with one touch open or close buttons will have a crush sensor on the bottom of the door installed and operational, or photoelectric sensors installed and operational no higher than six inches above the floor. **(T-1) Note**: Powered roll-up doors equipped with dead man switches do not require crush sensors.

2.7.1.3. Controls for the door will be located so there is an unobstructed view during door operation. **(T-1)**

2.7.1.4. Motion alarm will sound on the closing cycle of powered roll-up doors, unless equipped with a dead-man switch. **(T-1) Note**: This requirement does not affect powered roll-up doors installed prior to January 2016. However, this requirement must be met when the doors are modified or replaced. **(T-1)**

2.7.2. Prior to a vehicle entering or exiting a facility, drivers will sound their horn to alert personnel. **(T-0)**

2.8. Receiving/Loading Docks. Refer to **paragraph 7.1.9.6** information regarding loading docks.

2.8.1. Refer to **paragraph 7.1.9.6.1** for information regarding dock surfaces.

2.8.2. Employees will be instructed in proper handling techniques for the equipment and materials received. **(T-0)** Supervisors will periodically evaluate and advise employees on proper lifting techniques. **(T-1)** The occupational safety office will be consulted in the planning stages of a new facility design to minimize material handling hazards. **(T-1)**

2.8.3. Employees will receive training on the use of any mechanical leveling equipment to adjust docks to ease loading and unloading of materials. **(T-1)**

2.9. Walk-in Refrigerators and Freezers. A bypass or other type device will be installed on the door of a walk-in refrigerator or freezer to permit escape from inside if an employee is locked inside. **(T-0)** An internally activated alarm bell will be provided and tested weekly and documented. **(T-1)** If the bell is inoperable, it will be replaced immediately. **(T-1)** When a door can be locked from the outside, e.g., with a hasp and padlock, a permanent sign stating, "Warning – Determine No One Is Inside Before Locking Door," will be mounted on the door's exterior. **(T-1)** The letters will be IAW 29 CFR § 1910.145, *Specifications for Accident Prevention Signs and Tags.* **(T-0)**

2.10. Manual Material Handling and Lifting Techniques. Accomplish a hazard assessment to identify risks to employees or property and methods to mitigate these hazards, prior to moving equipment or furniture. **(T-1)**

2.10.1. Possible Exposures to Hazards. Some possible exposures to hazards include, but are not limited to:

2.10.1.1. Movable or detachable parts, such as doors or drawers which must be secured properly prior to moving. **(T-1)**

2.10.1.2. Remove doors or drawers to lighten load and to prevent shifting or falling hazards. **(T-1)**

2.10.1.3. Secure cords, communication cables or other gear attached to the item to prevent tripping or snagging hazards. **(T-1)**

2.10.1.4. For large or difficult to handle items, secure the load to the hand-truck or dolly with a cargo strap or other fastening device. **(T-1)**

2.10.1.5. Paths of travel must be evaluated for conditions such as slopes, carpeting or other irregularities to ensure safe movement of items. **(T-1)**

2.10.1.6. Ensure pathways are cleared and the object being moved will fit through doorways or other required openings. **(T-1)**

2.10.1.7. Use more than one person if moving the load up or down slopes or stairs. **(T-1)** **Note**: Team lifting will be used when items are considered too heavy for one person or when items are lifted from an awkward position or location. **(T-1)**

2.10.1.8. Choose the proper sized and designed dolly for the job.

2.10.1.9. If the use of an elevator is required, the size and weight of the item and manufacturer's loading and weight limit requirements must be considered. **(T-1)**

2.10.1.10. Evaluate the need for PPE. **(T-0)**

2.10.2. Lifting and Carrying. Several variables influence an employee's ability to manually handle and lift materials. Proper consideration and knowledge of employee limitations and the use of correct lifting and carrying techniques will reduce the possibility of injury. Consider the following issues that affect employee safety while lifting:

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

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

2.10.2.3. Pre-existing employee injuries should also be considered, if known.

2.10.2.4. 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 of the load to be handled.

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

2.10.2.6. 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 will be considered.

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

2.10.3. Training. Supervisors will ensure their employees receive thorough training on proper manual lifting techniques both routine or high risk and any PPE required. **(T-0)** In addition, employees will be trained in the use of available manual lifting devices. **(T-0)** To the new employee, hand trucks and wheelbarrows look deceptively easy to use. Supervisors will instruct employees on their use. **(T-0)** 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 will include both verbal and written materials that explain how to do the task correctly with practice and proper motions. **(T-1)** Training will be documented IAW DAFI 91-202. **(T-1)** 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 Public Health (PH) office for assistance in developing the program and to review the NSC publication. The supervisor will consider having personnel evaluated for physical fitness for duty when job tasks require continuous manual lifting. **(T-1)** Employees with physical profile changes will be evaluated for possible reassignment to prevent recurring injuries until cleared by medical authority. **(T-1)**

2.10.4. Minimizing Manual Material Handling Hazards.

2.10.4.1. 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 the use of scissor tables, elevators, conveyors, and gravity chutes.

2.10.4.2. 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.

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

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

2.10.4.3.2. Place objects as close to the body as possible.

2.10.4.3.3. 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.

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

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

2.10.4.3.6. Slide materials instead of lifting, whenever possible.

2.10.4.3.7. Use gravity assist in moving materials.

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

2.10.4.3.9. Consider team lifting 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. Refer to **paragraph 2.10.8** for additional guidance on team lifting.

2.10.5. 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 employees 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 2.1** for an illustration of proper lifting technique.

Figure 2.1. How to Lift Properly.

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

2.10.6.1. 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.

2.10.6.2. 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.

2.10.6.3. Crouch close to the load. Stay close to the load to minimize strain on the muscles.

2.10.6.4. 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.

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

2.10.6.6. 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.

2.10.7. 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.

2.10.8. Team Lifting. Always obtain assistance when it is necessary to move heavy or unusually shaped items manually. Assign additional employees 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 employees similar in size and train them in team-lifting. Employees need to understand that if one employee 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 employees are responsible for assessing all available methods to safely handle materials and for using mechanical assistance whenever possible.

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

2.10.9.1. Points to remember:

2.10.9.1.1. Use appropriate PPE for each task, such as gloves and protective footwear, as required by **paragraph 14.3.2**.

2.10.9.1.2. Keep fingers away from pinch and shear points.

2.10.9.1.3. Make sure the path of travel is clear.

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

2.10.9.1.5. 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.

2.10.9.2. 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.

2.10.9.3. 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.

2.10.9.4. 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.

2.10.9.5. 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.

2.10.9.6. 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.

2.10.9.7. Underarm 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 underarm carry method.

2.10.10. Carrying Items Up or Down Stairways.

2.10.10.1. Adhere to the guidance provided by the supervisor.

2.10.10.2. Try to reduce the bulk or size of the object carried to allow for maximum visibility.

2.10.10.3. Use assistance when required and available.

2.10.10.4. Use mechanical material handling equipment whenever loads are too heavy or bulky to be lifted or carried efficiently or safely by hand.

Chapter 3

WEATHER SAFETY

3.1. Responsibilities.

3.1.1. The supporting Air Force weather organization is responsible for making initial notifications of adverse or mission-limiting weather conditions to predetermined support agencies as defined by local weather support documents and IAW DAFI 15-129, *Air and Space Weather Operations.* **Note:** Adverse or mission-limiting weather conditions include strong and damaging surface winds, heavy rain, thunderstorms, hail, snow, and freezing precipitation.

3.1.2. Each DAF installation will develop local procedures to ensure key personnel and agencies involved in weather-impacted high-risk activities and operations are notified according to the installation weather support documents. **(T-1)** Examples include, but are not limited to, agencies with aircraft, petroleum/oil/lubricant (POL) facilities, opened air work, recreational activities, explosive loading, aircraft maintenance and utilities work. Key personnel, in turn, will advise all on-duty supervisors and employees to take proper precautions. **(T-1)**

3.1.3. Each installation will employ a lightning safety program with a two-tier notification system to minimize personnel exposure to lightning hazards. **(T-0)**

3.2. Two-tier Notification System.

3.2.1. A Lightning Watch is in effect 30 minutes prior to thunderstorms being within a 5 nautical mile radius of any predetermined location or activity as forecasted by the supporting Air Force weather organization. Weather personnel will not cancel a Lightning Watch if the potential for thunderstorms remain within 5 nautical miles of the installation or activity within 30 minutes. **(T-1)** However, all personnel must be prepared to implement Lightning Warning procedures without delay. **(T-1)** Be alert for any lightning activity, to include thunder, and advise supervisory personnel of any observations. If lightning does not occur within 5 nautical miles radius at the valid (forecast) time of the Lightning Watch, the supporting weather organization will reassess the Lightning Watch and amend or cancel the watch as required IAW DAFI 15-129. **(T-1) Note:** During a Lightning Watch, non-explosive operations or activities may continue.

3.2.2. A Lightning Warning is in effect when lightning occurs within a five nautical miles radius of the predetermined locations and activities. Personnel in affected locations or engaged in affected activities will cease all outside activity and seek shelter. **(T-1)** Recommended locations that provide safe shelter and locations to avoid are listed in **paragraph 3.3**. Lightning warnings will be cancelled by the supporting DAF weather organization that initiated the warning. **(T-1)**

3.3. General Lightning Safety for all DAF Activities and Operations. Note: This includes AF-led joint bases.

3.3.1. When lightning is detected or observed within the immediate vicinity of any activity or operation, do not go outdoors or remain out unless it is necessary. Seek shelter in:

3.3.1.1. Dwellings or other buildings that are protected against lightning.

3.3.1.2. Protected underground shelters.

3.3.1.3. Large metal framed buildings.

3.3.1.4. Enclosed automobiles, buses, aircraft and other vehicles with metal tops and bodies.

3.3.2. Certain locations are extremely hazardous during thunderstorms and the following locations will be avoided:

3.3.2.1. Hilltops and ridges. **(T-1)**

3.3.2.2. Areas on top of buildings. **(T-1)**

3.3.2.3. Open fields, athletic fields, golf courses. **(T-1)**

3.3.2.4. Parking lots, tennis/outdoor multi-purpose athletic courts. **(T-1)**

3.3.2.5. Swimming pools (indoor and outdoor), lakes and seashores. **(T-1)**

3.3.2.6. Near wire fences, power and telephone poles, clotheslines, overhead wires, towers, and railroad tracks. **(T-1)**

3.3.2.7. Under isolated trees. **(T-1)**

3.3.2.8. Near electrical appliances, telephones, plumbing fixtures, and metal or electrically conductive objects. **(T-1)**

3.3.2.9. Aircraft dry bays, tanks, and wheel wells. **(T-1)**

3.3.3. All aircraft fuel service maintenance activities, including liquid oxygen (LOX) servicing, will cease whenever a Lightning Warning is in effect. **(T-0) Note**: Refer to DAFI 23-201, *Fuels Management,* for additional guidance.

3.3.4. Locations with nuclear weapons will request notification of lightning within 10 miles of their location from their supporting DAF weather organization and follow the cessation and resumption of operations for lightning environments when necessary IAW DoDM 3150.02, *DoD Nuclear Weapon System Safety Program.* **(T-0)** Local procedures for these advisories are documented in DESR 6055.09_DAFMAN 91-201, *Explosives Safety Standards.* **(T-0)**

3.3.5. Controlled termination for explosives operations when lightning is forecasted to occur in 30 minutes or within 5 nautical miles will follow procedures as outlined in DESR 6055.09_DAFMAN 91-201. **(T-0)**

3.3.6. When working indoors during lightning storms, keep all doors closed. **(T-1)** Where doors must remain open for operations, a formal risk assessment will be conducted. **(T-1)**

3.4. Snow Safety for all Department of the Air Force (DAF) Activities and Operations.

3.4.1. Refer to Chapters **2**, **7**, **16**, **24** and **30** for specific information concerning hazards and controls when dealing with snow accumulation on walking-working surfaces and during vehicle operations.

3.4.2. Snow Loads on Roofs. Some locations may experience significant snowfall. Heavy snowfall can generate increased snow loads on rooftops that can create hazards requiring special attention. Snow loading exceeding the facilities' designed snow load can create

hazardous conditions in facilities that must be addressed. Facility managers will contact installation CE to ensure a snow plan addressing snow loads on roofs is in place. **(T-1)**

3.4.3. Refer to Federal Emergency Management Agency (FEMA) Pamphlet 957, FEMA *Snow Load Safety Guidance,* for more information.

Chapter 4

SERVICES OPERATIONS

4.1. Purpose. This chapter covers the safety requirements for services operations, e.g., laundry, lodging and food services. Refer to DAFI/AFI 34-series publications for services operations requirements such as fitness centers, sport fields, rental equipment, bowling centers, auto hobby shops, etc.

4.2. Laundry. Laundry operations in the DAF applies to installation facilities including billeting laundries and laundry facilities in shops/workplaces. Medical Treatment Facilities laundries will meet the requirements of NFPA 99, *Health Care Facilities Code,* and Joint Commission Accreditation Manuals. **(T-0)**

4.2.1. Supervisors will conduct monthly inspections of laundries and dry-cleaning facilities for hazards or deficiencies using a checklist containing requirements of this chapter and manufacturer's instructions, as required. **(T-2)** Copies of these inspections will be maintained on file for a rolling year. **(T-2)**

4.2.2. Facility Requirements.

4.2.2.1. Laundries and dry-cleaning plants will have separate areas designated for receiving and issue. **(T-0)**

4.2.2.2. Facilities located more than three to four minutes from a medical facility must provide first aid kits. **(T-0) Note**: Remote location is defined as emergency care that is more than three to four minutes from the workplace.

4.2.3. The F&ES Flight will be immediately notified of any flammable solvent spills. **(T-0)** Contact installation CE for guidance on spill procedures and installation BE for health risk assessment (HRA) and recommendations for personnel protection measures. **(T-0)**

4.2.4. Machinery producing potentially hazardous noise and/or vibration levels will be identified, and control measures initiated IAW installation BE's occupational and environmental health risk assessment guidance. **(T-0)**

4.2.5. Hazardous and flammable materials used in laundry and dry-cleaning processes will be stored IAW **Chapter 22**. **(T-0)**

4.2.6. Floors in dry-cleaning rooms will be of fire-resistant construction with a noncombustible and solvent-resistant surface. **(T-0)**

4.2.7. Follow manufacturers guidance on cleaning lint from dryers and hoses to prevent fires. **(T-2)**

4.3. Lodging.

4.3.1. Some lodging supply operations require forklift trucks. Refer to 29 CFR § 1910.178, *Powered Industrial Trucks,* DAFI 24-301, *Ground Transportation,* and **Chapter 12** for additional guidance.

4.3.2. Kitchen Cleaning.

4.3.2.1. As needed, grease will be cleaned from burners and ranges to prevent fires. **(T-0)**

4.3.2.2. Unplug heat producing appliances such as irons and coffee makers prior to cleaning or when not in use. **(T-0)** Refer to **Chapter 6** for additional guidance.

4.3.2.3. Microwave ovens will be cleaned daily. **(T-0)** Microwave ovens with broken doors or latches will be removed from service so personnel will not be exposed to microwave energy. **(T-0)**

4.4. Food Service Operations.

4.4.1. Walk-in Refrigerators and Freezers. Refer to **paragraph 2.9** for additional guidance.

4.4.2. Food Preparation Area.

4.4.2.1. Movable parts of equipment will be properly guarded. **(T-0)** Refer to **Chapter 11** for additional guidance.

4.4.2.2. Knives and cutting attachments will be safeguarded when not in use. **(T-0)**

4.4.2.3. Hoods and Ducting. Hood filters over grease vapor producing activities, e.g., deep fat fryers and grills, will be washed at least daily. **(T-1)** Hood filters in other areas will be washed at least weekly. **(T-1)** Ducting will be cleaned as necessary but at least once every six months. **(T-1)** Cleaning of filters and ducts will be documented IAW local procedures. **(T-1)** Cooking will not be permitted under hoods without properly installed filters or when the fire extinguishing system is not operating. **(T-1)** Exhaust hoods will be vented outside the facility. **(T-1)** 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 used for food service equipment may be extended to every two years if a dining facility prepares less than 10 meals per month.

4.4.3. Machinery/Equipment. Supervisors will maintain manufacturer's instructions for all machinery or equipment under their control or develop local operating instructions (OI), to include job safety, maintenance, lubrication, inspection and identify operator and maintenance technician responsibilities. **(T-1)** Supervisors may use manufacturer's instructions to develop OIs or lesson plans to train operators on requirements of specific machinery. Refer to 29 CFR § 1910.212, *General Requirements for All Machines,* and 29 CFR § 1910.263, *Bakery Equipment,* for additional guidance on machinery. Equipment connected by flexible cords, e.g., extension cords, will be disconnected when not in use for extended periods of time or at the end of the work shift. **(T-1)**

4.4.4. Fire Prevention. Refer to **Chapter 6** and NFPA 96 for guidance and information on food service facilities.

Chapter 5

NONDESTRUCTIVE INSPECTION (NDI) AND OIL ANALYSIS

5.1. Scope.

5.1.1. Nondestructive Inspection (NDI). The purpose of NDI is to employ inspection methods such as magnetic particle, eddy current, liquid fluorescent penetrant, ultrasonic and radiographic to detect cracks or flaws, measure geometric characteristics or determine material structure or composition of equipment. Refer to TO 33B-1-1, *Nondestructive Inspection Methods, Basic Theory,* for additional guidance.

5.1.2. Oil Analysis Program. The purpose of the oil analysis program is to measure and evaluate metal property results by interpreting oil analysis samples. Most samples are from engine oil on special or routine aeronautical flights but may also include special and routine non-aeronautical equipment from other fluid lubricated mechanical systems, such as equipment from other Services. Refer to TO 33-1-37-1, *Joint Oil Analysis Program Manual,* for additional guidance.

5.2. Safety Precautions.

5.2.1. Ultraviolet Radiation. Unfiltered ultraviolet radiation can be harmful to the eyes and skin. Black light bulbs will not be operated without proper lenses and/or filters. **(T-0)** Black lights can severely burn hands, arms, face, or other exposed body areas and ignite fuel vapors. Black lights will not be operated when flammable vapors are present. **(T-0)**

5.2.2. Ionizing Radiation and X-ray Equipment. Refer to 29 CFR § 1910.1096, *Ionizing Radiation,* DAFMAN 48-125, *Personnel Ionizing Radiation Dosimetry,* AFMAN 48-148*,* 21 CFR § Parts 1020.30 through 1020.33, TO 33B-1-1, and TO 33B-1-2, *Nondestructive Inspection General Procedures and Process Controls,* for additional guidance.

5.2.3. Electrical Safety. NDI equipment to be used in hazardous areas will meet NFPA 70 requirements. **(T-0)**

5.2.4. Compressed Gases. Compressed gases commonly used in NDI and/or oil analysis program 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. **(T-1)**

5.2.5. Housekeeping. Good housekeeping is essential to safe operations in the NDI and oil analysis program laboratories. Soiled rags, paper towels, craft paper and other trash contaminated with oil or grease will be placed in self-closing metal containers plainly marked to indicate contents. **(T-1)** Refer to **paragraph 2.4** for additional guidance on housekeeping.

5.2.6. Ventilation Systems. Only basic guidelines for NDI and/or oil analysis program laboratory ventilation are provided in this publication.

5.2.6.1. Surface area exhaust ventilation evaluations will be conducted at least annually. **(T-0)**

5.2.6.2. Ventilation evaluation frequency is determined by installation BE's HRA. 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 oil analysis program work area. Ventilation for oil analysis program spectrometers will comply with TO and manufacturer's requirements. **(T-1)** Refer to installation BE's occupational health assessment (OHA) IAW DAFMAN 48-146, *Occupational Health Program Management.* **Note:** Additional reference information can be found in American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance.*

5.3. Supervisor Responsibilities. Supervisors will:

5.3.1. Ensure personnel are properly trained on NDI and oil analysis procedures prior to being authorized to accomplish NDI and oil analysis work. **(T-1)**

5.3.2. Ensure used oil and cleaning rags do not accumulate in the oil analysis program lab. **(T-1)** Used oil, not to exceed five gallons, may be stored in a metal or plastic container having a sealed, tight-fitting cover and labeled as "Used Oil.". Used cleaning rags and towels will be removed from the lab at the end of each shift. **(T-1)**

5.4. NDI Equipment and Fire Protection Systems. Contact the F&ES Flight prior to operating equipment which utilizes black lights, X-rays, ultraviolet and/or infrared rays. Some fire suppression systems are actuated by ultraviolet 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. **(T-1)**

Chapter 6

FIRE PREVENTION AND PROTECTION

6.1. Fire Extinguishers.

6.1.1. Hazards. 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. 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 when required in the Emergency Action Plan (EAP) to use extinguishers. Employers will receive fire education safety on preventing fires, protecting themselves and evacuation plans. Refer to 29 CFR § 1910.157(a) for additional guidance on the use of portable fire extinguishers. Coordination and approval from F&ES Flight are required.

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 programs are conducted IAW UFC 3-601-02, *Fire Protection Systems Inspection, Testing, and Maintenance*. When a fire protection system is out of service follow procedures IAW DAFI 32-2001, *Fire and Emergency Services (F&ES) Program.* **(T-1)**

6.1.3. The National Defense Authorization Act for Fiscal Year 2022 implemented requirements for all DoD facilities to have portable fire extinguishers. Portable fire extinguishers will be mounted as required in **Figure 6.1**. **(T-0)**

Figure 6.1. AFCEC Guide to the Provision of Organizational Portable Fire Extinguishers and Real Property Extinguisher Cabinets/Mounting[ghi].

Life Safety Code (NFPA 101) Occupancy Classification of Facility	**New Facilities** DAF & NFPA 1 Requirement for Portable Fire Extinguishers	**Existing Facilities** DAF & NFPA 1 Requirement for Portable Fire Extinguishers	**Extinguisher Mounting Requirements**
New Assembly	Required[b]	N/A	Cabinets
Existing Assembly	N/A	Required[b] NLT 31 December 2026	Options per NFPA 10
New Educational	Required	N/A	Cabinets
Existing Educational	N/A	Required NLT 31 December 2026	Cabinets
New Day Care	Required	N/A	Cabinets
Existing Day Care	N/A	Required NLT 31 December 2026	Cabinets
New Health Care	Required	N/A	Cabinets
Existing Health Care	N/A	Required[f]	Cabinets
New Ambulatory Health Care	Required	N/A	Cabinets
Existing Ambulatory Health Care	N/A	Required[f]	Cabinets
New Detention and Correctional	Required[cd]	N/A	Options per NFPA 10

Existing Detention and Correctional	N/A	Required[cdf]	Options per NFPA 10
Lodging or Rooming Houses	Required	Required NLT 31 December 2026	New – Cabinets Existing – Options per NFPA 10
New Hotels and Dormitories	Required	N/A	Cabinets
Existing Hotels and Dormitories	N/A	Required NLT 31 December 2026	Options per NFPA 10
	New Facilities DAF and NFPA 1 Requirement for Portable Fire Extinguishers	Existing Facilities DAF and NFPA 1 Requirement for Portable Fire Extinguishers	Extinguisher Mounting Requirements
New Apartment Buildings	Required[a]	Required[a] NLT 31 December 2026	Cabinets
Existing Apartment Buildings	Not Required	Required[a] NLT 31 December 2026	Options per NFPA 10
New Residential Board and Care	Required	N/A	Cabinets
Existing Residential Board and Care	N/A	Required[f]	Cabinets
New Mercantile	Required	N/A	Cabinets
Existing Mercantile	N/A	Required[f]	Cabinets
New Business	Required	N/A	Cabinets
Existing Business	N/A	Required[f]	Cabinets
Industrial	Required	Required NLT 31 December 2026	Options per NFPA 10
Storage	Required[e]	Required[e] NLT 31 December 2026	Options per NFPA 10
Airport Traffic Control Towers	Required	Required NLT 31 December 2026	Options per NFPA 10
Commercial Cooking Spaces	Required – Class K (EU: Class F is acceptable)	Required[f] – Class K (EU: Class F is acceptable)	Options per NFPA 10
Electronics Spaces (DoD Requirement)	Required (Clean Agent-type)	Required[f] (Clean Agent-type)	Options per NFPA 10
One and Two-Family Dwellings	Not Required	Not Required	None

Notes:

[a]Portable fire extinguishers may be located at exterior locations or interior locations but all portions of the building must be within 75 feet (22.8 m) of travel distance to a portable extinguishing unit.

[b]Portable fire extinguishers are not required in seating or outdoor performance areas.

[c]Access to portable fire extinguishers is permitted to be locked.

[d]Portable fire extinguishers are permitted to be located at staff locations only.

[e]Fixed extinguishers may not be required when forklift, powered industrial truck or cart operators are the primary occupants (See NFPA 1, Table 13.6.1.2 for requirements).

[f]Portable fire extinguishers were already required in this occupancy by UFC 3-600-01, Fire Protection Engineering for Facilities, to comply with Public Law (2020 NDAA of 19 December 2019).

[g]See NFPA 1 and NFPA 10, Standard for Portable Fire Extinguishers, for type, size and placement requirements for portable fire extinguishers.

[h]This table reflects requirements that comply with Public Law (2022 NDAA of 27 December 2021). For planning purposes, the date of 31 December 2026 is proposed for the installation of portable fire extinguishers into those

facilities where not previously required by Public Law. This date is subject to change upon receipt of guidance from DoD or HAF.
[i]Supersedes document entitled "AFCEC Guide to the Provision of Organizational Portable Fire Extinguishers and Real Property Extinguisher Cabinets/Enclosures as of 01 July 2020."

6.2. General Requirements.

6.2.1. Facility Managers/Supervisors will:

6.2.1.1. Establish and maintain a fire prevention training program via the JSTO to ensure employees are trained and understand their fire prevention and protection responsibilities in their work areas IAW 29 CFR § 1910.157, *Portable Fire Extinguishers.* **(T-0)** This requirement will be fulfilled through job safety training and a documentation process IAW DAFI 91-202. **(T-3)**

6.2.1.2. If further guidance is required, consult the F&ES Flight. **(T-1) Note**: Building evacuation procedures in Services facilities may be practiced without actual participation of patrons, with the prior approval of the F&ES Flight Chief.

6.2.1.3. Make sure the facility is in a fire-safe condition at the close of business. **(T-1)**

6.2.1.4. Conduct and document daily closing inspections. **(T-3)**

6.2.1.5. Coordinate approval with the F&ES Flight concerning all social events when temporary decorations or unusual arrangements are anticipated. **(T-1)**

6.2.1.6. Emergency Lighting. Emergency lighting will be provided IAW NFPA 101. **(T-0)**

6.2.2. Server rooms, e.g., information technology or data management rooms, located below floors equipped with water sprinkler systems, are susceptible to water damage if the sprinkler systems are actuated. Managers will provide a means of protecting data processing equipment in the event of a water leak or sprinkler activation (time permitting). **(T-0)** This may be accomplished by strategically locating pre-cut pieces of plastic sheeting within server rooms. In the event of a water leak or spill, equipment will be shut down before it is covered with plastic sheeting. **(T-0)** This will reduce the possibility of the equipment overheating and catching fire. The plastic sheeting will be removed before restarting equipment. **(T-0)**

6.2.3. To determine if a water hazard exists, request a survey of each server room by installation CE. **(T-1)** The building custodian will keep the completed survey on file and brief incoming personnel during initial safety orientation. **(T-1)**

6.2.4. Commercial Food Service Facilities. Commercial food service facilities will be maintained in a safe condition to prevent the loss of DAF resources. **(T-1)** The F&ES Flight will inspect grease and heat removal hoods, ducts, and exhausts at all food service facilities. **(T-1)** The F&ES inspection time and the contractor cleaning frequency will be approved by the fire chief. **(T-1)** The commander will appoint in writing a Quality Assurance Evaluator for cleaning, maintenance and testing conducted under a service contract. **(T-3)** The Quality Assurance Evaluator function is usually accomplished by the facility manager. **(T-3)**

6.2.5. Health Care Facilities. Facility managers and/or safety officers of health care occupancies will maintain a written fire plan that addresses appropriate staff response to a fire emergency. **(T-0)** Appropriate education and training will be provided to employees concerning all elements of the fire plan. **(T-0)** The plan will address facility-wide fire response and evacuation procedures for all staff, employees, and volunteers, and appropriate training

for facility occupants required to participate in the fire plan. **(T-0)** The fire chief or designee will approve the fire plan. **(T-3)**

6.2.6. Portable Fire Extinguishers.

6.2.6.1. F&ES Flight. The F&ES Flight oversees organizational compliance of the base fire extinguisher program and is the authority for all matters involving fire extinguishers. The F&ES Flight will provide facility managers with information on facility fire extinguisher requirements outlined in NFPA standards and as required by UFC 3-600-01. **(T-1)**

6.2.6.2. Extinguishers are not normally provided for military family housing. Should MAJCOMs, FLDCOMs, DRUs, or FOAs direct installation of extinguishers in military family housing, procedures will be developed to ensure occupants are trained in their use and extinguishers are maintained. **(T-3)**

6.2.6.3. Fire Extinguisher Location. The F&ES Flight will approve the location of all fire extinguishers. **(T-3)**

6.2.6.4. Fire Extinguisher Purchase and Maintenance. Facility managers and using organizations will budget for the purchase and maintenance of fire extinguishers. **(T-3)** **Note**: 150-pound flightline fire extinguisher programs are maintained under the Aircraft Maintenance Squadrons or Generation Squadrons as required per HAF Mission Directive (HAFMD) 1-38, *Deputy Chief of Staff, Logistics, Engineering and Force Protection*.

6.2.6.5. All fire extinguishers will meet the requirements of NFPA 10, *Standard for Portable Fire Extinguisher.* **(T-1)** **Note**: TO 13F4-4-121, *Fire Extinguisher, Wheeled Liquified Gas, 150 LB Capacity,* and NFPA 10 are to be used for maintenance and inspection of wheeled flightline fire extinguishers.

6.2.6.6. Employee Responsibilities. All employees are responsible for fire extinguishers in their work areas. Employees will ensure fire extinguishers are readily accessible with unobstructed access and are used only for the intended purpose. **(T-0)** F&ES Flights will be notified of any fire extinguisher discharge, accidental or intentional. **(T-3)**

6.2.6.7. Supervisor Responsibilities. Supervisors are responsible for fire extinguishers in areas under their control. Supervisors will:

6.2.6.7.1. Perform visual inspections of fire extinguishers. **(T-0)**

6.2.6.7.2. Take defective extinguishers to an authorized servicing location, as determined locally, and coordinated with the F&ES Flight, for services. **(T-0)** Fire extinguishers removed from service will be immediately replaced. **(T-1)**

6.2.6.7.3. Mount fire extinguishers in or on vehicles or equipment in approved brackets, or otherwise secure them, to prevent damage as directed by TO or other directive. **(T-0)** **Note**: Vehicle fire extinguishers will only be purchased with the approval of Vehicle Management to ensure the vehicle TOs and AFIs require the vehicle to carry fire extinguishers. **(T-1)**

6.2.6.8. Visual Inspection. Managers and supervisors at all levels will ensure a visual inspection is performed and documented monthly for all fire extinguishers under their

control. **(T-0)** Extinguishers with discrepancies will be removed from service and replaced immediately until repaired. **(T-0)** This inspection includes:

6.2.6.8.1. Extinguisher located in a designated place.

6.2.6.8.2. No obstruction to access or visibility.

6.2.6.8.3. Instructions on name plates are legible and facing outward.

6.2.6.8.4. Safety seals and/or tamper indicators are not broken or missing.

6.2.6.8.5. No obvious physical damage, corrosion, leakage, or clogged nozzle.

6.2.6.8.6. Pressure gauge reading or indicator in the operable range or position.

6.2.6.8.7. For wheeled units, the condition of the tires, wheels, carriage, hose and nozzle checked.

6.2.6.8.8. Fullness determined by weighing or "hefting."

6.2.7. Space Heaters.

6.2.7.1. Use Nationally Recognized Testing Laboratory (NRTL)-listed or host nation equivalent space heaters equipped with automatic shutoff devices that will shut off the heater if it tips over. Space heaters will also have an overheat protection device, an automatic thermostat control and will be disconnected when not in use. **(T-3) Note**: Space heaters will be approved by the facility manager prior to use. **(T-3)** For a current list of OSHA-recognized NRTLs, visit **https://www.osha.gov/dts/otpca/nrtl/nrtllist.html**.

6.2.7.2. Plug space heaters directly into a wall receptacle, not into extension cords or multiple outlet strips. **(T-0)**

6.2.7.3. Maintain a 36-inch minimum distance or IAW manufacturer's instructions between any space heater and combustibles. **Note**: The more restrictive guidance will apply. **(T-3)**

6.2.7.4. Do not leave these devices unattended when in use and unplug them at the end of the day or shift. **(T-3)**

6.2.7.5. The use of space heaters in any hazardous location as defined by NFPA 70, *National Electric Code,* is prohibited. **(T-1)**

6.2.8. Coffee Makers.

6.2.8.1. Keep coffee makers and the area around them free of paper products and other loose combustibles. **(T-1)**

6.2.8.2. Follow manufacturer's instructions and consult with facility manager prior to placement of coffee makers.

6.2.8.3. Unplug coffee makers at the end of the day. **Note**: Coffee makers/machines with integral timers and single serve coffee makers do not need to be unplugged, e.g., Bunn-type coffee brewers and Keurig.

6.2.9. Heating Systems.

6.2.9.1. Heating devices, such as furnaces or heaters, must be kept clear of combustible and flammable material. **(T-1)**

6.2.9.2. All heating, boiler, air conditioning, air handling and mechanical rooms will be secured. **(T-0)** Only the F&ES Flight, installation CE or authorized personnel will have access to these areas. **(T-3)**

6.2.10. Decorations.

6.2.10.1. Electric string lights and wiring recognized by an NRTL are authorized. **(T-0)**

6.2.10.2. Unplug or switch off all electrical decorations when the work area is unoccupied. **(T-3)**

6.2.10.3. Decorations will be noncombustible or fire retardant. **(T-1)** Use of an open flame is prohibited. **(T-1)**

6.2.11. Fire Alarm Systems. Supervisors will ensure all personnel are familiar with the fire alarm systems, know how to report an emergency and how to activate the fire alarm system. **(T-0)** At no time will a fire detection, suppression or alarm system or device be painted, blocked, or obstructed in any manner. **(T-1)**

6.2.12. Emergency Evacuation Procedures.

6.2.12.1. Supervisors will establish an EAP. **(T-0) Note**: Employees will know primary and secondary escape routes for every area of the building. **(T-1)**

6.2.12.2. Consult the F&ES Flight to determine requirements for practicing fire evacuation drills. Supervisors ensure new personnel are trained in evacuation procedures. **(T-3)**

6.2.12.3. Personnel will 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. **(T-1)** Commanders may approve in writing, with coordination from the occupational safety office and F&ES Flight, any combat ready positions authorized to remain in their work center during fire alarm activation. Upon direction of the senior fire official, all personnel will immediately evacuate to include those combat mission ready positions. **(T-3) Note**: Command post and/or job control personnel are not considered combat mission ready.

6.2.12.4. Do not use elevators during evacuation; use the stairs. **(T-1)**

6.2.12.5. Establish the predetermined areas for personnel to gather after evacuation to account for personnel. **(T-0)**

6.2.12.6. Appoint Emergency Action Procedures representatives to account for personnel at the predetermined meeting area. **(T-0)** This will help emergency response personnel determine who may still be in the building. At least two representatives per section will 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. **(T-3)** Sections with many personnel (20 or more) in their allocated space may require additional representatives.

6.2.12.7. Assign employees to assist people in wheelchairs or anyone else who would have difficulty descending stairs on their own. **(T-0)** Also, ensure people with hearing or sight problems know they are to evacuate. **(T-0)** Assign someone to help them evacuate and report to the designated meeting area. **(T-3)**

Chapter 7

WALKING – WORKING SURFACES

7.1. General Requirements. Slips, trips, and falls at the same level create numerous injuries each year. Proper design, maintenance, and good lighting are paramount in the prevention of slip, trip and fall injuries. Refer to 29 CFR § 1910, Subpart D – *Walking-Working Surfaces,* for definition and additional guidance.

7.1.1. Maintenance. All walking-working surfaces will be maintained in clean and dry condition. **(T-0)**

7.1.1.1. Drip or oil pans will be used whenever the possibility of spilling or dripping exists. **(T-0)**

7.1.1.2. Where wet processes are used, drainage will be maintained and false floors, platforms, mats, or other dry standing places will be provided. **(T-0)** If floor drains are present, floors will be sloped to allow liquids to naturally flow to the drains. **(T-0)** Drains will be kept clear to prevent clogging, especially when hazardous or contaminated materials are present. **(T-0)**

7.1.1.3. In locations where wet processes do not normally occur, and drains are not available, wet areas will be clearly marked (e.g., wet floor signage) and immediately cleaned up and dried before permitting other personnel to enter the area. **(T-0)**

7.1.1.4. Protective footwear for wet slippery surfaces will be provided where appropriate. **(T-1)** 7.1.1.5. Obstacles in walk areas, liquid spills, sawdust accumulations and the use of slippery surface cleaners can cause slipping hazards and will be cleaned up immediately to prevent slips, falls and injuries. **(T-0)**

7.1.2. Condition. Floors, aisles, and passageways will be kept clear and in good repair, with no obstructions, free of defects that can endanger employees or interfere with the handling of materials, or hinder people leaving during emergencies. **(T-0)** Ensure sharp or protruding objects, loose boards, damaged carpet, damaged concrete are repaired to prevent slips, trips, and falls. **(T-0)** Floors will be maintained to ensure that they can support the maximum intended load for that surface. **(T-0)** Refer to 29 CFR § 1910.22, *General Requirements-Walking Working Surfaces*, for additional information.

7.1.3. Illumination. 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 will be provided where general lighting is not sufficient. **(T-1)** Facility managers will ensure lighting is sufficient for walking surfaces in their work/facility area and that obstacles are visible. **(T-0)**

7.1.3.1. Consult the installation CE facility design section whenever specific guidance on lighting is required. Some work may require increased illumination. Submit a work request when a lighting survey is required. If the safety of personnel is a factor, the work request will be coordinated with the occupational safety office, who may assign a Risk Assessment Code (RAC). **(T-1)**

7.1.3.2. When fluorescent lighting fixtures are used, supervisors will ensure any stroboscopic effect with moving machinery is avoided. **(T-1)**

7.1.4. Guards for Floor and Wall Openings. Every floor opening, such as a hatchway, chute, pit, trap door, manhole, and ladderway, will be guarded. **(T-0) Note**: Manholes will comply with 29 CFR § 1910.24, *Step Bolts and Manhole Steps*. **(T-0)** The type of guard used depends on the location, reason for the opening and frequency of use. Refer to 29 CFR § 1910.28, *Duty to Have Fall Protection and Falling Object Protection,* for additional guidance. One of the following guards will be installed:

7.1.4.1. Standard Railings Systems and Toeboards. **(T-0)**

7.1.4.1.1. Guardrails used to prevent falls into holes or openings, including skylights, will be fixed on all exposed sides, except at a stairway entrance. **(T-0)** If there is danger of a person walking straight into the opening, a swinging gate or offset passage will be used. **(T-0)** Refer to 29 CFR § 1910.28 for specific detail on the use of guardrail systems.

7.1.4.1.2. All open-sided floors, platforms, and runways four feet or more above the next lower level will be guarded by a standard railing on all open sides, except at ramp entrance to a ramp, stairway, or fixed ladder. **(T-0)** Collapsible or removable railings may be installed on a runway, but will 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 occupational safety office, are used. **(T-0)** Railings will be reinstalled when the task is complete. **(T-0)**

7.1.4.1.3. Every permanent or temporary wall opening, to include windows, less than 39 inches above the floor (where there is a four foot or more drop) will be protected from falling by use of: guardrail system, safety net system, travel restraint systems or personal fall arrest systems (PFAS). **(T-0)** If a guardrail system is used, the guard may be removable but will be installed when the opening is not in use. **(T-0)** A toeboard will be installed when falling materials may present a hazard. **(T-0)** Refer to 29 CFR § 1910.28 for additional information.

7.1.4.1.4. Toeboards are required to prevent objects from falling to a lower level and prevents struck by hazards to employees below. **(T-0)** Refer to 29 CFR § 1910.28 for additional information.

7.1.4.2. Floor Opening Cover. A cover will 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. **(T-0)** In addition, covers or guards will be used to protect people from the hazards of open pits, tanks, vats, ditches, etc. **(T-0)** Refer to 29 CFR § 1910.28 for additional requirements.

7.1.5. Guardrail Systems, Toeboards and Covers Design.

7.1.5.1. Guard railings are barriers erected along an unprotected or exposed side, edge, or other area of a walking-working surface to prevent employees from falling to a lower level. **(T-0)** Guardrails will be designed and installed to meet the following:

7.1.5.1.1. The vertical height will be 42 inches, plus or minus 3 inches, from the upper surface of the top rail to the floor, platform, runway, or ramp level. **(T-0)** Heights greater than 45 inches are permissible, provided the guard rail system meets all criteria of 29 CFR § 1910.29(b).

7.1.5.1.2. Top rails must be capable of withstanding, without failure, a force of at least 200 pounds (890 N) applied in any downward or outward direction at any point along the top rail. **(T-0)** When a 200-pound test is applied in a downward direction, the top rail must not deflect to a height of less than 39 inches above the walking-working surface. **(T-0)**

7.1.5.1.3. Midrails, screens, mesh, intermediate vertical members, solid panels, or equivalent intermediate members will be installed between, at the midpoint of the walking-working surface and the top edge of the guardrail system when there is not a wall or parapet that is at least 21 inches high. **(T-0)** Midrails, screens, mesh, intermediate vertical members, solid panels, and other equivalent intermediate members must be capable of withstanding, without failure, a force of at least 150 pounds (667 N) applied in any downward or outward direction at any point along the intermediate member. **(T-0)** Additional requirements can be found in 29 CFR § 1910.29.

7.1.5.1.4. Intermediate vertical members or other equivalent intermediate members will be installed at no more than 19 inches apart. **(T-0)**

7.1.5.2. Toeboards will be constructed to reach 3.5-inches measured from the walking-working surface to the top of the top edge of the toeboard and will not have a clearance greater than one-quarter of an inch (1/4 in) above the walking-working surface. **(T-0)** Made of solid material or one with openings not greater than one inch and securely fastened. **(T-0)** Toeboards must be capable of withstanding, without failure, a force of at least 50 pounds (222 N) applied in any downward or outward direction at any point along the toeboard. **(T-0)**

7.1.5.3. Covers used to protect employees from falling in walking-working surface holes will be capable of supporting, without failure, at least twice the maximum intended load that may be imposed on the cover at one time and secured to prevent displacement. Employees working around skylights will ensure they are protected by guardrails or covers to prevent falls. **(T-0)** Personal fall protection may be used when guardrails or covers are not feasible to use or may create a greater hazard. For personal fall protection requirements refer to **Chapter 13,** *Fall Protection,* for additional information. **(T-0)**

7.1.6. Coefficient of Friction of Walking and Working Surfaces. Consult installation CE when coefficient of friction guidance for a specific work surface is required or needs to be determined. Finished surfaces will have a coefficient of friction of at least 0.5 for level surfaces and 0.8 for sloped surfaces. ANSI/American Society of Safety Professionals (ASSP) A1264.2, *Provision of Slip Resistance on Walking/Working Surfaces,* may provide additional information. **(T-1)** This requirement applies to all types of floors and other walking-working surfaces, including vinyl, tile, wood, carpet, steel, concrete, etc., and any coating or surface treatment used on them.

7.1.7. Coatings include painted and unpainted walking - working surfaces and will exhibit anti-skid properties to reduce the risk of employee slips and falls. **(T-0)** The purchaser will verify anti-skid properties with coating manufacturer or supplier before purchasing. **(T-0)**

7.1.8. Interior Walking - Working Surfaces.

7.1.8.1. Layout. All interior walking and working surfaces that are part of the means of egress will comply with UFC 3-600-01, *Fire Protection Engineering for Facilities,* and NFPA 101, *Life Safety Code.* **(T-0)**

7.1.8.1.1. Equipment and machinery will be arranged to permit an even flow of materials. **(T-1)**

7.1.8.1.1.1. Sufficient space will be provided to handle the material with the least possible interference from or to employees or other work being performed. **(T-1)**

7.1.8.1.1.2. Machines will be placed so it will not be necessary for an operator to stand in a passageway, aisle or exit access. **(T-0)**

7.1.8.1.1.3. Machine positioning will allow for easy maintenance, cleaning and removal of scrap. **(T-1)**

7.1.8.1.1.4. After the initial positioning of equipment and machines is decided, clear zones (workspaces) of sufficient dimensions to accommodate typical work will be established. **(T-1)**

7.1.8.1.1.5. If material exceeds established clear zones, rope and stanchions may be used to temporarily extend the workspace.

7.1.8.1.1.6. The supervisor will consult with the occupational safety office as needed to determine the need to mark clear zones based upon hazard potential. **(T-1)**

7.1.8.1.1.7. Yellow or yellow-and-black hash-marked lines, two to three inches wide, will be used when marking is necessary. **(T-1)**

7.1.8.1.2. Passageways, aisles and exit access will be provided to permit free movement of employees and material, independent of clear zones and storage spaces and clearly recognizable. **(T-0)** Markings will be used unless impractical. **(T-0)** Floor markings will provide a contrast to the floor color, such as yellow lines two to three inches wide on a gray floor. **(T-0)**

7.1.8.1.3. Where powered materials handling equipment (lift truck, etc.) is used, facility layout will provide enough clearance in aisles, loading docks and through doorways to permit safe turns. **(T-0)** Obstructions that could create hazards will not be permitted in aisles. **(T-0)** Aisles will be at least two feet wider than the widest vehicle used or most common material being transported. **(T-0)** Refer to 29 CFR § 1910.176, *Handling Materials—General,* for additional information.

7.1.8.1.4. Aisles will be at least 36 inches wide to permit free movement of employees, equipment, and supplies. **(T-0)** A minimum of 18 inches will be provided for passageways formed by or between movable obstructions. **(T-0)** Refer to NFPA 101 and UFC 3-600-01 for additional information.

7.1.8.1.5. Sufficient access and working space of no less than 30 inches or width of the equipment, whichever is greater, will be provided and maintained around all electrical equipment and ensure the space permits at least a 90-degree opening of the equipment doors or hinged panels. **(T-0)** Refer to 29 CFR § 1910.303, *General (Electrical)*, for additional information.

7.1.8.2. Condition.

7.1.8.2.1. Floors will not be cleaned with flammable liquids. **(T-0)** IAW DAFMAN 32-7002 floor cleaning chemicals not currently loaded in the standardized Air Force Hazardous Material (HAZMAT) tracking system must be approved by the installation Hazardous Materials Management Process (HMMP) Team prior to use. **(T-1)** Adequate ventilation will be provided and/or respiratory protection may be required. **(T-0)** Combustible or explosive dust will be eliminated at the source. **(T-0)** If this is not possible, it will be minimized during sweeping by spreading a noncombustible sweeping compound over the floor. **(T-0)**

7.1.8.2.2. After floors have been properly cleaned, nonskid finishing compounds may be used. In some locations, such as electroplating shops, finishing compounds will not be applied if there is a possibility of a reaction with shop chemicals. **(T-0)**

7.1.8.2.3. When floors are being cleaned or finishing compounds applied, signs will be posted to warn employees of a slipping hazard and will remain in place until floors have dried. **(T-0)** The placement of these signs will be at the discretion of the supervisor but will be visible to those entering the hazardous area. **(T-0)** Refer to **Chapter 17** for additional information on safety, fire prevention and health signs.

7.1.8.2.4. Loading Capacity. Supervisors will ensure equipment weight and distribution comply with maximum floor loading capacity for all above grade storage areas, including areas above basements. **(T-0)** The weights of equipment, such as hoists suspended under a floor, will also be considered when determining floor loading capacity. **(T-0)** The supervisor will have signs that identify the floor load capacity determined by installation CE permanently installed in plain view of all employees. **(T-0)** installation CE will approve the installation of all equipment weighing more than 500 pounds in any multi-story building. **(T-1)** Supervisors will ensure heavy loads are evenly distributed according to the floor's safe load limit. **(T-0)** Refer to 29 CFR § 1910.22. for additional information.

7.1.9. 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 installation CE.

7.1.9.1. Parking Lots. The parking lots will be smooth, have good drainage and be free of pedestrian tripping hazards. **(T-0)** Walkways will be provided. **(T-0)** Entrances and exits will not have obstructions that block a driver's or pedestrian's view of traffic. **(T-0)** Supervisors should contact the occupational safety office and installation CE for more detailed information. Specifications for signs are contained in UFC 3-120-01, *Design: Sign Standards.*

7.1.9.2. Walkways. Lighting will be used to provide sufficient visibility for safe passage on a walkway and highlight hazards. **(T-0)** When loose gravel or crushed rock is used for surfacing, the largest dimensions of material used will not exceed one-half of an inch. **(T-0)** Motorized vehicles will not be operated over elevated walkways unless the load bearing capacity of the walkway will support the vehicle's weight. **(T-0)** Broken, uneven, or cracked surfaces, which might reasonably present a hazard, will be repaired. **(T-0)**

7.1.9.3. Grounds. All grounds adjacent to work areas will be kept free of hazardous materials, trash, weeds, unguarded pits, openings, or obstacles. **(T-0)**

7.1.9.3.1. Materials will not be stored, left under, or piled against buildings, doors, exits or stairways. **(T-0)**

7.1.9.3.2. Poisonous or toxic plants will not be used for landscaping without prior approval of the medical services. **(T-0)** Weeds will not be permitted to grow excessively or to accumulate on walkways. **(T-0)** Trees and bushes adjacent to walkways will be trimmed to permit a clear path for pedestrians. **(T-0)**

7.1.9.3.3. Open drainage ditches present a serious fall hazard and must be clearly marked or guarded by fences, barriers, or well-lit to identify the ditch location and prevent accidental falls. **(T-0)**

7.1.9.4. Construction. All construction work will be clearly identified by signs that can be read from at least 50 feet, in addition to barriers marked with night reflective materials. **(T-0)** Illumination or warning flashers will also be used after dark. **(T-0)**

7.1.9.5. Vehicle Repair, Service and Assembly Pits. The use of a fall protection system is not required for those work pits that are less than 10 feet deep provided that:

7.1.9.5.1. Access to pit is marked and limited within six feet of the edge to authorized and trained employees only IAW 29 CFR § 1910.30, *Training Requirements*. **Note**: Color use for floor marking must contrast with the surrounding area.

7.1.9.5.2. If floor markings are not feasible, physical stanchions (capable of resisting, without tipping over, a force of at least 16 pounds applied horizontally against the stanchion and a height of 30 inches) may be used and positioned six feet from the edge of the pit. **Note**: The use of stanchions and markings may be combined, where applicable.

7.1.9.5.3. When two or more pits in a common area are not more than 15 feet apart, compliance may occur by placing contrasting floor markings at least six feet from the pit edge around the entire area of the pits. Caution signs will be visible and posted, and meet the requirements of 29 CFR § 1910.145, *Specifications for Accident Prevention Signs and Tags*, and state CAUTION—OPEN PIT. **(T-0)**

7.1.9.6. Loading Docks. Frequently used loading docks will be located away from principal streets and intersections. **(T-1)** Vehicles parked at docks will not block general vehicular traffic unless control devices, such as cones, barricades or warning signs are used to redirect traffic. **(T-1)** Loading docks will adhere to fall protection requirements in **paragraph 7.1.4.1.2**. **(T-1)**

7.1.9.6.1. Dock surfaces will be smooth and even. **(T-1)** Where necessary, aisleways will be marked. **(T-1)** Edges of docks will be marked with four-inch-wide yellow lines when there is a chance of employees falling. **(T-0)** Where the potential for serious injury exists from falls greater than four feet, removable railings will be used. **(T-0)**

7.1.9.6.2. The dock will be at least two (2) feet wider than the widest vehicle or more common material being transported. **(T-0)** Additional clearance will be provided to permit safe turns. **(T-1)**

7.2. Stairs and Ramps Requirements. (Note : Egress components, such as stairs, ramps, guard rails or handrails, constructed to any 1970 or newer edition of NFPA 101 are acceptable.) The selection of a particular type of stairway or ramp is dependent upon the location, intended use and existing environmental conditions, and is normally performed by installation CE with recommendations from the occupational safety office and F&ES Flight. In addition to the below criteria, see NFPA 101, UFC 3-600-01, 29 CFR § 1910.28 and 29 CFR § 1910.25, *Stairways.*

7.2.1. 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.

7.2.2. Hazards 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. **(T-0)** 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.

7.2.3. Strength. Stairs and fixed ramps will 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. **(T-0)**

7.2.4. Width. Stairs, if part of the exit access, will have a minimum width of 36 inches if the occupant load of the building or structure is less than 50 persons. **(T-0)** If the occupant load is greater than 50, the minimum stair width is 44 inches. Fixed ramps, if part of the exit access, will have a minimum width of 44 inches. **(T-0)** Ramp requirements will be determined by NFPA 101 and appropriate building codes. **(T-0)** New designs will be coordinated through the Designated Fire Protection Engineer (DFPE) per UFC 3-600-01. **(T-0)**

7.2.5. Angle of Rise. Stairs will be installed at angles to the horizontal of 30 to 50 degrees. **(T-0)** For stairs constructed or installed after 17 January 2017, a maximum riser height of 9.5 inches, minimum tread depth of 9.5 inches and a minimum width of 22 inches between vertical barriers is required. Stairs constructed/installed prior to 17 January 2017 are compliant if they meet the requirements of 29 CFR § 1910.25, Table D-1. Tread depth and riser height must be consistent throughout a new facility. **(T-0)** Tread depth and riser heights must also be consistent throughout a staircase. **(T-0)** Where the slope is less than 30 degrees, a ramp with a non-slip surface will be installed. **(T-0)**

7.2.6. Ramps. Ramps not part of the exit access will follow guidance in NFPA 101. **(T-1)** For ramps that are part of the exit access, a maximum slope of 1 to 8 inches for existing ramps and 1 to 12 for new ramps is allowed. **(T-0)** To meet Americans with Disabilities (ADA) requirements, review the information/guidance on ADA requirements, which can be found at **https://www.access-board.gov/ada/**.

7.2.7. Width of Landings. Landings and platforms not part of the exit access will not be less than the width of the stairs and a minimum of 30 inches in length, measured in the direction of travel. **(T-0)** When doors or gates open directly onto a stairway, they will not reduce the available width of the landing to less than 20 inches for platforms installed before 17 January 2017, and less than 22 inches for platforms installed on or after 17 January 2017. **(T-0)**

Landings in stairs or ramps that are part of the exit access will meet the requirements of NFPA 101. **(T-0)**

7.2.8. Vertical Clearance. Where there is less than six feet, eight inches of headroom over stairs, obstructions will be padded. **(T-0)** When they cannot be padded, obstructions will be color coded yellow or yellow-and-black stripes to highlight the hazards. **(T-0)** In all cases, caution signs will be used to warn people of low clearances. **(T-0)**

7.2.9. Treads. All treads will be slip-resistant and free of projections or lips that could cause a tripping hazard. **(T-0)**

7.2.10. 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.

7.2.11. Sidewalk Ramps. Sidewalk ramps will be installed where equipment, such as housekeeping carts or hand trucks, are used. **(T-0)**

7.2.12. Stair Railings and Guards. Every flight of stairs with four or more risers will have standard guardrails or standard handrails as called for in 29 CFR § 1910.25. **(T-0)** The width of the stair will be measured clear of all obstructions except handrails. **(T-0)**

7.2.12.1. Stairs less than 44 inches wide with both sides enclosed will have at least one handrail, preferably on the right side going down. **(T-0)**

7.2.12.2. Stairs less than 44 inches wide with one side open will have at least one guardrail on the open side. **(T-0)**

7.2.12.3. Stairs less than 44 inches wide with both sides open will have one guardrail on each side. **(T-0)**

7.2.12.4. Stairs more than 44 inches wide but less than 88 inches wide will have a handrail on each enclosed side and a guardrail on each open side. **(T-0)**

7.2.12.5. Stairs 88 or more inches wide will have one handrail on each enclosed side, one guardrail on each open side and one intermediate guardrail built midway of the width. **(T-0)**

7.2.12.6. Spiraling and winding stairs will have a handrail offset to stop people from walking on the parts of the treads that are less than six inches wide. **(T-0)**

7.2.13. Illumination. Stairs and ramps will be lighted, so all treads and landings are visible. **(T-0)** Consult the installation CE facility design section whenever specific guidance on lighting is required.

7.2.14. Inclined Ladders. Some DAF 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 will have handrails on both sides and open risers. **(T-0)** Construction or installation after 17 January 2017 will have stairs installed within the range of 30-50 degrees. **(T-0)**

7.2.15. Maintenance. Stairs and ramps will be kept clean, free of obstructions or slippery substances, and in good repair. **(T-0)** Supervisors will ensure:

7.2.15.1. Loose boards, insecure treads, protruding nails and torn or worn stair treads are repaired or replaced immediately. **(T-0)**

7.2.15.2. Posters, bulletin boards and other objects that could distract a person's attention are not placed in stairwells or rampways. **(T-0)**

7.2.15.3. Slippery surfaces are replaced or made safe by coating them with nonslip surface materials. **(T-0)**

7.2.15.4. Treads and risers are of uniform size. **(T-0)**

7.2.15.5. Stair nosings (leading edge of the tread) are designed to prevent personnel from catching their heels on the treads. They must be securely fastened and rounded or beveled. **(T-1)**

7.2.15.6. Guardrails and handrails are smooth, free of splinters or burrs and securely mounted. **(T-0)**

7.2.15.7. 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. **(T-0)** This also includes all emergency exits and walkways leading from them.

7.3. Fixed Ladders.

7.3.1. Requirements.

7.3.1.1. Acquisition. Fixed ladders, and their parts and accessories, and safety devices will meet requirements of 29 CFR § 1910.23, *Ladders*. **(T-0)** Procurement specifications will include permanent treatment for corrosion control so future treatment will not be needed. **(T-1)**

7.3.1.2. Design and Installation. Fixed ladders provide a means of access to roofs, pits, silos, towers, tanks, and other limited-access areas. Stairs will 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. **(T-0)** Fixed ladders may be used when a stairway cannot be used. The following paragraphs provide general design and installation criteria for fixed ladders:

7.3.1.2.1. Rungs. All fixed ladder rungs, steps and cleats will be parallel, level and uniformly spaced. **(T-0)** Spacing between rungs will be consistent at no less than 10 inches and no more than 14 inches apart. **(T-0)** Rungs will have a minimum width of 16 inches (measured before installation of ladder safety systems). **(T-0)**

7.3.1.2.2. Length. Ladders 24 feet or less will be of a continuous length. **(T-0)** When they are more than 24 feet and of continuous length, the following requirements apply:

7.3.1.2.2.1. When platforms are required, they will not be less than 24 inches wide by 30 inches long and will be equipped with standard railings. **(T-0)**

7.3.1.2.2.2. Toeboards are required where the hazard of objects falling is present. Refer to 29 CFR § 1910.29, *Fall Protection Systems and Falling Object Protection—Criteria and Practices,* for additional information.

7.3.1.2.3. Ladder Safety Devices, Cages and Wells. All ladder safety devices such as those that incorporate positioning belts, friction brakes and sliding attachments will meet the design requirements of the ladders which they serve. **(T-0)** Ladder safety

systems will allow an employee to climb up and down the ladder with both hands and not require the employee to continuously hold, push or pull any part of the system while climbing. **(T-0)** Where a cage is installed, it will extend to a minimum of 42 inches above the top of landing unless other acceptable protection is provided. **(T-0)** Cages will extend down the ladder to a point not less than seven feet or more than eight feet above the base of the ladder. **(T-0)** Refer to 29 CFR §§ 1910.23 and 1910.28 for specific design and construction information. Ladder safety devices, cages or wells are required on all fixed ladders more than 24 feet as follows:

7.3.1.2.3.1. Existing fixed ladders. Each fixed ladder installed before 19 November 2018, is equipped with a PFAS, ladder safety system, cage, or well. **(T-0)**

7.3.1.2.3.2. New fixed ladders. Each fixed ladder installed on and after 19 November 2018, is equipped with a PFAS or a ladder safety system. **(T-0)**

7.3.1.2.3.3. Replacement. When a fixed ladder, cage, or well, or any portion of a section thereof, is replaced, a PFAS or ladder safety system is installed in at least that section of the fixed ladder, cage, or well where the replacement is located. **(T-0)**

7.3.1.2.3.4. Final deadline. IAW 29 CFR § 1910.28(b)(9)(i)(D), on and after 18 November 2036, all fixed ladders are equipped with a PFAS or a ladder safety system. **(T-0)**

7.3.1.2.4. When a one-section fixed ladder is equipped with a personal fall protection or a ladder safety system or a fixed ladder is equipped with a personal fall arrest or ladder safety system on more than one section, ensure the following:

7.3.1.2.4.1. The PFAS or ladder safety system provides protection throughout the entire vertical distance of the ladder, including all ladder sections. **(T-0)**

7.3.1.2.4.2. The ladder has rest platforms at intervals not to exceed 150 feet (45.7 m). **(T-0)**

7.3.1.2.4.3. Ensure ladder sections having a cage or well are offset from adjacent sections. **(T-0)**

7.3.1.2.4.4. Have landing platforms provided at maximum intervals of 50 feet (15.2). **(T-0) Note**: A cage or well may be used in combination with a PFAS or ladder safety system provided that the cage or well does not interfere with the operation of the system.

7.3.1.3. Ladder Pitch. The preferred pitch of fixed ladders will be 75 to 90 degrees from the horizontal. **(T-1)** Ladders with a pitch more than 90 degrees are prohibited. Refer to 29 CFR § 1910.23, *Ladders,* for additional information.

7.3.1.4. Load Capacity. All ladders, platforms, accessories, and fastenings will not have their maximum intended loads exceeded. **(T-0)** Maximum intended loads are defined in 29 CFR § 1910.21(b) as the total load (weight and force) of all employees, equipment, vehicles, tools, materials and other loads the employer reasonably anticipates being applied to a walking working surface at any one time.

7.3.1.5. Lighting. Adequate illumination will be available when using ladders. **(T-0)** Lamps will be installed so the light does not reflect in a climber's eyes. **(T-0)** Consult the installation CE when specific guidance on lighting is required.

7.3.1.6. Access. Where unauthorized use of a fixed ladder poses a hazard, the facility manager will ensure the ladders are secured from unauthorized access. **(T-2)** Ladders available to public access require guarding to prevent unauthorized access. **(T-0)** The bottom seven feet will be guarded. **(T-0)** 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. **(T-0)**

7.3.1.7. 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 will be provided. **(T-0)**

7.3.1.8. Electric Lines. Electrical conductors will not be installed on or adjacent to fixed metal ladders unless they are beyond reach and cannot be used as a handrail or grabbed inadvertently. **(T-0)** This distance must be at least five feet from the ladder. **(T-0)** If there is any potential for contact with parts of electric equipment or circuits, these parts will be de-energized and locked out IAW **Chapter 21. (T-0)**

7.3.1.9. Rung Ladders. Rung ladders will be built into the walls of each manhole over 12 feet deep. **(T-1)** The distance between rungs is the same as other fixed ladders. More detailed design criteria can be found in 29 CFR § 1910.23. **Note**: Newly constructed manholes completed on or after 17 January 2017 will comply with 29 CFR § 1910.24. **(T-0)**

7.3.1.10. Grounding and Bonding. Ladders and related equipment will 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. **(T-0)** Static discharge plates will also be provided. **(T-0)**

7.3.2. Inspections.

7.3.2.1. A formal, fully documented inspection of all fixed ladders will be accomplished upon installation and at least every three years thereafter. **(T-0)** These inspections will be performed by installation CE for ladders installed on real property facilities or real property installed equipment. **(T-0)** 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 the using organization, the unit will submit a Work Order Request to installation CE. **(T-3)** Inspection documentation will include the type of ladder and safety climb device installed, location, a detailed list of all discrepancies and corrective action status. **(T-2)** **Note**: Real Property Installed Equipment (RPIE) is an installation CE responsibility. Information regarding RPIE is provided in DAFI 32-9005, *Real Property Accountability,* and DAFMAN 65-605, Volume 1, *Budget Guidance and Technical Procedures.*

7.3.2.2. Climbers will be alert to potential hazards and perform informal inspections of fixed ladders prior to every use. **(T-1)** No attempt to climb will be made until all hazardous conditions are corrected. **(T-1)** 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.

7.3.3. Maintenance. Repairs made to fixed ladders and related equipment will meet the following requirements:

7.3.3.1. Materials used will meet or exceed original construction. **(T-0)**

7.3.3.2. Any modification to ladder components, safety climb device or related equipment will be coordinated with the property manager and occupational safety office, with final approval by installation CE. **(T-1)**

7.3.3.3. All welding will be performed by a qualified welder. **(T-0)** Refer to **Chapter 20** for more information on welding, cutting and brazing.

7.3.4. 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 will be vigilant in screening and observing employees required to work at heights. **(T-1)** If the supervisor suspects an employee may be subject to vertigo, the employee will be referred to the local medical facility for evaluation prior to resuming any height work. **(T-1)** Employees descending into pits or shafts may also experience vertigo. Individuals known to experience vertigo will be disqualified as ladder users. **(T-1)**

7.3.5. Supervisors will ensure climbers are trained to:

7.3.5.1. Check the ladder for defects and slippery substances. **(T-0)**

7.3.5.2. Ensure the ladder and climber's footwear are free of slippery substances. **(T-0)**

7.3.5.3. Raise or lower needed tools and materials by handlines after reaching the work position. **(T-0)** Never hand carry while climbing ladder.

7.3.5.4. Face the ladder and use both hands to grip the rungs or side rails firmly. **(T-0)**

7.3.5.5. Wear slip-resistant shoes with heels. **(T-0)**

7.3.5.6. Climb carefully, without haste and maintain three-point contact. **(T-0)**

7.3.5.7. Never run up or down or jump from the ladder. **(T-0)**

7.3.5.8. Remove hand jewelry (rings) prior to climbing. **(T-0)**

7.4. Portable Ladders.

7.4.1. Hazards and Human Factors Associated with Portable Ladders. Falls are the primary hazard associated with portable ladders. Falls result from several unsafe acts and conditions such as climbing with items in hand, or using a damaged ladder, which are minimized if employees adhere to proper ladder discipline and if supervisors ensure equipment is inspected, maintained in good condition and properly used.

7.4.2. The following practices are prohibited:

7.4.2.1. Ladders set on unstable surfaces. **(T-0)**

7.4.2.2. Ladders placed in front of doors which open towards the ladder without proper guarding. **(T-0)**

7.4.2.3. Ladders used as scaffolds, unless specifically designed for that purpose. **(T-0)**

7.4.2.4. Personnel reaching too far out to the sides. **(T-0)**

7.4.2.5. Personnel standing too high to maintain their balance. **(T-0)**

7.4.2.6. Personnel standing on the cap of the ladder. **(T-0)**

7.4.2.7. Use of a defective ladder, e.g., broken rail or rung. **(T-0)**

7.4.2.8. Improvising and using a make-shift ladder. **(T-0)**

7.4.2.9. Personnel carrying materials in their hands while ascending or descending a ladder. **(T-0)**

7.4.2.10. Using a ladder with conductive side rails while working on electrical circuits or near live electrical lines, etc. **(T-0)**

7.4.2.11. Descending with their back to the ladder. **(T-0)**

7.4.2.12. Painting wood ladders with an opaque coating, since possible defects may be covered up. **(T-0)**

7.4.3. Requirements.

7.4.3.1. Acquisition and Selection Considerations.

7.4.3.1.1. Portable ladders will meet ANSI design and construction specifications. **(T-0) Exception**: Fire department ladders will be maintained and inspected IAW NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, and NFPA 1932, *Standard on Use, Maintenance, and Service Testing of In-Service Fire Department Ground Ladders.* **(T-0)**

7.4.3.1.2. There are a variety of ladder styles and selections, including construction material and proper size. However, the right selection will be based on where and how the ladder may be used. **(T-1)** Ladders come in five workload ratings. Supervisors will order Type IAA, IA or I ladders, whenever possible. **(T-1)** Type II ladders will only be considered when local purchase is required, and local manufacturers cannot provide Type IAA, IA or I. **(T-1)** Type III ladders will not be procured for industrial use. **(T-1)** Refer to **Table 7.1** for additional information.

7.4.3.1.3. The supervisor should 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 will not be use in areas where an employee or the ladder could contact exposed energized electrical circuits. **(T-0)** Carrying steel and wood ladders is fatiguing if the employee carries them for a considerable distance.

Table 7.1. Ladders Workload Ratings.

Ladders Workload Ratings		
Duty Rating	**Ladder Type**	**Working Load (Pounds)**
Extra Heavy Duty	IAA	375

Extra Heavy Duty	IA	300
Heavy Duty	I	250
Medium Duty	II	225
Light Duty	III	200

7.4.3.2. Inspections. Thorough visual inspections of ladders will be made by the supervisor when the ladder is initially received and prior to being placed in service. **(T-1)** Employees will perform a visual inspection prior to each use. **(T-0)** Refer to 29 CFR § 1910.23 for additional information. Defects or damage to look for include:

7.4.3.2.1. 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 will be questioned. **(T-0)** The ladder will be retested IAW manufacturer's instructions. **(T-1) Note**: Any ladder with structural or other defects will be immediately tagged with an AF Form 979 or commercial equivalent and removed from service until repaired or replaced. **(T-0)** Refer to 29 CFR § 1910.23(b)(10) for additional guidance.

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

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

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

7.4.3.2.5. Nonskid base material that is loose or missing. Metal and metal-reinforced single and extension ladders, except aircraft boarding ladders, will be equipped with safety shoes, spurs, spikes, or combinations thereof to prevent slipping. **(T-0)**

7.4.3.2.6. Ladders with conductive side rails that are not marked for electrical hazards. Ladders not already marked with safety use instructions by the manufacturer will 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). **(T-0)**

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

7.4.3.2.8. Ladders with broken or missing steps, rungs or cleats, broken side rails, or other defects will not be used. **(T-0)**

7.4.3.3. Maintenance. Proper maintenance ensures the safe condition of the ladder. Hardware, fittings, and related equipment must be checked frequently and kept in proper working condition. **(T-0)** All bolts and rivets will be in place and secured. **(T-0)** Joints between steps or rungs and the side rails will be tight. **(T-0)** Refer to 29 CFR 1910.23 and manufacturer guidance for additional information and requirements.

7.4.3.3.1. Lubricate metal bearings of locks, wheels, pulleys, etc.

7.4.3.3.2. Replace frayed or worn rope.

7.4.3.3.3. Keep slip resistant material on ladder feet and other parts in good working condition.

7.4.3.3.4. Coat wood, metal and fiberglass ladders with a suitable protective material. If protective coatings are considered desirable for wooden ladders, use only transparent coatings or wood preservatives to prevent possible defects from being hidden. Protect metal ladders that may contact 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, fiberglass ladder rails or surfaces have the appearance of exposed fibers or an apparent color change from weather exposure, refer to manufacturer requirements for repair or replacement. **(T-1)**

7.4.3.4. Ladders with defects which cannot be immediately repaired will be removed from service and scheduled for repair or replacement**. (T-0)** Use an AF Form 979 or commercial equivalent, to warn employees that the ladder cannot be used. If a ladder is to be discarded, remove it from the work area and cut it in half to prevent further use. Do not attempt to straighten or use a bent ladder.

7.4.3.5. Requirements Applicable to All Ladders. Refer to manufacturer's instructions and OSHA requirements:

7.4.3.5.1. Inspect ladders before climbing to ensure all parts are in good condition. **(T-0)** To permit inspection, procure and maintain wood ladders with transparent finish only.

7.4.3.5.2. Store ladders in a way that provides easy access for inspection and permits safe withdrawal for use. **(T-0)** 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.

7.4.3.5.3. Allow only one person on a portable ladder at any time, unless designed for use by two people. **(T-0)** Only ladders specially designed to support greater loads will be used in combination with ladder jacks and scaffold planks when an operation requires more than one person. **(T-0)** Refer to **Chapter 16** for additional guidance. **(T-0)**

7.4.3.5.4. Always maintain three-point contact (two feet and a hand or two hands and a foot) when ascending or descending a ladder, face the ladder, and maintain a firm hold on the ladder. **(T-0)**

7.4.3.5.5. Place straight and extension-type ladders in a position to have at least one foot of slope for each four feet of ladder length. **(T-0)** For example, the base of a 12-foot extension ladder must be 3 feet from the supporting structure.

7.4.3.5.6. Use ladders of sufficient length to permit employees 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. **(T-0) Note**: The top of a stepladder is not a step and is not counted as a step when the ladder is greater than five feet in length.

7.4.3.5.7. Do not carry anything that will interfere with the free use of both hands when climbing a ladder. **(T-0)** Raise material and equipment to the working position using a rope and canvas bucket or another approved method.

7.4.3.5.8. Do not stand on the top cap of trestle or combination ladders, nor the top step of stepladders. **(T-0) Note**: Three-step aircraft ladders are exempted.

7.4.3.5.9. Do not leave ladders in place unattended. **(T-0)**

7.4.3.5.10. Do not use portable metal reinforced ladders when performing work on or near electrical equipment but use wood or fiberglass ladders. **(T-0)** Keep them clean. Remove all surface buildup of dirt, grease or oils to avoid creating a ready path for electrical current. **(T-0)** Refer to 29 CFR § 1910.333, *Electrical-Selection and Use of Work Practices,* for additional information. **Exception**: Fiberglass ladders with metal rungs are acceptable.

7.4.3.5.11. Ladders will be stored when not in use. **(T-1)** On the flightline and outdoor environments, ladders will be laid down and secured when not in use. **(T-1)** Where possible, employees will secure or remove the ladder to prevent unauthorized use or tripping hazards. **(T-1)**

7.4.3.6. Additional Requirements for Extension Ladders. Refer to manufacturer's instructions and the following:

7.4.3.6.1. Develop local procedures for raising and lowering the ladder, if not covered in the manufacturer's instructions.

7.4.3.6.2. To support the top of the ladder at a window opening, an approved attachment per the manufacturer of the ladder will be attached across the back of the ladder, extending across the window to provide firm support against the building walls or window frames. **(T-1)**

7.4.3.6.3. Short ladders will not be spliced together to provide long sections. **(T-1)**

7.4.3.6.4. Follow manufacturer's instructions for proper minimum overlap of two-section extension ladders.

7.4.3.6.5. A ladder will 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 eave, gutter or roof line. **(T-1)** The ladder will be secured or stabilized to prevent accidental displacement. **(T-0)**

7.4.3.6.6. Hooks may be attached at or near the top of portable ladders to provide added stability.

7.4.3.7. Personnel Training. Personnel who use ladders at any working height will be trained in the care and use of different types of ladders. **(T-0)** The supervisor or a designated trainer will conduct this training when an employee is first assigned. **(T-1)** All training will include hands-on instruction to include inspection of ladders for defects, possible electrocution hazards, proper positioning, and placement of ladders for various job sites. **(T-0)** Refer to **paragraph 7.3.5** for training topics and training will be documented IAW instructions in DAFI 91-202. **(T-1)**

7.5. Stepladders.

7.5.1. A stepladder is self-supporting, nonadjustable in length, has flat steps and a hinged back.

7.5.2. Employees will maintain three-point contact ascending or descending stepladders. **(T-0)** **Exception**: This requirement does not apply to stepladders under four feet.

7.5.3. Bracing on the back legs of stepladders will not be used for climbing because it is designed solely for increasing stability. **(T-0)**

7.5.4. Stepladders will be fully opened out and locked in position. **(T-0)**

7.6. Emergency Operations. Ladders used in emergency operations such as firefighting, rescue and tactical law enforcement operations or training for these operations or designed into or is an integral part of machines or equipment *do not* have to meet the general requirements of 29 CFR § 1910.23.

Chapter 8

ELECTRICAL SAFETY

8.1. General Information.

8.1.1. Hazards. Refer to **paragraph 1.5,** and DAFI 91-202 for further information on the JHA and job safety lesson plan. **Note**: A JHA 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.* Refer to Chapters **2** and **14** for additional guidance.

8.1.2. Only qualified electricians, using approved materials, will install or perform electrical work IAW NFPA 70. **(T-0)**

8.2. Receptacles. Follow NFPA 70E, *Standard for Electrical Safety in the Workplace,* Article 245. It is not necessary to replace the cover for small cracks around the mounting screws.

8.2.1. Multiple plug adapters will not be linked to provide additional or more convenient outlets as this could overload electrical circuits. **(T-0)** At no time will a multiple plug adapter or strip be plugged into another multiple plug adapter or strip. **(T-0)**

8.2.2. Tamper-Resistant Receptacles. Tamper-resistant electrical receptacles will be provided IAW the requirements of NFPA 70, Article 406.4 and Article 406.12. **(T-0)**

8.2.3. Ground fault circuit interrupter (GFCI) will be used IAW 29 CFR § 1910.304(b). **(T-0)** Receptacles on a two-wire, single-phase portable or vehicle-mounted electrical generator rated not more than five kilowatts (kW), where electrical generator conductors are insulated from the generator frame and other grounded surfaces, will be permitted without GFCI protection. Receptacles will be located outside wet process areas or protected by a GFCI. **(T-0)** To protect large areas, GFCI breakers will be located in the circuit panel. **(T-1)**

8.2.4. Arc-fault Circuit Interrupters. Arc-fault circuit interrupters are required in certain circuits in dwelling units. **(T-0)** Refer to NFPA 70, Article 210.12 for guidance.

8.3. Plugs. Follow NFPA 70E, Article 110.4.

8.4. Flexible Cords and Extension Cords. Flexible cords and extension cords will only be used IAW guidance outlined in the NFPA 70, Article 240.5(B), NFPA 70E, Article 110.5, and as directed by 29 CFR § 1910.334 and 29 CFR § 1910.305(g). **(T-0)**

8.4.1. Extension Cords.

8.4.1.1. If extension cords are used, they will have a single connection. **(T-0) Exception**: A heavy-duty industrial extension cord with a multiple-outlet junction box may be utilized if the equipment amperage rating does not exceed the extension cord/circuit which it is plugged into. The wattage will be verified. **(T-0)**

8.4.1.2. Report, replace, inspect, or dispose of worn, cracked, damaged, or frayed electrical extension cords, loose, or broken electrical wires, and worn or broken electrical plugs. **(T-0)** These characteristics could be an indication of possible short circuiting or overheating. Defective cords will be removed from service. **(T-0)** Refer to 29 CFR § 1910.334(a)(2) for defective electrical equipment and cords.

8.4.1.3. Electrical extension cords may be used when it is impractical to power equipment from facility wiring, such as in large hangars, flightline locations, field environments and when using electrical generators.

8.4.1.4. Only commercially procured extension cords bearing an OSHA-recognized NRTL certification or host nation equivalent certification may be used. Extension cords amperage rating must meet or exceed the amperage draw of the device being plugged into it. **(T-1)** The amperage will be verified. **(T-0)** Extension cords may not be manufactured or altered.

8.4.1.5. Do not hang extension cords over nails, rafters or in a manner that constitutes a safety or fire hazard.

8.4.1.6. Do not place extension cords under rugs, carpets, or other combustible material.

8.4.1.7. Refer to 29 CFR § 1910.334(a)(2) for visual inspection requirements.

8.4.2. Refer to 29 CFR § 1910.334(a)(3) for grounding of tools and equipment connected by flexible cords requirements. A grommet, stress relief device or National Electrical Code-approved clamp will be installed on equipment housings to prevent abrasion of cord insulation and to prevent pull or strain put on the cord's internal wiring. **(T-1)** Cords used with heating appliances, such as electric irons, will meet the requirements of 29 CFR § 1910.303(b)(2). **(T-0)**

8.4.3. When possible, equipment power cords will be suspended from overhead in rigid raceways. **(T-1)**

8.4.4. When disconnecting cords, pull on the plug rather than the cord, to avoid damaging internal connections.

8.4.5. Electrical wiring/conduits will only be used IAW 29 CFR § 1910.305. **(T-0)**

8.4.6. High powered appliances such as refrigerators, microwaves, coffeemakers, heaters, etc., will be plugged directly into a facility outlet. **(T-0)** Power strips/taps will not be used for equipment that will exceed its amperage rating. **(T-0)** In foreign countries, a voltage converter may be required to transform the facility power to match that of the host nation, as many times, overseas power systems operate at a higher voltage (220V) and a lower frequency (50 cycles) than the U. S. standard of 110/120 volts and 60 hertz. **Note:** IAW **paragraph 2.5.2.3,** the facility manager must review and approve high wattage appliances prior to use. **(T-1)** In this case, the voltage converter is considered the "direct connection," or "facility outlet," required by the guidance. Uses of these voltage converters are therefore permissible, provided neither the rated power, nor current of the transformer is exceeded.

8.4.7. Multi-receptacle surge protectors will only be used IAW 29 CFR §§ 1910.303 and 1910.304. **(T-0)**

8.5. Disconnecting Means (Circuit Breakers and Disconnect Switches). Refer to NFPA 70, Article 408.4(A), *Circuit Directory or Circuit Identification,* for circuit breakers/fuse box identification requirements. 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." **(T-0)** Supervisors, in conjunction with the installation CE, will ensure electrical fuse, switch, and circuit-breaker boxes are marked with correct voltage, current, wattage, foreign source of power, or other ratings, as appropriate. **(T-1)** Personnel will not stand directly in front of circuit

breakers or switches when activating or deactivating them. **(T-0)** Refer to UFC 3-560-01, *Operation and Maintenance: Electrical Safety,* for additional guidance.

8.5.1. Circuit breakers and disconnect switches will clearly indicate status - open (off) or closed (on). **(T-0)** Refer to NFPA 70, and 29 CFR § 1910, Subpart S for additional guidance.

8.5.2. Circuit breakers, disconnect switches and fuses will be readily accessible to employees and building management personnel. **(T-0)** Workspace in front will be clear and unimpeded and will not be located where exposed to physical damage or in the vicinity of easily ignitable material. **(T-0)** Refer to 29 CFR § 1910, Subpart S for additional criteria.

8.5.3. Circuit breakers will not be taped in the "on" position. **(T-0)** Breakers that trip frequently indicate electrical problems and will be promptly reported to installation CE and corrected. **(T-1)**

8.5.4. Employees will not substitute larger fuses or breakers or use bypass wires, pennies, etc. **(T-0)**

8.5.5. If circuit breakers fail to close or immediately trips after resetting, a qualified electrical employee (electrician) will be called to troubleshoot the circuit breaker, e.g., installation CE will be called immediately. **(T-1)**

8.5.6. Remote Disconnect Control circuits will comply with requirements found in NFPA 70. **(T-0)**

8.6. Guarding of Live Parts. Premises wiring will meet the requirements of NFPA 70, Article 215. **(T-1)**

8.7. Equipment Grounding.

8.7.1. Frames of electrical motors, regardless of voltage, will meet the requirements of 29 CFR § 1910.304(g). **(T-0)**

8.7.2. Exposed noncurrent-carrying metal parts of fixed equipment that may be energized under abnormal conditions will meet the requirements of 29 CFR § 1910.304(g). **(T-0)**

8.8. Restrictions. While working on or around live electrical equipment, employees are prohibited from wearing garments with exposed metallic fasteners or flammable articles such as celluloid cap visors. **(T-0)** Additionally, clothing will be of the material necessary to comply with NFPA 70E requirements. **(T-0)** Refer to **paragraph 2.3** for jewelry and other metal article restrictions.

8.9. Electrical Installations and Equipment. Guidance in NFPA 70E, 29 CFR § 1910, Subpart S – Electrical, UFC 3-560-01, and AFMAN 32-1065, *Grounding and Electrical Systems*, for electrical installations and equipment will be complied with. **(T-0)** Motor data plates will be legible and not painted. **(T-0)**

8.9.1. Electrical Repairs. Only authorized, qualified electricians or appliance employees may install or repair electrical equipment. Work will only be performed on electrical equipment that is de-energized, locked out and tagged out IAW NFPA 70E and AFMAN 32-1065. **(T-0)** Refer to **paragraph 8.17** for work on energized equipment.

8.9.2. Supervisors will ensure work areas are inspected for electrical hazards. **(T-1)** Sufficient workspace will be provided and maintained around electrical 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. **(T-0) Note**: High voltage is defined as greater than 600 volts, nominal.

8.9.3. Wires will be enclosed in an electrically listed box or control panel. **(T-0)**

8.9.4. In locations requiring the use of special tools (e.g., non-sparking), only tools certified for those areas will be used. **(T-0)**

8.9.5. When equipment is replaced, a renovation project is planned or new construction is performed that potentially involves more than the control electrical energy in **paragraph 8.9.1,** make provisions to comply with hazardous energy control requirements in **Chapter 21.**

8.9.6. Parts of electrical equipment which ordinarily produce arcs, sparks, etc., will not be operated or used in explosive atmospheres or near combustible materials. **(T-0)**

8.10. Additional Electrical Equipment Requirements.

8.10.1. Rack, panel, or control box doors will be kept closed except as necessary to accomplish repairs circuit resets by authorized personnel. **(T-1)**

8.10.2. Operators will open and close equipment switches quickly and positively and will not break contact between brushes and commutators or slip rings while equipment is operating. **(T-1)**

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 (e.g., SDSs, installation BE HRA). High Efficiency Particulate Arresting (HEPA) filter vacuum approved for the task, can be an effective cleaning method. Refer to **paragraph 2.4.8.8** for compressed air cleaning requirements.

8.11.2. Technicians will 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. **(T-1)**

8.11.3. Personnel will not hold meters in their hand while performing measurements on energized circuits or equipment. **(T-1)** Where work must be accomplished on energized circuits, use non-conductive, insulated gloves or other effective PPE, and stand on a non-conductive mat or dry surface while holding meters or metering cables and appropriate work practices. **(T-0)** Refer to **paragraph 14.3.7** for additional guidance.

8.11.4. Workbenches.

8.11.4.1. Workbenches will be kept clean. **(T-1)**

8.11.4.2. When voltage is applied to equipment being repaired or tested, personnel will ensure tools and equipment not essential to the test are removed from the bench. **(T-1)**

8.11.4.3. Ground metal workbenches are used for repairing and testing electronic equipment to a low resistance ground. **Note**: Refer to TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance, and Test of Electrical Equipment,* for electrostatic discharge control procedures.

8.11.5. Insulating Matting Specific Requirements. Refer to 29 CFR § 1910.137, *Electrical Protective Equipment,* and **paragraph 32.4** for additional guidance on PMEL insulating mat requirements.

8.11.5.1. Insulating matting will be used near electrical apparatus or circuits in high voltage maintenance areas as an additional safety measure to protect personnel. **(T-1)** It will be used to protect against accidental shock only and will 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*, provide information and instructions on control, use, and marking of insulating matting. Insulating matting will be permanently marked. **(T-0)**

8.11.5.2. Supervisors will consult with occupational safety office to determine if insulating matting is required in their areas of responsibility. **(T-3)** This includes areas where potential shock hazards exist and additional protection is needed, floor resistance is lowered due to dampness, and where employees are exposed to voltages of 50 volts or more. Refer to NFPA 70E, Article 130, *Work Involving Electrical Hazards,* for additional guidance.

8.11.5.3. Mats will be cleaned as necessary to prevent contamination, using domestic cleaners, such as carpet cleaners, or other locally approved cleaners required for special situations. **(T-0)**

8.11.5.4. Insulating matting will be replaced when worn to manufacturers recommended replacement requirements. **(T-0) Note**: Shoes with nails, spikes or cleats will not be worn on insulating matting. **(T-0)** 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., will be one continuous length or strip. **(T-1)** Where possible, matting will 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 will determine the amount needed. **(T-1)**

8.11.5.6. Insulating matting will not be used for nonskid applications such as walkways, hall runners, in front of work benches (non-electric) on work-and-test benches, etc. **(T-0)** General purpose low-cost matting will be used as it is satisfactory for areas where shock protection is not required. **(T-0)** No certification for the use of general-purpose matting is required.

8.11.6. Use stools made of fiberglass or other non-conductive materials when working on electrical or electronic equipment.

8.11.7. Supervisors will establish procedures requiring all accessories used with electronic and electrical equipment be serviceable and safe for use. **(T-1)** Supervisors will also establish procedures to eliminate or control all hazard potentials to a safe acceptable level. **(T-1)**

8.12. Emergency Equipment (Electrical Safety). In addition to electrical PPE provided to employees, functional managers will ensure emergency equipment is available at each operating location where maintenance is performed on high voltage energized circuits. **(T-1)** High voltage is defined as over 600 volts (nominal phase-to-phase). 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 will be situated in a conspicuous and prominent location at each site, well-marked and readily accessible IAW 29 CFR § 1910.151, *Medical Services and First Aid.* **(T-0)** Equipment will be protected against chemical, mechanical or environmental deterioration and will be inspected, or tested for serviceability IAW 29 CFR § 1910.335, *Safeguards for Personal Protection.* **(T-0)** Emergency equipment will consist of:

8.12.1. Safety OIs or procedures for the site. **(T-1) Note**: If the F&ES Flight's emergency medical teams are rapidly available and the medical clinic operates on limited hours, contact the F&ES Flight emergency medical teams. **(T-2)**

8.12.2. CPR instructions. **(T-1)**

8.12.3. CPR facemask with disposable mouthpiece. **(T-1)**

8.12.4. Emergency phone numbers and building number. **(T-1)**

8.12.5. First aid kit provided by the unit. **(T-1)** This item is required for work performed in remote locations away from emergency responders. The medical treatment facility can provide recommendations on contents of the first aid kit. **Note**: OSHA considers a three to four minutes response time to the worksite from a medical facility may comply with 29 CFR § 1910.151(b), where there is no first aid trained and equipped employees at the worksite. **(T-0)**

8.12.6. Disposable gloves, impervious to body fluids, for first aid use. **(T-1)**

8.12.7. Nonconductive cane or hook with insulated handle (with less than 180 degrees of bend). **(T-1)**

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. **(T-1)** Voltage rating will be suitable for voltages encountered in the work area. **(T-1) Note**: Electrical gloves will be checked before use IAW UFC 3-560-01 and will be tested and marked with the next test due date. **(T-0)** This may be accomplished as a step in a JHA prior to the workday or as a step in a unit's daily or weekly work preparation. The American Society for Testing Materials (ASTM) F496-08, *Specification for In-service Care of Insulating Gloves and Sleeves,* may provide additional information.

8.12.9. A 15-foot length of natural fiber rope, preferably ½- or 5/8-inch diameter. **(T-1) 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. **(T-1)**

8.12.11. Flashlight with nonmetallic case in operating condition. **(T-1)**

8.12.12. Grounding stick (shorting stick). **(T-1)**

8.12.13. Wool blanket(s), for extinguishing clothing fires and keeping injured person warm. **(T-1)**

8.12.14. Optional site-specific items (e.g., rescue breather; insulated lineman's gloves, etc.). **(T-1) Note**: Protect electrostatic sensitive components and equipment IAW TO 00-25-234.

8.13. Automated External Defibrillator (AED). AED presence and use is governed by the base commander and director of medical services. Safe use of an AED and its location and training is

governed by AFI 44-177, and *Guidelines for Public Access Defibrillation Programs in Federal Facilities.*

8.14. Lighting. Consult installation CE facility design office for specific guidance on lighting. Control of light is important to avoid glare, harsh shadows, and stroboscopic effects. Soft shadows are usually acceptable, but harsh shadows will be avoided since they may obscure hazards or interfere with visibility. **(T-1)**

8.15. Moisture Guarding. Refer to 29 CFR § 1910.305, *Wiring Methods, Components, and Equipment for General Use,* for additional guidance and information.

8.16. Under-voltage Protection. Machines not adequately safeguarded to protect the employee during an under-voltage situation, or a power failure will have an under-voltage device installed. **(T-0)** This device prevents the machine from starting up after a power interruption, exposing the employee to the hazards of moving parts.

8.17. Work on Energized Equipment.

8.17.1. Electrical circuits and equipment will be de-energized before being worked on. **(T-0)** When authorized by the commander, applicable technical data, or manufacturer 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. A qualified electrician checking for the presence of voltage is not considered energized work. For energized work refer to AFMAN 32-1065, and UFC 3-560-01 for task specific required number of qualified electricians. Depending on the task, one member of the two- or three-person team will act as safety observer. **(T-1)** All employees will be trained in CPR and equipment shutdown procedures and responsible for immediate assistance in an emergency. **(T-0)** Install electrical equipment IAW guidance contained in NFPA 70, UFC 3-560-01, and AFMAN 32-1065. **Note**: Supervisor may be safety observer.

8.17.2. Additional PPE for Work On or Near Energized Equipment. Refer to NFPA 70, Sections 130.3. and 130.7., and UFC 3-560-01, Table 4.1., *PPE Criteria,* for additional guidance.

8.17.2.1. A rubber insulating blanket or other suitable guards will be used when necessary to work adjacent to energized circuits. **(T-0)**

8.17.2.2. Arc flash protection will be provided for all DAF operations exposing personnel performing duties on or in proximity of energized parts operating at 50 volts or more. **(T-0)** Protective clothing required, if any, will be based on the procedures outlined in UFC 3-560-01, NFPA 70E and AFMAN 32-1065. **(T-0)**

8.17.2.3. Individuals required to work on or near (within 8 feet of) exposed energized equipment over 50 volts will wear long sleeved, Arc Thermal Performance Value-rated PPE IAW UFC 3-560-01. **(T-0)**

8.17.2.4. Individuals operating or servicing electrical switchgear over 15 kilovolts (kV) will wear an appropriate Arc Thermal Performance Value-rated blast suit with hood and polycarbonate face shield. **(T-0)** Sheet metal and gypsum building materials do not provide the required minimum level of blast protection.

8.17.2.5. Clothing will follow the requirements of UFC 3-560-01. **(T-0)**

8.17.2.6. Any tools, e.g., hot sticks, insulating rubber sleeves, used as part of the task must follow the requirements of AFMAN 32-1065 and UFC 3-560-01. **(T-0)**

8.17.2.7. For additional guidance on working on energized equipment, refer to UFC 3-560-01, and AFMAN 32-1065.

8.17.3. Work Near Energized Equipment. Refer to UFC 3-560-01 and AFMAN 32-1065 for additional guidance on working near energized equipment.

Chapter 9

EMERGENCY SHOWER AND EYEWASH UNITS

9.1. Scope. This chapter addresses regulations and standards, acquisition, location and installation, maintenance, use and testing of emergency shower and eyewash units. Also included are performance specifications for both permanently installed and self-contained units. The types of equipment covered are emergency showers, eyewash units, eye and face units, combination units, hand-held drench hoses and eyewash bottles.

9.2. Regulations and Standards.

9.2.1. OSHA Regulation.

9.2.1.1. General Requirements. IAW 29 CFR § 1910.151(c) and 29 CFR § 1926.50(g), Medical Services and First Aid, where the eyes or body of any employee may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of eyes and body will be provided in the work area for immediate emergency use. **(T-0)**

9.2.1.2. Specific Requirements.

9.2.1.2.1. Storage and Handling of Anhydrous Ammonia. Refer to 29 CFR § 1910.111, *Storage and Handling of Anhydrous Ammonia.*

9.2.1.2.2. Telecommunications. Refer to 29 CFR § 1910.268, *Telecommunications.*

9.2.1.2.3. Batteries and Battery Charging. Refer to 29 CFR § 1926.441(a)(6).

9.2.2. UFC 3-420.01, *Plumbing Systems.*

9.2.3. More information may be found in ANSI/International Safety Equipment Association (ANSI/ISEA) Z358.1, *Emergency Eyewash and Shower Equipment.*

9.3. Equipment - Acquisition.

9.3.1. Emergency shower and eyewash equipment may be locally and centrally procured. The procuring document will include a requirement that the manufacturer has documented that their equipment meets or exceeds ANSI/ISEA Z358.1 specifications. **(T-1)**

9.3.2. Each request for emergency showers and/or eyewashes will be evaluated by the occupational safety office and installation BE to determine the need for the installation and proper location of units IAW 29 CFR § 1910.151, 29 CFR § 1926.50, *Medical Services and First Aid,* this standard and the chemical SDS. **(T-1)**

9.3.2.1. Rationale for decisions will be documented and maintained by the respective owner. **(T-1)**

9.3.2.2. The type of material used, its properties, how the material is dispensed, probability of injury, extent of potential injury and PPE available and used will be considered in determining the need for the units. **(T-0)**

9.3.3. Self-contained Units. Units will be constructed of noncorrosive materials and provide a minimum of 15 minutes continuous flow. **(T-1)** Self-contained units should only be used in locations unable or found unfeasible to plumb a permanent eye wash station. Stored fluid will be protected against contaminants and temperature extremes. **(T-1)** Units may be filled with

potable water, or a solution approved by either the manufacturer or medical services. Instructions and expiration dates will be permanently affixed to the unit. **(T-1)**

9.3.4. Eyewash Bottles. Will provide an immediate flushing to the eyes. Eyewash bottles are not a replacement for other types of emergency equipment. **(T-1)** These bottles may be filled with potable water or an eye-flushing solution, either approved by the manufacturer or by medical services. Local procedures will be developed to prevent these units from being exposed to extreme temperatures. **(T-1)** Instructions and expiration dates will be permanently affixed to the unit, if applicable. **(T-1)**

9.4. Location and Installation.

9.4.1. Location.

9.4.1.1. Eyewash and emergency showers will be located as near to the hazard as possible with maximum of 10 seconds unobstructed travel distance from the source of exposure to the unit. **(T-0)**

9.4.1.2. Unobstructed means no objects, equipment, furniture, or doors lie in the travel path. **(T-1)**

9.4.1.3. Path will be well lit. **(T-1)**

9.4.1.4. The emergency shower and eyewash station will be clearly marked with appropriate signage. **(T-1)**

9.4.1.5. Recommend emergency shower and eyewash station be located near an emergency exit to allow easy access by emergency responders.

9.4.2. Installation.

9.4.2.1. Permanent plumbed in emergency showers and eyewash stations will meet UFC 3-420-01 or applicable code at time of construction. **(T-1)**

9.4.2.2. Installation must meet manufacturer's requirements. **(T-1)**

9.4.2.3. Water pipes servicing the emergency shower and eyewash station will be protected from freezing or heating. **(T-1)**

9.4.2.4. Valves servicing the equipment will be labeled to prevent inadvertent shut off. **(T-1)**

9.4.2.5. Water lines must be able to provide enough pressure to meet manufacturers' requirements for that equipment. **(T-1)**

9.4.2.6. The water supply used will be free of contaminants and will not be delivered at extreme temperatures. Temperature will be maintained between 60^{o} and 100^{o}F. **(T-1)** This prevents injury to the eyes and ensures personnel will be able to continue to use the equipment and not stop due to temperature discomfort. **(T-1)**

9.4.2.7. Emergency shower and eyewash stations will remain activated without the use of the operator's hands once activated. **(T-1)** Activation of the equipment will take one second or less. **(T-1)** Once activated, it will remain on until intentionally shut off. **(T-1)**

9.5. Maintenance and Testing.

9.5.1. Permanently installed shower and eyewash units will be activated by the supervisor weekly to verify operation and to reduce accumulation of bacteria/sediment for a time period directed by the manufacturer. **(T-1)** Maintain manufacturer's instructions with the unit. **(T-1)** **Note**: Eyewash station manufacturer's instructions provide direction on how often and how long to activate specific plumbed systems to reduce microbial contamination and generally reference their compliance with ANSI Z358.1.

9.5.2. Supervisor or designated employee will inspect unit(s) IAW manufacturer's instructions and document the inspection when completed. **(T-1)** Inspections will include activation and a thorough check for damage, scale accumulation or other defects as required by the manufacturer. Documentation will be maintained to show the date of inspection and name of individuals performing the test. **(T-0)** This documentation may be kept in a log, computerized, or affixed to the equipment by tag or label.

9.5.3. Self-contained units will be tested and inspected IAW the manufacturer's instructions and documented. **(T-0)**

9.5.4. Eyewash bottles will be tested, refilled, maintained, and disposed of IAW the manufacturer's instructions. **(T-0)**

9.5.5. All units will be inspected by the occupational safety office during the annual facility/workplace inspection for proper placement, installation and documentation of supervisory testing and operation. **(T-1)**

9.5.6. Installed units that no longer meet the criteria of the manufacturer's instruction will be evaluated by the occupational safety office for replacement or upgrade. **(T-1)**

9.6. Training. Employees will be trained initially and annually thereafter, as part of the JSTO. **(T-1)** Training will include:

9.6.1. Locations of each emergency shower and eyewash station in the work center. **(T-1)**

9.6.2. Ensuring the paths to the emergency shower and eyewash station remains clear and the equipment is properly maintained. **(T-1)**

9.6.3. Taking proper actions to assist personnel who are exposed and need to use the emergency shower and eyewash station, to include calling for medical assistance. **(T-1)**

9.6.4. Instructing employees on the proper way to use the station to wash the exposed area(s), e.g., how to get the water into their eyes in the most effective manner. **(T-1)**

Chapter 10

GROUNDS, MOWING AND AGRICULTURE TRACTORS

10.1. General Information. Personnel involved with landscape and ground maintenance will observe all safety precautions in this chapter and those recommended by the manufacturer of the equipment. **(T-0)** Always read/comprehend the owner's manual/instructions before operating any type of equipment.

10.1.1. Training. Supervisors will ensure employees are trained, using manufacturer's instructions, lesson plans, or JHA, prior to the operation of any type of equipment. **(T-0)** Supervisors will provide such instruction at the time of initial assignment and refresher training, as required. **(T-0)** Specific requirements for training, licensing and/or certification of equipment operators will be documented IAW AFI 24-301. **(T-1)**

10.1.2. PPE is determined through an evaluation of the hazards by the supervisor in consultation with the occupational safety office and installation BE. Results of the evaluation will be entered into the work center JSTO. **(T-1)**

10.1.3. 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. **(T-0)** Refer to 29 CFR § 1910.243, *Guarding of Portable Powered Tools*, for further guidance on the operation and maintenance of powered lawn equipment.

10.1.4. Employees will use boards and ramps of the appropriate size and construction for the weight of the equipment to be loaded and unloaded from vehicles or trailers. **(T-0)** Boards and ramps will be secured to prevent ramps from falling during loading and unloading. **(T-1)**

10.1.5. Employees will turn off equipment and allow them to cool before refueling. **(T-0)** Do not permit smoking in the refueling area. **(T-1)**

10.1.5.1. Refuel equipment prior to use instead of refueling before storing inside a building. **(T-0)**

10.1.5.2. Complete refueling outside at least 25 feet away from the building and any open flame source. **(T-0)**

10.1.6. Operations during inclement weather will adhere to established local policies. **(T-2)** Additional weather information may be found in **Chapter 3.**

10.1.7. When traveling on public roads, highways, local and state vehicle codes will be used. **(T-0)** Slow- moving vehicle emblems will be used IAW 29 CFR § 1910.145(d)(10). **(T-0)**

10.2. Inspection/Maintenance. The operator will walk around the equipment and inspect for faults prior to initial setup/use and prior to initial startup on each shift. **(T-0)** The AF Form 1800, *Operator's Inspection Guide and Trouble Report*, will be used as an inspection checklist and signed by the operator prior to use. **(T-1)** Manufacturer's instructions or technical data will be used to service or maintain the equipment. **(T-0)**

10.3. 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) and rotary (one or more knife like blades attached to a vertical shaft). They may be pushed, self-propelled, ridden, or towed. If equipped with a fuel shutoff valve, shut off the fuel

supply line when parking mowers at the end of the duty day. When possible, and to ensure a clear and safe walkway between mowers, leave one to three feet separation space between parked gasoline-operated riding mowers. Never use electric mowers and grass trimmers while it is raining or the grass is wet, excluding light dew. Ensure electric mowers, trimmers and attached extension cords are effectively grounded. **(T-0)** However, listed or labeled portable tools protected by an approved system of double insulation, or its equivalent, need not be grounded.

10.3.1. Ensure powered mowers (push or self-propelled) riding-rotary, converted sulky and reel power lawnmowers meet design specifications in 29 CFR § 1910.243. **(T-0)** Refer to ANSI B71.1, *Consumer Turf Care Equipment – Pedestrian-Controlled Mowers and Ride-On Mowers – Safety Specifications,* for additional guidance. **(T-0) Note**: Manufacturer's certification will identify whether the requirements found in OSHA and ANSI B71.1 are met.

10.3.2. Prior to mowing, operators will clear the area of all people and inspect for foreign objects, raised sprinkler heads, holes, soft ground, obstructions or any other condition that could have impact on a safe operation. **(T-1)**

10.3.3. Operators will never pull the mower backwards while the engine is running; the safety guard on the back may lift the mower off the ground and injure the operator. **(T-1)**

10.3.4. Always mow in a horizontal direction across the face of a steep slope, e.g., hills or banks exceeding a 30-degree angle, and always keep firm footing. **(T-0)**

10.3.5. Employees will stay clear of the front of self-propelled mowers during and after starting. **(T-1)** Employees will control the mower by hand pressure on the handle, not by foot pressure on the housing. **(T-1)**

10.3.6. Employees will not clean grass from the chute while the mower is running. **(T-1)**

10.3.7. Employees will follow the manufacturer's instructions when cleaning, repairing, or inspecting the mower. **(T-1)**

10.3.8. When using lawn mowers, wear hearing protection recommended by installation BE after evaluation and determination to protect hearing from hazardous noise. **(T-1)**

10.4. Edgers. Guards will always be checked prior to the operation to ensure they are in place. **(T-0)** Edgers will not be used when people are in line with the cutting blade discharge pattern. **(T-1)** Follow manufacturer's instructions when cleaning, repairing, or inspecting the edger.

10.5. Commercial Mowing and Turf Care Equipment. Commercial mowing and turf care equipment are 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 10.9**.). Commercial mowing equipment will be certified by the manufacturer to meet requirements in ANSI/Outdoor Power Equipment Institute (OPEI) B71.4., *Commercial Turf Care Equipment - Safety Specifications*. **(T-1)** Operators will read and understand the contents of the owner's manual before operating the equipment. **(T-1)**

10.5.1. If commercial mowers are used in areas where they can exceed the maximum slope allowed by the manufacturer, a Rollover Protective Structure and seatbelt will be installed IAW manufacturer's instructions and used whenever the vehicle is in motion. **(T-0)**

10.5.2. 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 employees can cut by hand using manual tools. **(T-1)**

10.6. Tree and Hedge Trimming. Supervisors will complete a JHA for both routine and emergency tree maintenance operations. **(T-1)** Critical elements with serious potential to affect employee's 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, will be included. **(T-1)** Employees will be trained for emergency conditions, such as adverse weather. **(T-0)** All employees will receive training in emergency rescue and lifesaving first aid techniques and fall protection/prevention. **(T-1)** Refer to 29 CFR § 1910.269, *Electric Power Generation, Transmission, and Distribution*, and OSHA's Enforcement Memorandum, *Enforcement Inspection Guidance for Tree Care and Tree Removal Operations,* found at **https://www.osha.gov/memos/2021-06-30/inspection-guidance-for-tree-care-and-tree-removal-operations**, for additional guidance.

10.6.1. PPE is determined through an evaluation of the hazards by the supervisor in consultation with the occupational safety office and installation BE. PPE identified for use to protect against the hazards will be entered into the work center JSTO.

10.6.2. Two or more employees and an on-site job supervisor, fully qualified in tree maintenance, will be assigned when routine 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. **(T-2)** The area around trees being trimmed or cut and in the vicinity of operating chippers and stump grinders will be effectively guarded with barricades or identified with cones or streamers to warn personnel against the danger of entry. **(T-0)**

10.6.3. Fall Protection. Fall protection equipment, ropes, D-rings, cutting tools, equipment and climbing gear will be inspected to ensure it is in safe condition prior to each use. **(T-0)** Any equipment or climbing gear that is frayed, worn, broken or defective will be removed from service immediately. **(T-0)** Each climber will have at least one lifeline and one handline, normally nylon, 1/2 inch by 125 feet. **(T-0)** At least 2 – 3/4-inch polypropylene or equivalent lines (250 feet long each) will be provided for each crew. **(T-0)** The nominal breaking strength of ½-inch ropes used for climbing will not be less than 2,385 pounds. **(T-0)** Climbing and safety ropes will not be spliced for repair or added length. **(T-0)** The ends of ropes will be wrapped to prevent fraying. **(T-0)** A climbing rope will always be used, even when work is performed from a ladder or lift device. **(T-0)** Refer to 29 CFR § 1910.140, *Personal Fall Arrest Systems,* for personal fall protection equipment requirements. ANSI A300, *Tree Care Operations – Tree, Shrub and Other Woody Plant Maintenance – Standard Practices,* may provide additional information.

10.7. Fertilizers.

10.7.1. 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. The F&ES Flight will be notified of any evidence of heating, smoking, combustion, or fire in fertilizer. **(T-1)** IAW NFPA 400, *Hazardous Materials Code,* no more than 60 tons of fertilizer (mixtures

containing 60 percent or more by weight of ammonium nitrate) will be stored in a location unless the location and storage facility have been approved by the F&ES Flight. **(T-0)**

10.7.2. When spreading fertilizer, pellets will not be directed toward anyone. **(T-0)** If personnel enter the area, the spreader will be turned off. **(T-0)** Fertilizer spreaders will be cleaned and lubricated daily. **(T-0)** Safety glasses and gloves will be worn during fertilizing spreading operations. **(T-0)**

10.8. Irrigation Systems. Irrigation systems may involve hazards related to trenching and shoring, confined spaces and/or hazardous energy control. For requirements, refer to 29 CFR § 1926, Subpart P – *Excavations,* 29 CFR § 1910.146, *Permit Required Confined Spaces,* and 29 CFR § 1910.147, *The Control of Hazardous Energy (Lockout/Tagout),* and Chapters **21** and **23.**

10.9. Agricultural Tractors and Implement Attachments. An agricultural tractor 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 agricultural tractors and fall under guidance in **paragraph 10.5**.

10.9.1. Rollover Protection. Agricultural tractors with engines exceeding 20 horsepower will be fitted with Rollover Protective Structure. **(T-0)** If a tractor is not equipped with Rollover Protective Structure, it will not be operated on sloped areas. **(T-0)** Rollover Protective Structure-equipped tractors will pass field upset tests (side and rear) specified in 29 CFR § 1926.1002, *Protective Frames (ROPS) for Wheel-Type Agricultural and Industrial Tractors Used in Construction*, and 29 CFR § 1928.51, *Rollover Protective Structures (ROPS) for Tractors Used in Agricultural Operations,* which will be indicated by a manufacturer's label permanently attached to the Rollover Protective Structure. **(T-0)** Where a suspended (e.g., air ride or shock absorber equipped) seat is used, the seatbelt will be fastened to the movable portion of the seat to accommodate the ride motion of the operator. **(T-0)** Seatbelts will not be worn while operating low profile tractors not equipped with Rollover Protective Structure or other types of agricultural equipment identified in 29 CFR § 1928.51(b)(5). **(T-0)**

10.9.2. Procurement. Agricultural tractors procured for the DAF will meet the requirements of 29 CFR § 1928.51 and military specifications. **(T-0)** Where commercially available, agricultural tractors and implement attachments will be purchased with noise levels at the operator position of less than 85 Decibels-A-Weighted (dBA). **(T-0)**

10.9.3. Training. Every employee who operates an agricultural tractor will be trained in safe operating procedures and practices dictated by the work environment IAW the commander's approved training program. **(T-0)** A training plan will be developed and, at a minimum, will include all attachments used by the organization and a copy of the most recent noise hazard survey conducted IAW DoDI 6055.12, *Hearing Conservation Program (HCP)*. **(T-0)**

10.9.4. Hazardous Noise Warnings. If the noise level at the operator position as determined by the noise hazard survey is 85 dBA or greater, tractors will be marked with a placard stating: "*Caution – Hazardous Noise – Operator Ear Protection Required*." **(T-0)**

10.9.5. Vehicle Emblems. Each agricultural tractor will have a "*Slow Moving Vehicle*" emblem affixed on the rear that is clearly visible to all traffic approaching the tractor from the rear. **(T-0)**

10.9.6. Guarding and Shielding. All power take-off shafts, including rear-, mid-, or side-mounted shafts, will be shielded to protect employees from contact with moving machinery parts. **(T-0)**

10.9.7. 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 the safety of the modified equipment has not been compromised during modification.

10.9.8. Special Considerations for Agricultural Tractors. Riders will not be allowed on tractors, the draw bar or towed equipment, except where the equipment is specifically designed to allow riders. **(T-0)** Speed will be reduced with heavy loads when vision is limited or when operating on rough terrain. **(T-1)**

10.9.9. Operation, Use and Training. Equipment operation, use, and training should be IAW manufacturer’s instructions and 29 CFR § 1910, 1926 and 1928, as applicable.

Chapter 11

HAND TOOLS, PORTABLE POWER TOOLS, AND MACHINERY

11.1. General Requirements.

11.1.1. Tool Procurement. Specific criteria for tool use will be contained in technical data requiring use of the tool. **(T-1)** Refer to TO 32-1-101, *Use and Care of Hand Tools and Measuring Tools,* for additional guidance and information on tools and equipment. Portable powered tools will conform to military specifications (Mil Specs), if available. **(T-0)** If Mil Specs applicable to a portable powered tool have not been published, the procuring document will 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.* **(T-0) Note**: When possible, low noise power tools or tools with noise reduction attachments will be utilized. Additionally, tools should be selected that minimize operator's exposure to noise, vibration, and awkward positions.

11.1.2. Machinery Acquisition. Machines and attachments may be locally and centrally procured. Newly acquired machines will meet the design and construction requirements identified in Mil Specs. **(T-0)** Machines design, foundation requirements, attachments, and safety guidance are found in 29 CFR § 1910.212, *General Requirements for all Machines.* OSHA standards in **Table 11.1** will be used when no Military Specifications exist. **(T-0)** If a machine is not specifically covered by this publication, a Military Specification or an OSHA standard, the occupational safety office will be contacted for assistance in identifying applicable criteria. **(T-1)**

11.2. Tools. The unsafe use of hand and power tools can injure employees or damage equipment. Supervisors will enforce strict tool control procedures. **(T-1)** Use of personally owned hand and power tools will be prohibited. **(T-1)** Tools will be properly stored when not in use. **(T-1)** Appropriate PPE will be provided to employees and use enforced. **(T-1)**

11.2.1. Hand Tools.

11.2.1.1. IAW 29 CFR § 1910.242, *Hand and Portable Powered Tools and Equipment, General,* and 29 CFR § 1926.302, *Tools-Hand and Power, General,* supervisors are responsible for the safe condition of tools and equipment used by employees.

11.2.1.2. Refer to **paragraph 2.4.8.8** for compressed air cleaning requirements.

11.2.1.3. Supervisors and employees will frequently inspect all hand tools required for the operation. **(T-1)** Defective tools will be immediately removed from service. **(T-0)**

11.2.1.4. Employees carrying hand tools while on ladders, scaffolds, platforms, or work stands will use carrying bags, e.g., shoulder bags or backpacks, or tool belts for tools that are not in use. **(T-0)** Employees will not intentionally drop tools from elevated surfaces or throw tools to each other. **(T-0)**

11.2.2. Non-powered Hand Tools.

11.2.2.1. Screwdrivers. Screwdrivers will not be used as a prying tool, punch, wedge, chisel, punch bar, nail puller, or be struck with a hammer. **(T-0)** If the tips of any

screwdriver or special fastener are worn or misshaped, they will be repaired or replaced. **(T-0)**

11.2.2.2. Chisels and Punches. Chisels will be kept sharp with the edge and striking surface ground true. **(T-0)** Cold chisels and punches with mushroom heads will not be used. **(T-0)** A chisel or punch holding device will be used when working space permits. **(T-0)** The angle of cut will be away from the body. **(T-0)** Safety goggles will be worn when using a chisel, punch, or an alignment drift. **(T-0)**

11.2.2.3. Wrenches. Damaged, bent, or broken wrenches, including those with sprung jaws, will not be used. **(T-0)** Wrenches will not be struck with a hammer unless designed for this purpose. **(T-0)** Worn box wrenches or sockets will be replaced. **(T-0)**

11.2.2.4. Hammers. A hammer of suitable design, size, and weight for the task will be used. **(T-0)** Hammers with loose or damaged handles will not be used until the handle is repaired/replaced. **(T-0)** A hammer will be discarded if it shows dents, cracks, chips, mushrooming, or excessive wear. **(T-0)**

11.2.2.5. Saws. Crosscut saws will be used for cutting (wood or lumber) across the grain, ripsaws for cutting with the grain, and hacksaws for cutting metal. **(T-0)** Saws with broken teeth or broken or cracked handles will not be used. **(T-0)** Saw teeth will be kept sharp and well set to prevent binding. **(T-0)** If a saw binds while cutting, the employee will not attempt to force it through the stock. **(T-0)** 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.

11.2.2.6. Pliers, Hand Snips, and Cutters. Pliers are designed for gripping and cutting operations and will not be used as a substitution for a wrench or any purpose for which it was not intended. **(T-0)** Hand snips are designed for cutting sheet-metal. Hand snips will not be hammered on to make a cut. **(T-0)** Cutters are designed for use on wire, rods, or bolts, and will not be used to pull nails or as a pry bar. **(T-0)**

11.2.2.7. Knives. Hook-bill knives, utility knives, or other similar extremely sharp knives, when not in use, will be stored in a holder or sheath. **(T-0)** Employees will always cut away from their body. **(T-0)** Hacking motions will not be applied when cutting. **(T-0)** Jackknives, multipurpose tools, or pocketknives with locking capability will be removed from service when the locking mechanism is inoperative. **(T-0)**

11.2.2.8. Crowbars and Wrecking Bars. Makeshift bars, such as pipes or other metal objects, will never be used in place of crowbars and wrecking bars. **(T-0)** Crowbars will have a point or toe to grip the object to be moved and a heel to act as a pivot or fulcrum. **(T-0)** A block of wood may be used under the heel to prevent the crowbar from slipping and injuring the user or fellow employees. Damaged crowbars will not be used. **(T-0)** Case-hardened steel tools will never be used to strike crowbars or wrecking bars. **(T-0)** Only plastic, wood, or soft metal objects will be used to hammer on pry-type bars. **(T-0)**

11.2.2.9. Files. Files will never be cleaned by being struck against a vise or other metal object, because they chip and break easily. **(T-0)** They will not be used as a pry bar. **(T-0)** Broken files will be discarded and not made into a center punch, chisel, or other type of tool, since the hardened steel may fracture in use. **(T-0)** Supervisors will ensure defective handles are replaced immediately. **(T-0)**

11.2.2.10. Shovels, Rakes, Ice Chippers and Sod Lifters. None of these tools will be used as prying tools. **(T-0)** Replace defective handle immediately. These tools will be properly stored when not in use. **(T-0)** When shovels, rakes, hoes, and similar tools are not in use at the job site, they will be positioned where the working surface cannot be stepped on. **(T-0)**

11.2.2.11. Chains. The chain will be inspected before and after each use. **(T-0)** The chain will not be held in the hand when pressure is applied, nor will an employee stand closer than one-half the length of the chain when the chain is under tension. **(T-0)**

11.2.3. Portable Power Tools. See 29 CFR § 1910, Subpart P for detailed information.

11.2.3.1. Electric power tools will either be of the approved double-insulated type or grounded IAW 29 CFR § 1926, Subpart K, *Electrical.* **(T-0)** The use of electric cords for hoisting or lowering will not be permitted. **(T-0)**

11.2.3.2. Extension Cords. Refer to **Chapter 8** for information on extension cord requirements for electric power tools. **Note**: Consideration may be needed for portable power tools purchased in host nations where OSHA-recognized NRTL certification and/or NFPA 70 are not recognized.

11.2.3.3. Use of GFCI devices is recommended with handheld power tools such as routers, planers, and shears. Refer to 29 CFR § 1910.304 for additional information.

11.2.3.4. Fire Hazards. Electric power hand tools will not be used near flammable materials or in explosive atmospheres unless approved to meet NFPA 70 requirements for the type of area and atmosphere in which the tool is to be used. **(T-0)**

11.2.3.5. Grounding. All portable electric tools with exposed metal parts will be grounded IAW the NFPA 70 to prevent electric shock. **(T-0)** Approved three-wire cords will be used to effectively ground these tools. **(T-1)** The ground prong of a three-wire plug will never be removed. If a cord is found with the ground prong removed, it will be removed from service, rendered unusable, and turned in for repair or replacement. **(T-0)** Refer to 29 CFR § 1910.304 for additional information.

11.2.3.6. Damp or Wet Locations. Electric powered tools used in damp or wet locations, such as in tanks, boilers, or outdoors, will be grounded, unless double insulated. **(T-0)** GFCI devices will be used IAW the NFPA 70. **(T-0)** Refer to 29 CFR § 1910.304 for additional information.

11.2.4. Powder-actuated tools. Powder-actuated tools will meet the requirements of 29 CFR § 1926.302(e). **(T-0)** Employees using powder-actuated tools will pass written and hands-on practical use examinations. Employees will carry their certification card while using these tools. **(T-0) Note**: Storage of powder-actuated shells may require an explosive storage license. Contact the weapons safety office for guidance.

11.3. Machinery. Refer to 29 CFR § 1910, Subpart O, *Machinery and Machine Guarding,* for additional guidance.

11.3.1. Safe Operations.

11.3.1.1. Supervisors will maintain manufacturer's operation manuals for all machinery or equipment under their control. **(T-1)** These manuals will be incorporated into on-the-job training and work center JSTO. **(T-1)** In the absence of manufacturer guidance, supervisors

will develop JHAs and procedures IAW TO, DAFMAN, OSHA and other related guidance. **(T-1)** Training will include job safety, maintenance (e.g., cleaning and sanitizing, lubrication), and inspection. **(T-1)** Identify location of training instructions (e.g., manufacturer's manuals, or JHAs procedures) in the work center JSTO. Ensure only authorized employees operate and maintain shop equipment. **(T-0)** Refer to 29 CFR § 1910.212, and 29 CFR § 1910.263, *Bakery Equipment,* for additional information.

11.3.1.2. Supervisors will periodically evaluate machinery or equipment operators to ensure they are following proper and safe operating procedures. Machines will be used only for work within the rated capacity specified by the machine manufacturer. **(T-0)**

11.3.1.3. Machines will not be operated unless all guards are securely in place and operational. **(T-0)** Any time guards are to be removed, follow hazardous energy control procedures. Refer to 29 CFR § 1910.212, 29 CFR § 1910.147, *The Control of Hazardous Energy (Lockout/Tagout),* and **Chapter 21.**

11.3.1.4. Employees operating, helping, or observing machine operations will comply with PPE requirements for each machine and work area. **(T-0)** Refer to 29 CFR § 1910.132, *Personal Protective Equipment,* and **Chapter 14** for additional information.

11.3.1.4.1. Machine operators or other personnel near machines/equipment will not wear gloves, loose fitting clothing, neckties, rings, bracelets, or other apparel that is not authorized by the machine/equipment manufacturer, or that may become entangled in moving machinery, power transmission apparatus, powered hand tools, or moving parts. **(T-1)**

11.3.1.4.2. Hair nets or caps will be worn to keep long hair under control and safely away from moving machinery, power transmission apparatus, or moving parts. **(T-0)**

11.3.1.4.3. Machine operators will not wear gloves during operations when manufacturer's instructions specify that the wear of gloves will increase the chance of injury. **(T-1)**

11.3.1.5. The operator will 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. **(T-0)** Chips or other particles will be removed using brushes, tools designed for such a purpose or compressed air. **(T-0)** Refer to **paragraph 2.4.8.8** for compressed air cleaning requirements.

11.3.1.6. Refer to **Chapter 8** for additional guidance on under-voltage protection.

11.3.2. Inspection and Maintenance.

11.3.2.1. Supervisors will ensure all machines are inspected upon receipt to detect and correct defects. **(T-0)** Follow manufacturer's instructions and TO 34-1-3, *Inspection and Maintenance – Machinery and Shop Equipment*, for periodic inspection requirements. **(T-1)**

11.3.2.2. Operator inspections will be conducted prior to following a new setup or when operators change. **(T-0)** This inspection will 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. **(T-0)** Records of inspections and any machine maintenance will be maintained on AFTO Form 244 IAW TO 34-1-3.

11.3.2.3. Repairs or maintenance beyond the operator's qualifications will only be accomplished by a qualified technician. **(T-1)** Any maintenance and repair, regardless of whether it is performed by an operator or qualified technician, will be performed IAW work center hazardous energy control program requirements. **(T-0)** If machinery is out of service for a period of time, it will be properly tagged to show it is inoperable. **(T-0)** Refer to **Chapter 17** for tagging procedures. Refer to **Chapter 21** for specific guidance on hazardous energy control.

11.3.3. References. Refer to **Table 11.1.**

Table 11.1. OSHA Standards for Machinery.

OSHA Standards	
Subject	**OSHA Standards**
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

11.3.4. Training. Employees will be trained by the supervisor or a designated trainer on all machinery or equipment they are required to use prior to use. **(T-0)** Only trained personnel or those undergoing supervised on-the-job training will operate shop machinery or equipment. **(T-0)** Training will be documented and immediately available in the work center.

11.3.4.1. Operators will be trained on machine or equipment maintenance or repairs they are required and qualified to perform. **(T-0)**

11.3.4.2. Supervisors and operators will receive training on hazardous energy control procedures contained in **Chapter 21,** as appropriate, to ensure the purpose of the program is understood. **(T-0)** (**Note**: Services craft or hobby shop patrons will 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.) **(T-1)** An Arts and Crafts Equipment Qualification card will be issued to identify the machinery the patron is authorized to operate. **(T-1)** Personnel will not operate machines or equipment if this card is not available. **(T-1)** Services patrons, e.g., base hobby shops, will receive general awareness training to understand the Hazardous Energy Control program, but will not apply or remove locks or tags. **(T-0)**

11.3.5. Machine Layout Requirements.

11.3.5.1. Machines subject to movement because of vibration, rotation, or other reasons will be securely fastened to prevent their movement while operating. **(T-0) Exception**: Machines, such as meat slicers, cause very little vibration or movement and can be satisfactorily held in position with rubber feet.

11.3.5.2. Sufficient space for material handling and maintenance will be provided around each machine. **(T-0)** The occupational safety office and installation CE will be contacted for assistance on layout issues. **(T-3)**

11.4. Specific Requirements for Machinery.

11.4.1. Refer to 29 CFR § 1910.213 and 1910.147 for electrical requirements and safeguards.

11.4.1.1. The motor START switch will be protected against accidental or inadvertent operation. **(T-0)** Refer to 29 CFR § 1910.217 for additional information.

11.4.1.2. Electrical hardwiring of all machinery will be installed IAW NFPA 70. **(T-0)**

11.4.2. Safeguarding devices will be installed, adjusted, and used IAW manufacturer's operating and maintenance instructions. **(T-0)** Refer to 29 CFR §§ 1910.212, 1910.213 and 1910.217 for additional safe distance and maximum opening requirements.

11.4.3. Safety Devices.

11.4.3.1. Devices such as anti-kickback dogs and fingers or safety hold-down wheels will be installed when ripping material. **(T-1)** Anti-kickback dogs and fingers will be inspected before each use and kept sharp to maintain their holding power. **(T-1)**

11.4.3.2. When procuring new table saws, consider purchasing them with skin sensing safety features, if available, to prevent injury. **(T-1)** This type of sensing technology detects contact with the skin, immediately shutting off the motor and stopping the blade.

11.4.3.3. The working part of a band saw blade, between the guide rolls and the upper wheel enclosure, will be guarded to prevent accidental human contact with the saw blade. **(T-0)** The guard will be self-adjusting and attached to the gauge so that, in any position the guard will protect the saw blade at the front and outer side. **(T-0)**

11.4.4. Safeguarding by Location or Distance. Before attempting safeguarding by location or distance, a thorough JHA of each machine and particular situation will be performed by the supervisor with consultation from the occupational safety office as needed. **(T-1)** The analysis must clearly identify that employees are protected from dangerous moving parts and one of the restrictions in **paragraph 11.4.3** is met. **(T-0)**

11.4.4.1. 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 an employee during the normal operation of the machine. **(T-0)** This may be accomplished by locating a machine where a building design feature, such as a wall, protects the employee 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 employee.

11.4.4.2. Unguarded moving parts of machines will be at least eight feet above the work level, e.g., floor, platform, or passageway. **(T-0)** Refer to 29 CFR § 1910.212 for additional guidance.

11.4.4.3. Machines with live parts will be in an enclosed area with a locked entrance. **(T-1)** The enclosure (wall or fence) will be at least eight feet high. **(T-1)** Refer to 29 CFR § 1910.219 for additional guidance.

11.4.5. 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. Sound judgment is needed in their application. Since these aids are not used instead of the safeguards, sound judgment is needed in their application.

11.4.5.1. Shields may be used to provide protection from flying particles.

11.4.5.2. Holding tools designed to aid material placement in and out of machinery will be used to prevent placing hands in the danger zone. **(T-1)** These tools are not a substitute for guarding required by this or any other machine standard. They will only be used to supplement guard protection provided. **(T-1)**

11.4.6. Exhaust Ventilation. Machines that develop fine dust and fumes must be evaluated by installation BE to safeguard employees. **(T-0)** Refer to DAFMAN 48-146, *Occupational Health Program Management,* and 29 CFR § 1910.94, *Ventilation*, for additional guidance.

11.4.7. Illumination. Refer to **paragraph 11.4.3** for additional guidance.

11.4.8. Machine energy isolating devices will 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. **(T-1)**

11.4.9. Wheel and Spindle Speeds.

11.4.9.1. The spindle rpm of grinders will be shown on the machine in a location readily visible to the operator. **(T-0)** The supervisor and employee have the 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 29 CFR § 1910.215 for additional guidance.

11.4.9.2. All grinding wheels will have the operating speed affixed to the wheel. **(T-0)** Those without a rating will be tagged and removed from service until the rpm rating is validated. **(T-0)**

Chapter 12

MATERIAL HANDLING EQUIPMENT (MHE)

12.1. Scope. This chapter specifies requirements for MHE used for moving, storing, lifting, and controlling equipment in warehouses and industrial workplaces. **Note**: **Table 12.1** provides a comprehensive list of reference sources.

12.1.1. Hazards. Common hazards associated with MHE include overloading, dropping, improperly secured loads and obstruction to load passage. Improper operation of MHE is commonly caused by inadequate training, a lack of safety-rule enforcement leading to unsafe behaviors and a lack of PPE.

12.1.2. This chapter does not cover manual material handling (e.g., lifting, use of dollies) requirements, which can be found in **Chapter 2,** *General Work Procedures.*

12.2. General Requirements.

12.2.1. Documentation. Personnel may use authorized Air Force forms, to include MAJCOM/FLDCOM or locally devised forms, general purpose forms or automated systems for documenting and tracking inspections, maintenance, training, and other MHE activities. Electronic signatures are acceptable for documentation. Check the prescribing standards prior to discontinuing use of any forms to meet additional requirements. Aircraft maintenance will follow documentation guidance in DAFI 21-101, *Aircraft and Equipment Maintenance Management,* and 00-20 series TOs. **(T-1)** Units will review the Air Force Records Disposition Schedule for disposal guidance for historical records of all inspection, repair, and test documentation. **(T-1)**

12.2.2. MHE Parked Inside Warehouses. Gasoline or diesel-powered MHE parked in general purpose warehouses must be approved by the group commander responsible for the designated warehouse, with recommendations by the F&ES Flight, installation BE, and Occupational Safety office. **(T-2)** Administrative areas/offices must be protected from exhaust buildup in relation to the warehouse activities. **(T-1)** Warehouse location will be equipped with an automatic fire suppression system or heat sensor device. **(T-1)** The equipment will be parked so it does not block fire aisles, firefighting equipment, fire alarm boxes, stairways, elevators, or fire exits. **(T-0)** The warehouse supervisor will 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. **(T-1)** A minimum of 10-foot clearance will be maintained between parked equipment and combustible materials. **(T-1) Note:** When internal combustion engine equipment is used inside warehouses, ventilation requirements will be determined by the installation BE to prevent hazardous atmosphere exposure in the workplace. **(T-1)**

12.2.2.1. Operators will not park liquid petroleum (LP)-fueled industrial and lift trucks near sources of heat, open flames, or similar sources of ignition. **(T-1)** Trucks equipped with a permanently mounted LP-gas container will be fueled outdoors. **(T-1)**

12.2.2.2. Gasoline or diesel-powered equipment used in multistory buildings will be parked on the ground floor when not in use. **(T-1)**

12.2.2.3. Units with internal combustion engines will not be refueled inside warehouses or while the engine is running. **(T-1)** Refueling will be accomplished in outside areas approved by the F&ES Flight. **(T-2)** When fuel is spilled during servicing, operations must be stopped, and equipment cleaned up IAW local procedures prior to restarting fuel servicing operations. **(T-1)** The F&ES Flight and installation CE must be notified when a significant spill occurs. **(T-0)**

12.2.3. Electric or battery powered equipment will be used indoors when possible. **(T-1)**

12.2.4. Where MHE is used in warehouses or industrial workplaces, sufficient space clearances will be provided for aisles, loading docks, doorway entrances, overhangs, and passageways with no obstructions that could create a hazard. **(T-0)** Operators will use caution when traveling on docks or loading platforms and remain clear of the edge. **(T-0)**

12.2.5. Passengers will not ride on powered lift equipment unless a passenger seat is part of the manufactured design. **(T-0)**

12.2.6. The maximum load capacity will be posted on each piece of lifting equipment, in view of the operator. **(T-0)** Modifications and additions which affect capacity and safe operation require manufacturer's written approval. **(T-0)** If modifications or additions are completed, capacity, operation and maintenance instruction plates, tags or decals will be changed accordingly. **(T-1)**

12.2.7. Spotter Requirements During Loading/Unloading Operations. Safe loading and unloading requirements to include the use of trained spotters during loading and unloading operations, when the vehicle is operated in a congested area, or when the operator's vision is obscured Spotters will be used, and procedures will include:

12.2.7.1. Spotters will always remain in full view of the operator. **(T-1)**

12.2.7.2. Spotters will be trained on forklift load stability, identification of hazards in the area, standard hand signals between operator and never place yourself between forklift and any object. **(T-1)**

12.2.7.3. Supervisors will establish a spotter training plan. **(T-1)** Training will be accomplished and documented upon initial completion, and on a three-year occurring basis. **(T-1)** Methods of documentation include the DAF Form 623, *Individual Training Record Folder,* DAF Form 1098, *Special Task Certification and Recurring Training,* DAF Form 55, *Employee Safety and Health Record,* or other MAJCOM/FLDCOM-directed record system. **(T-1)**

12.2.7.4. Refer to **paragraph 30.3.3.2** for additional guidance.

12.3. Acquisition.

12.3.1. Commercially procured materials handling and lifting equipment or parts will comply with design manufacturing requirements and specifications in OSHA standards and applicable ANSI/ASME requirements and specifications. **(T-0)** **(Note:** Refer to manufacturer certification of compliance for verification that equipment meets requirements.) Local modifications of centrally procured materials handling equipment will be approved by manufacturer in writing. **(T-0)** Where the manufacturer approval cannot be gained a registered professional engineer will be consulted by equipment item managers. **(T-1)** Local purchase acquisition requests for medication will also be coordinated with the Occupational Safety

office for awareness. **(T-1) (Note:** Manufacturers may void the warranty of equipment modified without their approval. Therefore, coordinate with the contracting and occupational safety offices prior to contracting the equipment item manager.

12.3.2. Lever-operated hoists will have manufacturer's certification that the hoist meets the requirements and specifications of recognized industry standards. **(T-0)** Slings procured for DAF use will have manufacturer's certification of compliance with design and manufacturing requirements found in 29 CFR § 1910.184, *Slings,* and ASME B30.9, *Slings*. **(T-0)** Locally manufactured slings that do not meet the engineering requirements of ASME B30.9 are prohibited and will be disassembled and removed from service. **(T-0) Note**: Design and manufacturing requirements are specified in OSHA's *Tables and Figures: Guidance on Safe Sling Use* (**https://www.osha.gov/dsg/guidance/slings/tables-figures.html**).

12.3.3. Capacity of all lever-operated devices will be permanently and conspicuously marked in a readily visible place on the hoist. **(T-1)** Only ratchet and pawl, and load brake hoists, which include a means to prevent a suspended load from self-lowering, will be procured. **(T-1)** Lowering under load will be by operation of the hoist lever. **(T-1)**

12.3.4. Overhead hoists will be certified by the manufacturer that it meets design specifications, characteristics, and rules of ASME B30.7, *Winches*, ASME B30.10, *Hook*s, and ASME B30.16, *Overhead Underhung and Stationary Hoists*. **(T-0)** When applicable, a system safety program will be established. **(T-1) Note 2**: Nuclear-certified hoists must also meet requirements in **paragraph 12.5** and DAFMAN 91-118, *Safety Design Criteria for Nuclear Weapon Systems.* **(T-1)**

12.3.5. New or Modified MHE. Prior to initial use, all newly procured or modified (altered or repaired) MHE will be inspected by a person qualified to ensure compliance with the provisions of this chapter and manufacturer's requirements. **(T-1)**

12.3.6. Hoist, Sling and Hook Certification. Hoist, sling and hook certification documents received from the manufacturer when hoists, slings or hooks are purchased or repaired will be maintained for the life of the equipment (or until the hooks are replaced). **(T-1)** For repaired items, the previous certification will be replaced with the new documentation. **(T-1)**

12.4. Inspections. MHE (specifically hoists, cranes, derricks, powered industrial trucks) and associated components will be inspected for damage or wear at intervals specified, as described below, and including observations made during operations based on level of usage and/or as recommended by the manufacturer. **(T-0)** 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. **(T-1)** Inspections and preventative maintenance checks on motorized material handling equipment must be completed IAW TO 36-1-191. **(T-0)**

12.4.1. Frequent. A visual inspection will be performed by the operator or designated person at daily (e.g., pre-use) to monthly intervals. **(T-0)** The record of inspection will be maintained by the using agency until the next periodic inspection has been performed. **(T-1)**

12.4.2. Periodic. A complete inspection will be performed by a person qualified to conduct the inspection at intervals between 1 and 12 months. **(T-1)** 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. Follow periodic inspection schedules outlined in applicable technical orders and/or manufacturer's instructions where

intervals are established. **Note:** These intervals will apply unless MAJCOMs/FLDCOMs, or installations have more stringent directives. **(T-1)**

12.4.2.1. During the periodic inspection, some systems may require the removal of covers or parts to gain access. Appropriate hazardous energy control 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. **(T-0)** Refer to **Chapter 21** for additional guidance.

12.4.2.2. Disassembly of the MHE or major components, not designed to be removed or opened, is not required for the sole purpose of the inspection.

12.4.2.3. 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 or equivalent entity instructions for additional guidance.

12.4.3. Inspections identified as monthly and annual inspections will be considered as such and not a 30- or 365-day inspection. **(T-1)** The next inspection must occur by the last day of the respective month. **(T-1)**

12.4.4. Mandatory Monthly Inspections. Wire ropes, chains, and hooks associated with overhead and gantry cranes will be thoroughly inspected monthly. **(T-0)** Inspections for each item will be documented. **(T-1)** 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. **(T-0)** Inspection criteria will be IAW this chapter and manufacturer instructions. **(T-1)** **Note**: Units will review the Air Force Records Disposition Schedule for disposal guidance for historical records of all inspection, repair, and test documentation. **(T-1)**

12.4.5. MHE Not in Regular Service. Cranes, hoists, and derricks idle for at least one month, but less than six months, must be inspected prior to placing back in service. **(T-0)** Cranes, hoists, and derricks idle for six months or more will be given a complete inspection as defined in paragraphs **12.4.1**, **12.4.2** and **12.4.4**, prior to placing back in service. **(T-0)** Standby cranes and derricks will be completely inspected at least semiannually as defined in paragraphs **12.4.1**, **12.4.2** and **12.4.4** **(T-0)** The user will determine the need for more frequent inspections of cranes and derricks exposed to an adverse environment. **(T-1)** Refer to 29 CFR § 1910.179, *Overhead and Gantry Cranes,* 29 CFR § 1910.180, *Crawler Locomotive and Truck Cranes,* and 29 CFR § 1910.181, *Derricks,* for specific equipment requirements.

12.4.6. For cranes and derricks used in construction, consult with the installation CE and refer to 29 CFR § 1926.1400, *Cranes and Derricks in Construction.*

12.4.7. Inspections will be documented IAW **paragraph 12.2.1**. **(T-1)**

12.5. Nuclear-certified Lifting Equipment. For nuclear-certified MHE, the supervisor or designated representative will perform periodic inspection semiannually. **(T-1)** The supervisor or designated representative will ensure operational and load tests of nuclear-certified hoists, cranes or slings are conducted annually at not less than 100 percent or more than 125 percent of rated capacity. **(T-0)** Perform annual tests in conjunction with one of the two semiannual inspections. **(T-1)** Nuclear-certified hoists must also meet requirements in DAFMAN 91-118. **(T-1)**

12.5.1. The annual load test may be performed either as a static or dynamic test as determined by the person qualified to conduct such tests.

12.5.2. For nuclear-certified slings and wire rope assemblies, supervisors will use the appropriate 11N series TOs for testing criteria. **(T-1)**

12.5.3. Supervisors will ensure synthetic rope slings are not used to lift nuclear loads. **(T-1)** Critical non-nuclear loads can use slings made of synthetic fibers, such as synthetic round slings and synthetic web slings, with completion and documentation of a risk assessment demonstrating the sling can safely handle the load. **(T-1)**

12.5.4. For nuclear-certified hoist hooks and hooks used in lifting critical loads, perform a dye penetrant, magnetic particle, or other suitable NDI on the hook annually. **(T-1)** Perform the annual NDI in conjunction with one of the two scheduled semiannual hoist and crane inspections. **(T-1)** 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 will be performed. **(T-1)** If the block is designed such that disassembly is not feasible, this inspection is not required. If hook is removed from hoist for NDI, verify that the hook is properly reinstalled before 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 will not be used on nuclear-certified hoists or lifting equipment or equipment used to lift critical loads. **(T-1)**

12.6. Qualification and Training.

12.6.1. MHE operator qualification and training will be provided by the organization responsible for the operation of equipment and will be IAW applicable DAF guidance, OSHA requirements and manufacturer's instructions. **(T-0)** Organizations requiring MHE training will designate personnel qualified to instruct trainees. **(T-1)** Appropriate shop supervisor and vehicle control officer or noncommissioned officer will keep the list of approved instructors, with the background and experience on the type(s) of equipment the instructor is providing training. **(T-1)**

12.6.2. Lesson plans for each vehicle or equipment type will be accomplished by the unit IAW DAFI 24-301. **(T-1)** Lesson plans will 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. **(T-1)**

12.6.3. MHE training will be IAW applicable technical data and manufacturer's instructions, e.g., cranes, hoists, conveyors, forklifts. **(T-1)** A qualified instructor will evaluate each forklift operator at least once every three years and provide refresher training, as applicable, to maintain currency in relevant topics, where an operator shows unsafe operation of the vehicle, the operator has been in an accident in the MHE, operation of a different type of MHE, or to address changes in the workplace that create new hazards. **(T-0)** MHE will be operated only by properly trained, and qualified personnel or trainees under direct supervision of a qualified trainer/instructor. **(T-1)** The operator will be familiar with all operating controls and be instructed in the operations to be performed. **(T-1)** Training should include warnings, manufacturer's instructions, requirements from this manual, and OSHA guidelines, as applicable.

12.6.4. Mobile cranes will only be operated 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. **(T-1)** (**Exception**: Operators of DAF special purpose truck crane will be licensed IAW AFI 24-301 in lieu of AF Form 483.) **(T-1)** No other personnel will enter a crane cab except for oilers, supervisors, and qualified inspectors whose duties require cab entry. **(T-1)** A list of qualified crane operators will be kept by the using organization and appropriate entries will be made in the individual's training records. **(T-1)**

12.6.5. Training Currency for Deployment. Supervisors will ensure personnel scheduled for deployment are current/trained in operations on this equipment prior to deploying. **(T-0)** Additionally, supervisors at deployed locations will 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 of equipment and address local hazards. **(T-0)**

12.7. Testing.

12.7.1. All new hoists, cranes, derricks, and other similar lifting devices, regardless of type, required to lift any type of load will be tested prior to initial use and every four years thereafter by a person qualified to conduct the load test. **(T-0)** This load test will incorporate a pre-test and post-test inspection per periodic inspection guidelines and be conducted at not less than 100 percent or more than 125 percent of the rated load, unless otherwise recommended by the manufacturer or equivalent entity. **(T-0)** Test reports will be placed on file readily available to appointed personnel and maintained on file for the life of the equipment. **(T-1)** Refer to 29 CFR § 1910.179, 29 CFR § 1926.552*, Material Hoists, Personnel Hoists and Elevators,* 29 CFR § 1926.1433, *Design, Construction and Testing,* for additional guidance. The Crane Manufacturer's Association of America (CMAA) Specification 78, *Standards and Guidelines for Professional Services Performed on Overhead and Traveling Cranes and Associated Hoisting Equipment,* and applicable ASME's B30 Codes and Standards may also contain additional information.

12.7.2. DAF 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. **(T-1)** Hoists, cranes, or other similar lifting devices, regardless of type, required to lift critical loads, as defined in **Attachment 1,** Terms (*Critical Loads*), will be tested, as stated in **paragraph 12.7.4** annually per manufacturer requirements. **(T-1)** Prior to accomplishing load tests on equipment attached to facility structural members, a qualified person to conduct the tests such as a civil engineer, will assess the sufficiency of the structure to withstand the loads being tested. **(T-0)**

12.7.3. Load Tests.

12.7.3.1. Hoists and Cranes. All new or altered hoists/cranes, with replaced or repaired load suspension parts will be load tested prior to use at not less than 100 percent or more than 125 percent of the rated load of the equipment, unless otherwise recommended by the manufacturer. **(T-0)** This load test will include all functions outlined in applicable technical data or manufacturer's instructions. **(T-1)** The replacement of load chain or rope is specifically excluded from this test; however, an operational test under a no-load condition will be conducted prior to putting the hoist back into service. **(T-0)** Prior to accomplishing load tests on equipment attached to facility structural members, a person qualified to conduct such tests, such as civil engineer, will assess the sufficiency of the structure to

withstand the loads being tested. **(T-0)** Using organizations will maintain written certification that all required load testing has been accomplished. **(T-1)**

12.7.3.2. The test will be conducted as follows:

12.7.3.2.1. Hoist the test load a distance to assure load is supported by the crane and held by hoist brake(s). **(T-0)**

12.7.3.2.2. Transport test load by the trolley or carrier for the full length of the bridge. **(T-0)**

12.7.3.2.3. 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. **(T-0)** When cranes operate on more than two 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. **(T-0)**

12.7.3.2.4. For monorail systems, follow manufacturer guidance for the hoist test and transport test load by the carrier for the full length of the monorail system. **(T-0)** Refer to ASME B30.16, *Overhead Hoists (Underhung),* for additional information.

12.7.3.2.5. On hoists incorporating overload devices, a load test will be accomplished with a test load of least 100 percent of rated capacity, after which the overload device will be tested. **(T-0)**

12.7.3.2.6. Test weights for load testing will be tagged or marked indicating total weight in pounds and owner or agency identification number. **(T-0)** Rebar steel will not be used for test weight lift points. **(T-0)**

12.7.4. Operational Tests. All new hoists, cranes and other similar lifting devices which have had load-suspension parts altered, replaced, or repaired will be operationally tested before use. **(T-0)** Rebar steel will not be used for test weight lift points. **(T-0)** Conduct tests first by hand, if practical, and then at the slowest possible speed. Test with increasing speeds up to maximum speed. Actuated mechanisms will be located so they trip switches or limiting devices in sufficient time to stop motion without damage to the hoisting arrangement. **(T-0)** On hoists having adjustable trip-setting limit devices, care will 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. **(T-0)**

12.7.4.1. Hoists, cranes, and other similar lifting devices not used within the preceding 12 months will be operationally tested by a person qualified to do so. **(T-0)**

12.7.4.2. Operational testing will consist of operating all functions of the lifting device under a no-load condition to test all functions of the lifting device, including hoisting and lowering, operation of brakes, and testing of all limits, locking, safety devices, and other movable mechanisms, such as trolley travel, bridge travel, load lifting and lowering mechanisms, etc. **(T-0)**

12.7.5. Derricks. Prior to initial use, all modified and altered derricks will be operationally tested to ensure compliance with this manual and requirements in 29 CFR § 1926, Subpart CC, *Cranes and Derricks in Construction.* **(T-0)** All new derricks will have the manufacturer's certification that all required testing has been completed. **(T-0)**

12.8. Powered Industrial Trucks.

12.8.1. 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, pipe, 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.

12.8.2. New commercially procured powered industrial trucks will meet the design and construction requirements of ANSI B56.1, *Safety Standard for Low, High Lift Trucks,* except those designed primarily for earth moving or over-the-road hauling. **(T-0)** Supervisors will review the manufacturer's certification to validate compliance. (**T-1**) A label or other identifying marks showing approval by a testing laboratory must be affixed to the truck. **(T-0)**

12.8.3. Local modifications and additions of centrally procured MHE will be done IAW **paragraph 12.3.1**.

12.8.4. Safe Operations.

12.8.4.1. The maximum load capacity will be posted on each piece of lifting equipment, in view of the operator. **(T-0)**

12.8.4.2. All high-lift rider trucks will be equipped and operated with overhead guards to protect the operator from falling objects. **(T-0)** Overhead guards will not be covered with material that could obstruct the operator's vision. **(T-0)**

12.8.4.3. When a forklift is used to elevate personnel, an approved work platform with all designed safety equipment, such as fall protection requirements, will be in place while in use. **(T-0)** The operator must always remain at the controls when personnel are on the work platform and must not move the forklift. **(T-0)** Instructions prohibiting movement of the forklift with personnel on the work platform will be posted on the work platform in plain sight, visible to the operator and all personnel working near the platform. **(T-0)**

12.8.4.4. Whenever possible, electric or battery powered equipment will be used indoors. **(T-1)** Internal combustion engines will not be operated inside buildings unless an exhaust system or other ventilation approved by installation BE is installed and used. **(T-1)** Administrative areas, e.g., offices, must be protected from exhaust buildup either by distance or positive air flow in relation to the warehouse activities. When internal combustion engine equipment is used inside warehouses, installation BE personnel will determine ventilation requirements to preclude exposure of employees to a hazardous atmosphere. **(T-1)** Forklifts used in hazardous areas will meet the requirements for designated locations as found in 29 CFR § 1910.178(c). (**T-0**) Refer to DESR 6055.09_DAFMAN 91-201 for operating in explosives and weapons areas.

12.8.4.5. MHE powered by an internal combustion engine will have an adequate fire extinguisher available. **(T-1)** Size, type and location will be determined by the F&ES Flight and owning organization and will be based on the risk assessment for the operation conducted. **(T-1)** Additional requirements may be mandated by DAF publications, TOs or other directives for specific environments and operations.

12.8.4.6. When leaving powered lifts unattended, operators will fully lower the forks, neutralize controls, shut power off and set brakes. **(T-0)** Wheels of the vehicle will be chocked, if parked on an incline. **(T-0)**

12.8.4.7. Operators will use caution when traveling on docks or loading platforms and remain clear of the edge. **(T-0)** Consider the use of spotters or signage where operator experience or nature of work center could cause confusion.

12.8.4.8. Operators will not use forklifts to push or pull objects, such as freight cars, or to open and close freight, hangar, or warehouse doors. **(T-0)** (**Exception:** DESR 6055.09_DAFMAN 91-201 allows munitions containers with permanently installed skids to be pushed or pulled for positioning. Ensure safety precautions, such as keeping personnel clear of potentially hazardous areas, have been considered and included in the procedure.)

12.8.4.9. Operators will 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. **(T-0)**

12.8.4.10. Personnel will not stand or pass under the elevated portion of a lift when loaded or empty. **(T-1)**

12.8.4.11. Operators who load and unload aircraft using materials handling and lifting equipment will comply with TO 36M-1-141, *Operator and Operation Instruction—Material Handling Equipment System Components of 463L,* TO 36M2-3-35-11, *Operation and Operator Maintenance Instructions, Truck, Aircraft Cargo Loading/Unloading 60,000 Pound Capacity,* and TO 36M2-3-45-1, *Halvorsen 25K Aircraft Cargo Loaders.* **(T-1)**

12.8.4.12. Refer to DESR 6055.09_DAFMAN 91-201 for operating material handling and lifting equipment in explosives and weapons areas.

12.8.4.13. Forklifts will not be operated on an incline greater than that allowed by the manufacturer. **(T-0)**

12.8.4.14. When traveling, operators will:

12.8.4.14.1. Observe all established driving procedures and will not exceed five miles per hour inside warehouses. **(T-1)** Under normal traffic conditions, operators will keep to the right and maintain a safe distance, approximately three truck lengths, from the truck ahead. **(T-0)** Operators will always maintain safe control of trucks, especially during turns and while traveling over slippery or wet floors and rough surfaces. **(T-0)**

12.8.4.14.2. Not pass other vehicles or pedestrians at intersections, blind corners or at other dangerous locations. **(T-0)**

12.8.4.14.3. Slow down and sound the horn at cross aisles, warehouse entrances and exits or at other dangerous locations where vision is obstructed. **(T-0)** Operators will be prepared to stop and will not proceed until the way is clear. **(T-0)**

12.8.4.14.4. Travel with the load trailing when loads obstruct the forward view. **(T-0)**

12.8.4.14.5. Cross railroad tracks diagonally whenever possible to avoid jarring of the load. **(T-0)**

12.8.4.14.6. Do not park closer than eight feet from the center of railroad tracks. **(T-0)**

12.8.4.14.7. Look in the direction of travel and keep a clear view. **(T-0)**

12.8.4.14.8. Drive a loaded lift with the load upgrade when traveling up or down ramps or grades. **(T-0)** A spotter will be used if the operator's vision is obscured by the load. **(T-0)** Unloaded trucks will be operated on all grades with the forks downgrade. **(T-0)** Caution will be used on all grades. **(T-0)** The load on the forks will be tilted back as far as necessary to clear the road surface. **(T-0)**

12.8.4.14.9. Operate the lift at a speed that will permit it to stop in a safe manner. **(T-0)** Horseplay or stunt driving will not be permitted. **(T-0)**

12.8.4.14.10. Not travel with lift forks elevated more than six inches above the ground or surface or as necessary to clear surface projections. **(T-1)**

12.8.4.14.11. Tilt the mast back when transporting loads when operating a mast with tilt capability. **(T-0)**

12.8.4.14.12. Make smooth starts, turns, and stops to prevent the load from shifting or the truck from overturning. **(T-0)**

12.8.4.14.13. Ensure dock boards or bridge plates:

12.8.4.14.13.1. 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. **(T-0)**

12.8.4.14.13.2. Are strong enough to carry the load. **(T-0)**

12.8.4.14.13.3. Have handholds or other effective means to permit safe handling. **(T-0)**

12.8.4.14.13.4. Are of proper width and length. **(T-0)**

12.8.4.14.13.5. Contain a nonskid surface. **(T-0)**

12.8.4.14.14. Approach elevators slowly and enter squarely after the elevator car is properly level. **(T-0)** Once on the elevator, the operator will neutralize the controls, shut off the power and set the brakes. **(T-0)**

12.8.4.14.15. Ensure motorized hand trucks enter elevators or other confined areas with the load end first. **(T-0)**

12.8.4.14.16. Not permit passengers to ride on tractors unless adequate seats are installed. **(T-0)**

12.8.5. Loading.

12.8.5.1. Only stable or safely arranged loads will be handled. **(T-0)** Caution will be exercised when handling loads which cannot be centered. **(T-0)**

12.8.5.2. Only loads within the rated capacity of the truck will be handled. **(T-0)**

12.8.5.3. Long or high (including multiple-tiered) loads which may affect capacity will be adjusted. **(T-0)**

12.8.6. Training.

12.8.6.1. Each activity requiring training on powered materials handling and lifting equipment will designate qualified personnel as instructors to train and supervise the operator trainee. **(T-1)** The names and grades of instructor candidates will be provided to

the vehicle operations officer who will thoroughly screen each for background and experience in the type of equipment for which instruction will be given. **(T-1)** Refresher training will be provided when an operator operates the vehicle in an unsafe manner, has a vehicle mishap or near miss, needs additional training on a new type of truck, or changes in the workplace that could affect safe operation. **(T-1)** Operators will be reevaluated every three years to measure performance. **(T-1)**

12.8.6.2. Lesson plans for each vehicle will be accomplished IAW DAFI 24-301. **(T-1)** Lesson plans (course content) will 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. **(T-1)** Refer to **paragraph 12.6** for additional guidance on documenting training.

12.8.6.3. Powered industrial truck training will include:

12.8.6.3.1. Equipment design, to include restrictions, limitations, and hazards relative to the environment where used, e.g., steering, maneuvering and visibility. **(T-0)**

12.8.6.3.2. Operating and maintenance instructions, warnings, and precautions, including manufacturer's instructions and those contained in this manual for the types of trucks the operator will be authorized to operate. **(T-0)**

12.8.6.3.3. Safe loading and unloading requirements. **(T-0)**

12.8.6.3.4. Controls and instrumentation, where located, what they do and how they work. **(T-0)**

12.8.6.3.5. Engine operation, steering and maneuvering. **(T-0)**

12.8.6.3.6. Operating techniques inside and outside of warehouses. **(T-0)**

12.8.6.3.7. Visibility and restrictions caused by loads and other concerns. **(T-0)**

12.8.6.3.8. Load capacity and stability. **(T-0)**

12.8.6.3.9. Conducting vehicle inspection and operator maintenance. **(T-0)**

12.8.6.3.10. Refueling and/or charging of batteries. **(T-0)**

12.8.6.3.11. Operating limitations. **(T-0)**

12.8.6.3.12. Flightline rules and regulations, when applicable. **(T-1)**

12.8.6.3.13. Fire extinguisher training (initial and annual). Refer to **Chapter 6,** *Fire Prevention and Protection,* for additional guidance. **(T-1)**

12.8.6.3.14. Use of attachments such as extended forks or personnel lift pallets. **(T-0)**

12.8.6.3.15. Clearances, heights, surface conditions and limitations where vehicles will be operated. **(T-0)**

12.8.6.3.16. Safety clothing and equipment requirements. **(T-1)** Refer to **Chapter 14,** *Personal Protective Equipment (PPE),* for additional guidance.

12.8.6.3.17. Fire protection, fuel spills, maintenance of equipment, smoking, etc. Refer to **Chapter 6** for additional guidance. **(T-1)**

12.8.6.3.18. Operating restrictions in potentially hazardous storage areas, which include flammable, toxic, lumber, coal, etc. Refer to **Chapter 22**, *Flammables and Combustibles,* for additional guidance. **(T-1)**

12.8.6.3.19. How indoor environments and other areas with insufficient ventilation can create a build-up of vehicle exhaust that could affect employee safety. **(T-0)**

12.8.6.3.20. Damage that may be caused by acid or caustic material. **(T-1)**

12.8.6.3.21. Workplace related topics on stacking, unstacking and load manipulation; pedestrian traffic; and narrow aisles. **(T-0)**

12.8.6.3.22. Operation on ramps and other sloped surfaces that could affect vehicle stability. **(T-0)**

12.8.6.3.23. Other unique or potentially hazardous environmental conditions in the workplace that could affect safe operations. **(T-0)**

12.8.7. Maintenance.

12.8.7.1. Repairs to material handling equipment assets under Vehicle Management's control will be accomplished by Vehicle Maintenance (maintenance agreement may be necessary for locally procured assets). **(T-1)** Deviations to this requirement will be approved by host Vehicle Maintenance or vehicle maintenance contractor. **(T-1)**

12.8.7.2. Equipment will be cleaned in designated locations and only with cleaning agents approved by the HMMP team and tracked through EESOH-MIS. **(T-1)**

12.9. Conveyors.

12.9.1. Safe Operations.

12.9.1.1. Employees will not operate conveyors unless all guards are in place. **(T-0)** Do not take off guards at end of conveyor or from belts feeding the conveyor. Employees will report defective or worn shafts, rollers, or bearings that may break and permit rollers to fall from the frame. **(T-0)** Refer to ASME B20.1, *Safety Standard for Conveyors and Related Equipment,* for further information concerning conveyors and **Chapter 21** for additional guidance on hazardous energy control requirements. Keep the area around them free of obstructions to permit a clear view of the conveyor and ready access to the devices. **(T-0)**

12.9.1.2. Employees will not ride, step on or cross over conveyors except at designated locations. **(T-0)** Do not operate unless all guards are in place and interlocks are operational. **(T-0)** Inspect the conveyor system to keep loose objects and personnel away prior to operation. **(T-1)** Ensure employees do not have loose clothing, jewelry, or long hair that could be caught up in the conveyor. **(T-0)**

12.9.2. Inspections. Supervisors will ensure the entire conveyor system is inspected daily. **(T-1)** Defective parts that affect safe operation of the system will be replaced prior to continued operation. **(T-0)** Operators will ensure crossover walkway surfaces are in good condition. **(T-0)**

12.9.3. Maintenance. No work will be initiated on a power conveyor until hazardous energy control procedures have been implemented. **(T-0)** Refer to **Chapter 21** for additional guidance on hazardous energy control procedures.

12.10. Manual Hoisting and Pulling Devices.

12.10.1. Safe Operations.

12.10.1.1. Lever-operated hoists will only be used in a direct pull. **(T-0)** Where indirect pulls are permitted by design of the hoist, a sheave or pulley of adequate size will be used. **(T-0)**

12.10.1.2. Hoist cables, ropes and chains will not be wrapped around the load. **(T-0)** Use only slings or other approved lifting fixtures. **(T-0) Example:** Cargo straps will not be used for lifting, unless stated in approved Air Force technical data. **(T-1)**

12.10.1.3. Positive action safety latches will be installed on all hooks. **(T-0)**

12.10.1.4. Hooks will not be point loaded unless designed for this purpose. All loads will be seated in the saddle of the hook. **(T-0)**

12.10.1.5. Extensions to levers, such as cheater bars or pipes, unless designed and permanently installed by the manufacturer, will not be used to increase leverage. **(T-0)**

12.10.1.6. Manually operated lever hoists will only be operated by personnel trained on use of the equipment. **(T-0)** Operator qualifications will be as determined by the facility manager, shop supervisor or designated representative. **(T-2)**

12.10.1.7. Capacity of all lever-operated devices will be permanently and conspicuously marked in a readily visible place on the hoist. **(T-0)** The rated capacity will not be exceeded except for authorized load tests. **(T-0)**

12.10.1.8. Hoists will be attached to well-defined dead-end points capable of withstanding the intended load. **(T-0) Note**: Lifeline attach points will not be used for hoists. **(T-0)**

12.10.1.9. Operators must be careful to avoid pinch points during handling. **(T-0)**

12.10.2. Inspections.

12.10.2.1. Frequent. The inspection will include checking for:

12.10.2.1.1. Loose or worn parts, nuts, bolts, etc. **(T-0)**

12.10.2.1.2. Cracked or broken welds or parts. **(T-0)**

12.10.2.1.3. Damage to hooks (refer to **Chapter 12.16.10.1**). **(T-0)**

12.10.2.1.4. Bent or deformed pawls. **(T-0)**

12.10.2.1.5. Lubrication. **(T-0)**

12.10.2.1.6. Any additional items required by the manufacturer. **(T-1)**

12.10.2.2. Periodic.

12.10.2.2.1. Complete inspection of all wire rope, chain and fittings or attachments. **(T-0)**

12.10.2.2.2. Inspection of brakes, pawls, or other holding features. **(T-0)**

12.10.2.2.3. Inspection of chain length. **(T-0)** Chains elongated more than ¼ inch in 12 inches will be removed from service. **(T-0)**

12.10.2.2.4. Any additional items required by the manufacturer. **(T-1)**

12.10.2.3. Identification tags will be attached to all hoists. Tags will include the following information:

12.10.2.3.1. Date of annual inspection. **(T-0)**

12.10.2.3.2. Date of load test. **(T-0)**

12.10.2.3.3. Capacity of hoist. **(T-0)**

12.10.2.3.4. Identification number of hoist. **(T-0)**

12.10.3. Maintenance and testing will be performed IAW the manufacturer's instructions or applicable TO. **(T-0)**

12.11. Hoists. This section outlines basic requirements for power-operated hoists used for vertical lifting and are not permanently mounted to other equipment, e.g., a crane, monorail or derrick that serves as a supporting structure. **(T-0)**

12.11.1. Acquisition. Overhead hoists will be purchased from manufacturers whose products meet the design specifications, characteristics, and rules of ASME B30.7, *Winches,* B30.10, *Hooks: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings,* and B30.16, *Overhead Underhung and Stationary Hoists.* **(T-0)** When applicable, a system safety program will be established. **(T-1)** **Note:** Nuclear-certified hoists must also meet requirements in DAFMAN 91-118. **(T-1)**

12.11.2. Safety Requirements.

12.11.2.1. Hoist platforms will have suitable side and overhead protection to prevent operator injury from a falling load. **(T-0)**

12.11.2.2. Standard operating signals, understood by operators and signalers, will be posted on the equipment or conspicuously posted in the vicinity of hoisting operations. **(T-0)**

12.11.2.3. Hoist engines and motors will be guarded to protect personnel. **(T-0)**

12.11.2.4. Self-locking brakes, also known as holding brakes, will be installed on all hoists. **(T-0)**

12.11.2.4.1. 125 percent when used with a control braking means other than mechanical.

12.11.2.4.2. 100 percent when used in conjunction with a mechanical control braking means.

12.11.2.4.3. 100 percent each if two holding brakes are provided.

12.11.2.5. The conductors and switches of electric hoists will be guarded against accidental contact. **(T-0)**

12.11.2.6. All loads will be balanced on hoist carriages and secured to prevent slipping or shifting. **(T-0)**

12.11.2.7. Latch-type safety hooks will be installed on all hoists. **(T-0)**

12.11.2.8. Slack Chain. A chain container will be provided where slack chain hanging from a hoist may be a hazard. **(T-1)**

12.11.2.9. Load Rating. The rated capacity will be permanently marked on the hoist or its load block and must be legible from the operating position. **(T-0)** The rated capacity for each member of the suspension device, when used as intended, will be equal to the other suspension members to which it is attached. **(T-0)** When this is not feasible, a plan will be developed to identify special precautions that will be taken to ensure the lowest rated suspension member's rated capacity is not exceeded. **(T-0)**

12.11.2.10. Warnings. Supervisor will ensure information concerning operating procedures will be posted by all hoists or displayed on a label affixed to the hoist, controls, or block. **(T-1)** This will also include cautions regarding:

12.11.2.10.1. Lifting more than the rated capacity. **(T-0)**

12.11.2.10.2. Operating the hoist when the hook is not centered under the hoist. **(T-0)**

12.11.2.10.3. Operating a damaged or malfunctioning hoist. **(T-0)**

12.11.2.10.4. Operating a rope hoist with a rope not properly seated in its groove. **(T-0)**

12.11.2.10.5. Lifting people or loads over people. **(T-0)**

12.11.2.10.6. Operating the hoist with twisted, kinked, or damaged chain or rope. **(T-0)**

12.11.2.10.7. Removing or obscuring the warning label. **(T-0)**

12.11.2.11. Pendants. The pendant station will be supported by a cable, chain or rope that will protect the electrical conductors against strain. **(T-0)** Pendant control stations will be constructed to prevent electrical shock and will be clearly marked for identification of functions. **(T-0)**

12.11.2.12. Support. The supporting structure of the hoist, including tripod, trolley, monorail, crane, or facility beam will be designed to withstand the load and forces imposed by the hoist. **(T-0)**

12.11.2.13. Location. The hoist will be installed to give the operator room to always remain clear of the load and full view of the load hook in all positions. **(T-0)**

12.11.2.14. Remote Operated Hoists. Remote operated hoists will function so that if the central signal for any hoist motion becomes ineffective, hoist motion will stop. **(T-0)**

12.11.2.15. Upper Limit Switches. Upper limit switches will be installed and operable on all powered hoists. **(T-1)**

12.11.3. Safe Operations.

12.11.3.1. Qualifications of Operators. Hoist will only be operated by trained personnel or trainees under the direct supervision of a qualified trainer/instructor. **(T-0)** The operator will be familiar with the equipment and its proper care. **(T-0)**

12.11.3.2. The rated capacity will not be exceeded except for properly authorized tests. **(T-0)** If it is known or suspected that a hoist may have been overloaded (other than a required and approved test load), the supervisor will ensure that all frequent and periodic inspections are completed prior to use. **(T-0)**

12.11.3.3. When an AF Form 979*,* AF Form 981*,* AF Form 982, *Do Not Start,* or AF Form 983, *Danger – Equipment Lockout* tag is attached to the starting controls, the operator will not apply power to the unit or start operations until the condition has been corrected and the tag and any lock(s) are removed. **(T-0)**

12.11.3.4. If adjustments or repairs are necessary or any damage is observed or suspected, the operator will promptly report the problem to the supervisor. **(T-0)** Equipment identified as damaged will not be used until repaired. **(T-0)**

12.11.3.5. Prior to starting hoist, operator will ensure all personnel are clear of the area. **(T-0)**

12.11.3.6. Operators who must divert their attention while operating the hoist will stop the hoist. **(T-0)**

12.11.3.7. Operators will ensure their hands are clear of all moving parts prior to hoist operation. **(T-0)**

12.11.3.8. Handling the load.

12.11.3.8.1. The hoisting rope or chain will not be wrapped around the load. **(T-0)**

12.11.3.8.2. The load will be attached to the hook, equipped with a safety latch, by means of slings, or other devices designed specifically for the load lifted. **(T-0)**

12.11.3.8.3. Slings or other devices will be seated properly in the saddle of the hook before lift operations start. **(T-0)**

12.11.3.8.4. The load will not be raised more than a few inches until it is well balanced in a sling or lifting device and center of gravity is known. **(T-0)**

12.11.3.8.5. Tag lines will be attached to a lifted load for purposes of controlling load spinning and pendular motions or used to stabilize a bucket or magnet during material handling operations. **(T-0)**

12.11.3.9. Hoisting the load. Ensure that:

12.11.3.9.1. Hoist ropes or chains are not twisted about each other. **(T-0)**

12.11.3.9.2. The load does not contact any obstruction. **(T-0)**

12.11.3.9.3. Ropes or chains are protected against sharp edges of the load. **(T-0)**

12.11.3.10. The rope or chain will be properly seated on the drum sheaves or sprockets before starting the lift. **(T-0)** Hoists will not be operated until the hoist unit is centered over the load. **(T-0)**

12.11.3.11. A hoist will not be used for hoisting personnel unless specifically designed for this purpose and only if it is the safest means of accomplishing the work. **(T-0)** Loads will not be carried over personnel. **(T-0)**

12.11.3.12. The operator will 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. **(T-0)** The lift will be continued only after ensuring the braking system is operating properly. **(T-0)**

12.11.3.13. The operator will not leave their position at the controls with a load suspended. **(T-0)**

12.11.3.14. If a load must remain suspended for a considerable time, a pawl, or other equivalent means, rather than the brake alone, will be used to hold the load. **(T-0)** An operator will be at the controls while the load is suspended. **(T-0)**

12.11.3.15. Excessive jogging or inching (rapid, repeated starts and stops) of hoist controls will be avoided. **(T-0)** Premature wear or possible uncontrolled movement could occur.

12.11.4. Maintenance.

12.11.4.1. Preventive Maintenance. The using organization will establish a preventive maintenance program based on the manufacturer's recommendations. **(T-1)** If manufacturer's instructions cannot be obtained, the using organization will contact the DAF equipment item manager for assistance. **(T-1)** Preventive maintenance will be documented IAW **Chapter 12.2.1,** as appropriate. **(T-1)**

12.11.4.2. Lubrication. All moving parts of the hoist for which lubrication is specified will be regularly lubricated. **(T-0)** Manufacturer's or TO recommendations for points and frequency of lubrication and quantity and type of lubricant to be used will be followed. **(T-0)** Machinery will be stationary, with energy sources locked out, while lubricants are applied. **(T-0)**

12.11.4.3. Rope Replacement and Maintenance. Items requiring replacement or maintenance will be IAW technical data, manufacturer's instructions. Additional information can be found in ASME B30.

12.11.4.4. Adjustments and Repairs. Repair, replacements, or adjustments will be made as necessary to ensure correct performance of all hoist components. **(T-0)**

12.11.4.4.1. Replace all worn braking components such as friction discs, ratchets, pawls, and pawl springs. **(T-0)**

12.11.4.4.2. Replace worn, corroded, or otherwise damaged load chain and rope. **(T-0)**

12.11.4.4.3. Replace hooks showing defects. Repair or replace damaged hook safety latches. **(T-0)**

12.11.4.4.4. Replace load supporting components which are cracked, bent, or excessively worn. **(T-0)**

12.11.4.4.5. Replace missing or illegible warning labels. **(T-0)**

12.11.4.4.6. Replace pitted or burned electrical contacts in sets only. **(T-0)** Lubricate controller parts as recommended by the manufacturer. **(T-0)**

12.11.4.4.7. Keep pendant control stations clean and functions labels legible. **(T-0)**

12.11.4.4.8. Adjust all functional operating mechanisms, brakes and pawls, limit switches and other limiting devices to ensure correct functioning. **(T-0)**

12.11.4.5. Maintenance Procedures. The following precautions will be taken before adjustments or repairs are started on a hoist:

12.11.4.5.1. Use of lockout device(s) and AF Form 983 will be placed on the hoist and all energy controls (air, electrical, hydraulic, etc.) IAW **Chapter 21** hazardous energy control requirements when adjustments, modifications, or repairs are scheduled. **(T-0)**

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. Refer to **Chapter 21** for additional guidance. **(T-0)**

12.11.4.5.2. Drum pawls will be engaged, or other means provided to prevent load ropes from inadvertently rotating the mechanism. **(T-0)**

12.12. Below-the-Hook Devices.

12.12.1. All below-the-hook devices, defined as the devices used to attach a load to the hook of a hoist, such as slings and other rigging will be inspected, used and maintained IAW manufacturer requirements. **(T-1)** Refer to ANSI/ASME B30.20, *Below-the-Hook Lifting Devices,* for additional information.

12.12.2. Slings. Refer to 29 CFR § 1910.184 and ASME B30.9 for additional guidance. Note: Locally manufactured slings that do not meet the engineering requirements of ASME B30.9 are prohibited and will be disassembled and removed from service. **(T-1) Note**: Written proof test certification is not required for new synthetic rope slings manufactured IAW ASME B30.9 and not used to lift nuclear or critical loads. **(T-1)**

12.12.2.1. DAF primarily uses four types of slings: ally steel chain, wire rope, metal mesh and synthetic web slings. **Note**: Refer to OSHA's Guidance on Safe Sling Use located at: **https://www.osha.gov/dsg/guidance/slings/tables-figures.html**, for guidance on other types of slings. Refer to ASME B30.9 for additional information.

12.12.2.2. Ensure manufacturers certify that the required markings and identifications for each type of sling are provided. Refer to ASME B30.9 for additional information.

12.12.2.3. Prior to use, each new, repaired or reconditioned alloy steel chain sling, including all welded components in the sling assembly, will be proof tested by the manufacturer or equivalent entity and certificate of proof test maintained and available for inspection. **(T-0)** Periodic load testing will only be accomplished with written permission and procedural guidance from the sling manufacturer or equivalent, e.g., the specific equipment TO or the item manager for locally manufactured equipment. **(T-1)**

12.12.2.4. Specific Requirements.

12.12.2.4.1. Alloy Steel Chain Slings.

12.12.2.4.1.1. Prior to use, all new, repaired, or reconditioned alloy steel chain slings, including all welded components in the sling assembly will be proof tested by the sling manufacturer or equivalent entity to certify capacity. The employer will retain a copy of the manufacturers certificate of the proof test and will make it available for examination. **(T-0)**

12.12.2.4.1.2. For multiple leg slings, each leg will be proof tested by the sling manufacturer or equivalent entity and certifying compliance with ASTM Specifications A391-65. **(T-0)**

12.12.2.4.1.3. Master links and master coupling links for double or triple leg slings will be proof tested by the sling manufacturer or equivalent entity and certifying compliance with ASTM Specification A391-65. **(T-0)**

12.12.2.4.1.4. Hooks, rings, oblong or pear-shaped links, welded or mechanical

coupling links or other attachments will have a rated capacity at least equal to that of the alloy steel chain with which they are used. **(T-0)** The sling will not be proof tested more than the rated capacity of the weakest component. **(T-0)**

12.12.2.4.1.5. Unauthorized makeshift links or fasteners, such as those formed from bolts or rods, will not be used. **(T-0)**

12.12.2.4.1.6. Alloy steel chain slings will not be used with loads more than the rated capacities. **(T-0)**

12.12.2.4.1.7. Worn or damaged alloy steel chain slings and attachments will not be used until repaired (or reconditioned) and proof tested by the manufacturer or equivalent entity. **(T-0)**

12.12.2.4.1.8. Mechanical coupling links or low carbon steel repair links will not be used to repair broken lengths of chain. **(T-0)**

12.12.2.4.1.9. If the chain size at any point of any link is less than that stated in **Table 12.6** the sling will be removed from service. **(T-0)**

12.12.2.4.1.10. Alloy steel chain slings with cracked or deformed master links, coupling links, or other components will be removed from service. **(T-0)**

12.12.2.4.1.11. 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 5 percent, not to exceed ¼ inch (or as recommended by the manufacturer), or any wear exceeding 10 percent (or as recommended by the manufacturer) or the original manufacturer or baseline section dimension of the hook. **(T-0)**

12.12.2.5. Wire Rope Slings.

12.12.2.5.1. Prior to initial use, all new wire rope slings will be proof tested by the manufacturer or equivalent entity. **(T-0)** The certificate provided by the manufacturer will be kept on file for review. **(T-0)**

12.12.2.5.2. Wire rope slings will not be used with loads exceeding capacities. **(T-0)**

12.12.2.5.2.1. Cable laid and 6 x 19 and 6 x 37 slings will have a minimum clear length of wire rope between splices, sleeves, or end fittings 10 times the component rope diameter. **(T-0)**

12.12.2.5.3. Braided slings will have a minimum clear length of wire rope between loops or end fittings 40 times the component rope diameter. **(T-0)**

12.12.2.5.4. Cable laid grommets, strand laid grommets, and endless slings will have a minimum circumferential length of 96 times their body diameter. **(T-0)**

12.12.2.5.5. Fiber core wire rope slings of all grades will be permanently removed from service if exposed to temperatures more than 200° F. **(T-0)** When non-fiber core wire rope slings of any grade are used above 400° F or below -60° F, sling manufacturer recommendations regarding use at that temperature will be followed. **(T-0)**

12.12.2.5.6. Welding of end attachments, except covers to thimbles, will be welded before the sling is assembled. **(T-0)**

12.12.2.5.7. Welded end attachments will be proof tested at twice their capacity by the manufacturer or equivalent entity prior to use. **(T-0)** The owning agency will maintain a record or certificate of proof test and make it available for inspection. **(T-0)**

12.12.2.5.8. Wire rope slings will be removed from service if any of the following conditions are present: **(T-0)**

12.12.2.5.8.1. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay. **(T-0)**

12.12.2.5.8.2. Wear or scraping of a third (1/3) of the original diameter of outside individual wires. **(T-0)**

12.12.2.5.8.3. Kinking, crushing, bird caging or any other damage that distorts the wire rope structure. **(T-0)**

12.12.2.5.8.4. Evidence of heat damage. **(T-0)**

12.12.2.5.8.5. Cracked, deformed, or worn end attachments. **(T-0)**

12.12.2.5.9. Sling hooks that have any visibly apparent bend or twist from the plane of the unbent hook (using original manufacturer or baseline measurements), any distortion causing an increase in throat opening of 5 percent, not to exceed 1/4 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. **(T-1)**

12.12.2.5.10. Corrosion of rope or end attachments. **(T-0)**

12.12.2.5.11. Only new ropes will be used to fabricate slings. **(T-0)** Use of repaired or reconditioned rope is prohibited. **(T-0)**

12.12.2.5.12. Slings used in a choker hitch will be long enough, so the choke point is on the rope and never on a splice. **(T-0)**

12.12.2.6. Metal Mesh Slings.

12.12.2.6.1. All new and repaired metal mesh slings, including handles, will be proof tested at a minimum of 150 percent of their rated capacity before use. **(T-0)** Elastomer impregnated slings will be proof tested before they are coated. **(T-0)**

12.12.2.6.2. Handles will have a rated capacity at least equal to the metal fabric and exhibit no deformation after proof testing. **(T-0)**

12.12.2.6.3. The fabric and handles will be joined so that:

12.12.2.6.3.1. The rated capacity of the sling is not reduced. **(T-0)**

12.12.2.6.3.2. The load is evenly distributed across the width of the fabric. **(T-0)**

12.12.2.6.3.3. Sharp edges will not damage the fabric. **(T-0)**

12.12.2.6.3.4. Coatings which damage the sling and diminish the rated capacity will not be applied. **(T-0)**

12.12.2.6.4. Except for required proof tests, metal mesh slings will not be used to lift loads exceeding their rated capacities. **(T-0)**

12.12.2.6.5. Metal mesh slings not impregnated with elastomers may be used from minus 20° F to 550° F without decreasing the working load limit. **(T-0)** Metal mesh slings impregnated with polyvinyl chloride or neoprene may be used only from 0° F to 200° F. **(T-0)** For operations outside these temperature ranges or for metal mesh slings impregnated with other materials, the sling manufacturer's recommendations will be followed. **(T-0)**

12.12.2.6.6. Metal mesh slings will be removed from service if any of the following conditions are present:

12.12.2.6.6.1. Broken weld or broken brazed joint along the sling edge. **(T-0)**

12.12.2.6.6.2. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion. **(T-0)**

12.12.2.6.6.3. Lack of flexibility due to distortion of the fabric. **(T-0)**

12.12.2.6.6.4. Distortion of the female handle so slot depth is increased more than 10 percent. **(T-0)**

12.12.2.6.6.5. Distortion of either handle so width is decreased more than 10 percent. **(T-0)**

12.12.2.6.6.6. Reduction of 15 percent of the original cross-sectional area of metal at any point around the handle eye. **(T-0)**

12.12.2.6.6.7. Distortion of either handle out of its plane. **(T-0)**

12.12.2.6.6.8. Cracked end fitting. **(T-0)**

12.12.2.6.6.9. A broken wire in any part of the mesh. **(T-0)**

12.12.2.7. Synthetic Web Slings.

12.12.2.7.1. Prior to use, all new and repaired synthetic web slings will be proof tested to twice their rated capacity by the manufacturer or equivalent entity. A copy of the manufacturer certification will be maintained for inspection. N**ote:** Written proof test certification is not required for new synthetic rope slings certified by the manufacturer to meet ASME B30.9 and not used to lift nuclear or critical loads. **(T-0)**

12.12.2.7.2. Synthetic webbing will be of uniform thickness and width, and selvage edges will not be split from the webbing's width. **(T-0)**

12.12.2.7.3. Fittings will be:

12.12.2.7.3.1. Of a minimum breaking strength equal to that of the sling. **(T-0)**

12.12.2.7.3.2. Free of all sharp edges that could damage the webbing. **(T-0)**

12.12.2.7.4. Stitching will be the only method used to attach end fittings to webbing and to form eyes. **(T-0)** The thread will have an even pattern and contain enough stitches to develop the full breaking strength of the sling. **(T-0)**

12.12.2.7.5. Except for required proof tests, synthetic web slings will not be used with loads exceeding the specified rated capacities IAW manufacturer's requirements and as found in Tables **12.2 – 12.4**. **(T-0)**

12.12.2.7.6. When synthetic web slings are used, the following precautions will be taken:

12.12.2.7.6.1. Nylon web slings will not be used where acid or phenolic fumes, vapors, sprays, mists, or liquids are present. **(T-0)**

12.12.2.7.6.2. Polyester and polypropylene web slings will not be used where caustic fumes, vapors, sprays, mists, or liquids of acids are present. **(T-0)**

12.12.2.7.6.3. Web slings with aluminum fittings will not be used where caustic fumes, vapors, sprays, mists, or liquids are present. **(T-0)**

12.12.2.7.6.4. Synthetic web slings of polyester and nylon will not be used at temperatures exceeding 180° F. Polypropylene web slings will not be used at temperatures more than 200° F. **(T-0)**

12.12.2.7.6.5. Slings, including webbing and fittings, with temporary or makeshift repairs will not be used. **(T-0)**

12.12.2.7.6.6. Synthetic web slings will be removed from service if any of the following conditions are present:

12.12.2.7.6.6.1. Damage from acid or caustic materials. **(T-0)**

12.12.2.7.6.6.2. Melting or charring of any part of sling surface. **(T-0)**

12.12.2.7.6.6.3. Snags, punctures, tears, or cuts. **(T-0)**

12.12.2.7.6.6.4. Broken or worn stitches. **(T-0)**

12.12.2.7.6.6.5. Distortion of fittings. **(T-0)**

12.12.2.7.6.7. When not in use, slings will be stored in clean, dry areas that will protect the sling materials. **(T-0)**

12.13. 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 12.11** are applicable in this chapter. Hoist requirements of this chapter also apply to hoists used as components of cranes or monorail systems.

12.13.1. Acquisition.

12.13.1.1. All new overhead and gantry cranes constructed and installed on or after 31 August 1971 will be certified by the manufacturer to meet ASME B30.2, *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist),* and ASME B30.11, *Monorails and Underhung Cranes.* Cranes constructed before 31 August 1971 will 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. **(T-0)** Contracts for

procurements of overhead and gantry cranes will 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. **(T-1) Note:** Nuclear-certified hoists must also meet requirements in DAFMAN 91-118. **(T-1)**

12.13.1.2. Hazards will be identified by a system safety analysis, MIL-STD-882E, *DoD Standard Practice for System Safety,* or commercial equivalent. **(T-1)** The procuring activity will specify the required analyses, such as preliminary hazard analysis or operating hazard analysis. **(T-1)** The results of these analyses will be included in applicable contract deliverable documents. **(T-1)**

12.13.2. General.

12.13.2.1. 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 new rated capacity will be displayed on the crane or hoist. **(T-0)**

12.13.2.2. The rated capacity of the crane will be plainly marked on each side of the crane. **(T-0)** If the crane has more than one hoisting unit, each unit will have its rated capacity marked on it or its load block, and this marking will be clearly visible from the floor or ground. **(T-0)**

12.13.2.3. A minimum clearance of three inches overhead and two inches laterally will be maintained between crane and obstructions. **(T-0)**

12.13.2.4. Where passageways or walkways are provided, obstructions will not be placed so the safety of personnel is jeopardized by movements of the crane. **(T-0)**

12.13.2.5. The general arrangement of the cab and location of control and protective equipment will 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. **(T-0)** The arrangement will allow the operator a full view of the load hook in all positions. **(T-0)**

12.13.2.6. Pendant and cab hoist controls for trolley and bridge movement will use compass points (north, south, east, and west) as the preferred identification. **(T-0)**

12.13.2.7. Hoists utilizing synchronous controls for multiple point lifting movements will be of failsafe design to preclude inadvertent operation caused by malfunctions of selector switches, power failure, or improper sequencing of controls. **(T-0)**

12.13.2.8. Access to the cab and bridge walkway will be by a conveniently placed fixed ladder, stairs, or platform requiring no step over any gap exceeding 12 inches. **(T-0)** Fixed ladders will be designed and installed IAW 29 CFR § 1910.27, *Fixed Ladders.* **(T-0)** Also, refer to **Chapter 7**, *Walking – Working Surfaces,* for specific ladder requirements.

12.13.2.9. A carbon dioxide or dry chemical (or equivalent) fire extinguisher rated at least 10 BC will be kept in the cab. **(T-0)**

12.13.2.10. Pendant control boxes and fixed control stations will be constructed to prevent electrical shock and be clearly and legibly marked for identification of functions. **(T-0)**

12.13.2.11. Except for floor-operated cranes, a gong, buzzer, or other effective warning signal will be provided for each power traveling crane. **(T-0)**

12.13.2.12. The hoist of all electric traveling cranes will have an over-travel limit switch in the hoisting direction. **(T-0)**

12.13.2.13. Emergency descent means will be provided on all crane cabs. **(T-0)** Rope hand line is not acceptable. Only approved controlled descent devices will be used. **(T-0)**

12.13.2.14. Crane operators will not be placed in situations dangerous to life, health or which may pose safety hazards. **(T-0)**

12.13.2.15. Lift eyes or lift points used to attach slings, clevis, shackles, or hooks will be constructed of forged or alloy steel. **(T-0)** Rebar steel will not be permitted as attach points for any load. **(T-0)**

12.13.2.16. Monorails Hoists. Monorail hoists will not be used to move objects by pulling sideways, unless designed for that purpose. **(T-0)** Each trolley fame will be safeguarded against spreading. **(T-0)** Monorail track and track supports will be installed IAW manufacturer's installation specifications and capable of safely carrying intended loads. **(T-0)** Rail stops will be provided at ends of the monorail track and will extend at least as high as the radius of the wheels. **(T-0)** At switches, turntables and transfer tables, automatic bumpers will drop into position to prevent the trolley running off open ends of fixed and movable track if not properly lined up with each other. **(T-0)** Conversely, the track will be interlocked with the bumpers so the track cannot move until rail stops are in position. **(T-0)**

12.13.3. Cab Operated and Pulpit Operated Equipment.

12.13.3.1. Safe Operations.

12.13.3.1.1. Equipment will be operated only by a qualified person, trainees under the direct supervision of a qualified person, or maintenance and test personnel, when necessary to perform duties. **(T-0)**

12.13.3.1.2. Operators will continue to demonstrate the skills and knowledge, as well as the ability to recognize and avert risk, necessary to operate the equipment safely, including those specific to the safety devices, operational aids, software, and the size and configuration of the equipment. **(T-0)**

12.13.3.1.3. Operators will demonstrate the continued ability to perform the hoisting activities required for assigned work, including, if applicable, blind lifts, personnel hoisting, and multi-crane lifts. **(T-0)**

12.13.3.2. Equipment will only be operated by:

12.13.3.2.1. Persons qualified to do so. **(T-0)**

12.13.3.2.2. Trainees under the direct supervision of a qualified instructor. **(T-0)**

12.13.3.2.3. Maintenance and test personnel when it is necessary in performance of their duties. **(T-0)**

12.13.3.2.4. Qualified inspectors. **(T-0)**

12.13.3.2.5. 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. **(T-0)**

12.13.4. Floor-Operated Equipment. Equipment will only be operated by:

12.13.4.1. A qualified person. **(T-0)**

12.13.4.2. Trainees under the direct supervision of a qualified person. **(T-0)**

12.13.4.3. Maintenance and test personnel when it is necessary in the performance of their duties. **(T-0)**

12.13.4.4. Qualified inspectors. **(T-0)**

12.13.5. Operating Practices.

12.13.5.1. Operators must not divert their attention while engaged in operating the equipment. **(T-0)**

12.13.5.2. An operator will not operate equipment when physically or mentally unfit. **(T-0)**

12.13.5.3. The operator will respond to signals only from the person directing the lift or a designated signal person and must obey all stop signals. **(T-0)**

12.13.5.4. Each operator will be held directly responsible for the safe operation of the equipment. **(T-1)** When safety is in doubt, the operator will stop and refuse to handle loads until safety has been ensured. **(T-1)**

12.13.5.5. A warning signal will be sounded each time before traveling and intermittently during travel, particularly when approaching personnel. **(T-0)**

12.13.5.6. 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. **(T-0)**

12.13.5.7. 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. **(T-0)** 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 will remove it as prescribed in **Chapter 21,** *Hazardous Energy Control (Lockout and Tagout).* **(T-0)**

12.13.5.8. Before closing the main switch, the operator will ensure all controllers are in the "OFF" position. **(T-0)**

12.13.5.9. If power goes off during operation, the operator will immediately move all controllers to the "OFF" position. **(T-0)**

12.13.5.10. The operator will be familiar with the equipment and its proper care. **(T-1)** If adjustments or repairs are necessary (or any damage is observed) the operator will report it promptly to the appointed person and notify the next operator of the deficiencies when changing shifts. **(T-1)** The results of the above will be carefully recorded in the logbook, in full detail, and will be dated and signed. **(T-1)**

12.13.5.11. Contacts with stops or other equipment will be made with extreme caution and only after all persons on or below equipment are aware of the action. **(T-1)**

12.13.5.12. Before departing the work area, operators of outdoor cranes will secure them to prevent inadvertent movement. **(T-0)**

12.13.5.13. When a wind-indicating alarm is given, the bridge on outside cranes will be anchored. **(T-0)**

12.13.5.14. Before performing any maintenance work, the operator or maintainer will lock the main switch in the open position. **(T-0)** Refer to **Chapter 21** for assistance in developing hazardous energy control procedures.

12.13.5.15. All controls will be tested by the operator when beginning a new shift except when an operation is in progress. **(T-0)** If any controls do not operate properly, they will be adjusted or repaired before operations begin. **(T-0)**

12.13.6. Handling the Load.

12.13.6.1. Equipment will not be loaded beyond rated capacity except for tests IAW **paragraph 12.7**. **(T-1)**

12.13.6.2. When attaching the load, ensure:

12.13.6.2.1. Hoist chain or hoist rope is free from kinks or twists and not wrapped around the load. **(T-0)**

12.13.6.2.2. Load is attached to load hook by below-the-hook devices. **(T-0)**

12.13.6.2.3. Care is taken to ensure sling clears all obstacles. **(T-0)**

12.13.6.2.4. Ensure below-the-hook devices are seated properly in the hook saddle before operation. **(T-0)**

12.13.7. When moving the load:

12.13.7.1. Appointed person directing the lift will ensure the load is secured and properly balanced in the below-the-hook lifting device before lifting more than a few inches. **(T-0)**

12.13.7.2. Before starting to lift, check that:

12.13.7.2.1. Hoist rope or chain is not kinked or twisted. **(T-0)**

12.13.7.2.2. Multiple part lines are not twisted around each other. **(T-0)**

12.13.7.2.3. The hook is brought over the load in a way that prevents swinging. **(T-0)**

12.13.7.2.4. The rope is seated in drum grooves and sheaves if there is or has been a slack rope condition. **(T-0)**

12.13.7.3. Tag lines will be used on all free-swinging loads. **(T-0)**

12.13.7.4. During hoisting, care will be taken that:

12.13.7.4.1. There is no sudden acceleration or deceleration of the moving load. **(T-0)**

12.13.7.4.2. Load does not contact any obstructions. **(T-0)**

12.13.7.4.3. Equipment is not used for side pulls except when specifically authorized by a person qualified to make that decision and who has determined the suitability of the equipment. **(T-0)**

12.13.7.5. 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/FLDCOM, DRU or FOA, and so indicated on a permanent name plate attached to the hoist. **(T-0)** Refer to 29 CFR § 1926.1400, *Cranes and Derricks in Construction,* for additional guidance.

12.13.7.6. The operator does not carry loads over personnel. **(T-0)**

12.13.7.7. The operator tests the brakes each time a load is handled by raising the load two inches above floor or ground level and applying for brakes. **(T-0)**

12.13.7.8. The load is not lowered beyond two full wraps of rope remain on the hoisting drum. **(T-0) Exception:** One wrap may remain on drum if a lower limit device is provided.

12.13.7.9. When two or more cranes are used to lift one load, one designated person will be responsible for the operation. **(T-0)** That designated person will analyze the operation and instruct all personnel involved in proper positioning, rigging of load and movements to be made. **(T-0)**

12.13.7.10. The operator will not leave their position at the controls while the load is suspended. **(T-0)**

12.13.7.11. A warning signal will be given when starting the equipment and when the load or hook approaches near personnel. **(T-0)**

12.13.7.12. Appropriate clearance will be maintained between electrical power sources and any part of the crane. **(T-0)**

12.13.8. Signals and Instruction. Signals to the operator will be IAW **Figure 12.1** and **Figure 12.2** and be conspicuously posted on or immediately near all cranes **(T-0)** Voice communication equipment (telephone, radio or equivalent) will be fully operational when used. **(T-0)** Signals and instructions will always be distinct. **(T-0)**

12.13.9. Miscellaneous Requirements.

12.13.9.1. Ladders and Footwalks.

12.13.9.1.1. Employees will keep hands unencumbered while using ladders. **(T-0)**

12.13.9.1.2. Articles too large to be carried in pockets or belts will be lifted and lowered by hand line. **(T-0)**

12.13.9.1.3. Footwalks will be kept free of loose tools, parts, or other tripping hazards. **(T-0)**

12.13.9.2. Cabs.

12.13.9.2.1. Necessary clothing and personal belongings will be stored so they do not interfere with access or operation. **(T-0)**

12.13.9.2.2. Tools will be stored in approved toolboxes. **(T-0)** Wastes will be disposed of in appropriate containers. **(T-0)** No loose articles will be left in or about the cab. **(T-0)**

12.13.9.2.3. Fire Extinguishers. Supervisors will ensure operators are familiar with the operation and care of fire extinguishers provided. **(T-0)**

12.14. Mobile and Locomotive Cranes. All crawler, locomotive, and truck cranes will be certified by the manufacturer to meet design specifications, characteristics and rules of ASME B30.5, *Mobile and Locomotive Cranes.* **(T-1)**

12.14.1. Specific Requirements.

12.14.1.1. A substantial and durable rating chart with clearly legible letters and figures will be securely fixed to the crane cab in a location easily visible to the operator while seated at the control station. **(T-0)** A duplicate load rating chart (legible from the ground) will also be provided on the outside of the crane. **(T-0)** The load rating chart for truck cranes will list loads for the crane operating both with and without counterweights. **(T-0)**

12.14.1.2. Two-Blocking Prevention. A two-blocking damage preventive feature will 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. **(T-0)**

12.14.1.3. Boom Angle Indicator. A boom angle indicator will be provided on all cranes. **(T-0)**

12.14.1.4. 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. The user must evaluate anticipated use of the crane to determine the need for such a device. **(T-0)**

12.14.1.5. Color Coding for Strike Hazard. Parts of crane cabs that extend beyond the main chassis when rotated will be color coded yellow and black on the lower areas to highlight the strike hazard to ground personnel. **(T-0)** Colors will be reflective for night operations. **(T-0)**

12.14.1.6. Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets and reciprocating parts will be guarded, as they may create a hazard to personnel. **(T-0)**

12.14.1.7. Some crane hazards, such as rotating equipment or holes, cannot be mechanically safeguarded, a risk assessment will be conducted by supervision to evaluate other means of protecting employees from identified hazards. **(T-1)** (**Note:** Contact the occupational safety office for assistance.) Personnel will follow manufacturers' requirements and identified controls resulting from risk assessment and exercise care when exposed to unguarded rotating equipment or holes. **(T-1)** Such conditions will be clearly marked with appropriate warning decals. **(T-0)**

12.14.1.8. Cranes will be designed to protect operators from falling objects, swinging loads and cable failures. **(T-0)** Cranes must only be operated under weather conditions that are determined to ensure safe operation. **(T-0)**

12.14.1.9. An audible warning device will be provided when hoisting operations or moving equipment might endanger personnel in the work area. **(T-0)** The device control will be within easy reach of the operator. **(T-0)**

12.14.1.9.1. Warning sign. A permanent sign will be posted in the crane cab in full view of the operator. **(T-0)** This sign will read, "DANGER HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Lines." **(T-0)**

12.14.1.9.2. Night Operations. Cranes operated during darkness will have clearance lights installed. **(T-1)** Working areas will be illuminated so the designated signal person, loads, rigging, obstructions, etc., are readily visible. **(T-0)**

12.14.2. Safe Operating Practices.

12.14.2.1. The operator will sound or give an audible warning signal each time before traveling (backing), and when approaching employees or other congested areas. **(T-1)** The signal may be mechanical (automatic) or oral.

12.14.2.2. 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. **(T-1)**

12.14.2.3. Operators must be familiar with the equipment and its proper care. **(T-0)** If adjustments or repairs are necessary or any damage is known, the operator will report them promptly to the supervisor and document them IAW **paragraph 12.2.1,** as appropriate. **(T-1)**

12.14.2.4. All controls will be tested by the operator at the start of a new shift. **(T-0)** Controls that do not operate properly will be adjusted or repaired before continuing operation. **(T-0)** No crane will be loaded beyond its rated capacity, except for test purposes. **(T-0)**

12.14.2.5. Weight of all loads will be determined before lifting. **(T-1)**

12.14.2.6. The crane will not be operated while anyone is on the load or hook. **(T-0)**

12.14.2.7. The operator will not carry or swing load over personnel. **(T-0)**

12.14.2.8. On truck mounted cranes, loads will not be lifted over the front area of the truck unless specifically allowed by manufacturer's operating instructions. **(T-1)**

12.14.2.9. When two or more cranes are used to lift one load, one designated person will be responsible for the operation. **(T-0)** They will analyze the operation and instruct all personnel involved in proper positioning, rigging the load, and movements to be made. **(T-0)**

12.14.2.10. A designated supervisor will be responsible for determining and controlling safety before traveling a crane with a load. **(T-0)** Decisions such as position of load, boom location, ground support, travel route and speed of movement will be IAW their determination. **(T-0)** Specified tire pressures will be maintained. **(T-0)** The boom will be carried in line with the direction of motion, sudden starts, and stops will be avoided and tag or restraint lines will be used to minimize swinging of the load. **(T-0)**

12.14.2.11. All crawler, locomotive and truck cranes will operate on surfaces which will support the weight of the crane and the weight of the loads without supporting surfaces collapsing or slipping away from the crawlers, wheels, and support stanchions. **(T-1)**

12.14.2.12. Outriggers will be used when the load at a particular radius exceeds the rated load without outriggers as provided by the crane manufacturer. **(T-0)** When floats are used, they will be securely attached to outriggers. **(T-0)** Wood blocks used to support outriggers will be strong enough to prevent crushing, free of defects and of sufficient size to prevent shifting or toppling of the crane under load. **(T-0)**

12.14.2.13. Before any crane is moved to a new job site, the route of travel will be checked to determine that adequate clearances exist along the entire route. **(T-0)** This survey will be conducted by the vehicle heavy equipment supervisor and crane operator. **(T-1)** The empty hook will be secured to prohibit swinging, and the boom will be lowered to the boom rest or travel position. **(T-0)** A red cloth or warning flag, at least 12 inches square, or a warning light will be carried at the end of any boom that extends more than 4 feet beyond the truck platform. **(T-0)** At night or during periods of reduced visibility, a warning light will be used. **(T-0)** The superstructure will be secured to prohibit rotation except when there is an operator in the cab to ensure proper boom clearances around tight spots and corners. **(T-0)** Additional vehicles will be used to warn other motorists if the crane boom or wide load poses a hazard to the front or rear. **(T-0)**

12.14.3. Maintenance.

12.14.3.1. The Vehicle Fleet Manager or Vehicle Management Superintendent will establish a preventive maintenance program based on this publication and crane manufacturers' instructions. **(T-1)**

12.14.3.2. After adjustments and repairs have been made, the crane will not be operated until all guards have been reinstalled, trapped air removed from hydraulic system, safety devices reactivated, and maintenance equipment removed. **(T-0)** Adjustments to operating mechanisms, safety devices, control systems and power plants will be maintained to ensure correct functioning. **(T-1)**

12.14.3.3. All replacement parts or repairs will have at least the original manufacturer's design safety factor. **(T-0)**

12.14.3.4. Lubrication. All moving parts of the crane, where lubrication is specified, will be regularly lubricated IAW manufacturer's instructions or TO procedures as to points and frequency of lubrication, maintenance of lubricant levels and types of lubricant. **(T-0)** Cranes not equipped for automatic or remote lubrication will 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. **(T-0)**

12.15. Derricks. Refer to 29 CFR § 1910.181, *Derricks,* and 29 CFR § 1926.1436, *Derricks,* for guidance and information.

12.16. Related Hoisting Equipment.

12.16.1. Wire ropes, chains and hooks associated with cranes, hoists and other types of lifting equipment will be thoroughly inspected IAW **paragraph 12.4.4**. **(T-0)** Inspection for each item will be documented IAW **paragraph 12.2.1**. **(T-1)** For routine and preventative

maintenance on wire ropes, chains, sheaves, equalizers, and other related equipment, refer to applicable manufacturer documentation and OSHA requirements. Refer to ASME B30-series standards for additional information.

12.16.2. Wire Ropes.

12.16.2.1. Use and attachment considerations.

12.16.2.2. The rope or crane manufacturer's recommendation will be followed when hoisting ropes are used. **(T-0)**

12.16.2.3. Socketing will be done as specified by the assembly manufacturer. **(T-0)**

12.16.2.4. Swaged or compressed fittings will be applied as recommended by the rope or crane manufacturer. **(T-0)**

12.16.2.5. Rope will be secured to the drum as follows:

12.16.2.5.1. Not less than two wraps of rope will remain on the drum when the hook is in its extreme lowest position. **(T-0)**

12.16.2.5.2. The rope end will be anchored by a clamp securely attached to the drum or by a socket arrangement approved by the crane or rope manufacturer. **(T-0)**

12.16.2.5.3. If the crane is dual reeved with the rope terminated at the equalizer, the termination fitting will be rated to develop 100 percent of the rope strength. **(T-0)**

12.16.3. Rope clips attached with U-bolts will have the U-bolts on the dead or short end of the rope. **(T-0)** Spacing and number of clips will follow the clip manufacturer's recommendation. **(T-0)** Clips will be drop-forged steel in all sizes manufactured commercially. **(T-0)** When a newly installed rope has been in operation for an hour, all nuts on the clip bolts will be retightened. **(T-0)** Refer to Figure **12.4** through **12.13** and **Table 12.5** for additional guidance.

12.16.4. Inspection.

12.16.4.1. Frequent. All running ropes in service will be visually inspected daily or prior to use and have the inspection documented per **paragraph 12.2.1,** which includes date of inspection, signature of inspector, an identifier for ropes inspected and rope condition. **(T-0)** Inspection will be kept on file by the supervisor for a minimum of one year and made readily available. **(T-0)** Sections of rope normally hidden or difficult to see during inspection or maintenance procedures, such as parts passing over equalizer sheaves, will be given close inspection, as these are points most likely to fail. **(T-0)** Any degradation in conditions described below could result in loss of original strength, will be carefully noted, and will be considered for rejection:

12.16.4.1.1. Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion or wear of outside wires. **(T-0)** Rope calipers and micrometers are normally used to determine changes in wire rope diameters. Refer to **Figure 12.9** for proper measurement technique.

12.16.4.1.2. Broken outside wires and the degree of distribution or connection of such broken wires. **(T-0)**

12.16.4.1.3. Worn outside wires. **(T-0)**

12.16.4.1.4. Corroded or broken wires at end connections. **(T-0)**

12.16.4.1.5. Corroded, cracked, bent, worn, or improperly applied end connections. **(T-0)**

12.16.4.1.6. Severe kinking, crushing, cutting, or un-stranding. **(T-0)**

12.16.4.2. Periodic Inspection. Recommended interval of periodic inspections will be determined by a person qualified to make that determination, based on such factors as expected rope life as determined by experience with the installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. **(T-0)** Inspections need not be at equal calendar intervals and will be more frequent as the rope approaches the end of its useful life. **(T-0)** This inspection will cover the rope's entire length and requirements of **paragraph 12.16.9.1** **(T-1)** Inspections will be documented as outlined in **paragraph 12.2.1**. **(T-1)** Refer to manufacturer's guidance for additional requirements. **Note**: When the rope's periodic inspection schedule falls within the periodic inspection schedule of the hoist, the rope inspection will be recorded on the periodic inspection documentation. **(T-1)**

12.16.4.3. All rope that is idle for a month or more due to shut down or storage of a hoist on which it is installed will be given a thorough inspection before placed in service. **(T-0)**

12.16.4.4. Maintenance.

12.16.4.5. Rope will be stored and handled in a manner which prevents damage or deterioration. **(T-0)**

12.16.4.6. Unreeling or uncoiling of rope will be done as recommended by rope manufacturer and with extreme care to avoid kinking or inducing twist. **(T-0)**

12.16.4.7. Before cutting a rope, seizing will be placed on each side of where the rope is to be cut to prevent unlaying of the strands. **(T-0)**

12.16.4.8. During installation, avoid dragging the rope in dirt or around objects which will scrape, nick, crush, or induce sharp bends in the rope. **(T-0)**

12.16.4.9. Rope will be maintained in a well-lubricated condition. **(T-0)** The object of rope lubrication is to reduce internal friction and to prevent corrosion. Lubricant applied as part of a maintenance program will be compatible with the original lubricant. **(T-0)** The rope manufacturer's technical guidance/instructions will be consulted. **(T-0)** Lubricant applied will not hinder visual inspection. **(T-0)** Sections of rope located over sheaves or that are 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.

12.16.4.10. An independent wire-rope or wire-strand core, or other temperature-damage resistant core, will be used wherever there is exposure to temperatures at which fiber cores would be damaged. **(T-0)**

12.16.4.11. Replacement rope will 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. **(T-0)**

12.16.4.12. Replacement:

12.16.4.12.1. Ropes will be removed from service and replaced when any of the following conditions exist:

12.16.4.12.1.1. In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay. **(T-0)**

12.16.4.12.1.2. One outer wire broke 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. **(T-0)**

12.16.4.12.1.3. Wear or scraping of 1/3 the original diameter of outside individual wires. **(T-0)**

12.16.4.12.1.4. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure. **(T-0)**

12.16.4.12.1.5. Evidence of any heat damage or corrosion. **(T-0)**

12.16.4.12.1.6. Reductions from nominal diameter of more than:

12.16.4.12.1.6.1. One-sixty-fourth (1/64) inch for diameters up to and including 5/16 inch.

12.16.4.12.1.6.2. One-thirty-second (1/32) inch for diameters 3/8 inch to and including one-half inch.

12.16.4.12.1.6.3. Three-sixty-fourths (3/64) inch for diameters 9/16 inch to and including three-fourths inch.

12.16.4.12.1.6.4. One-sixteenth (1/16) inch for diameters 7/8 inch to and including one and one-eighth inch.

12.16.4.12.1.6.5. Three-thirty-seconds (3/32) inch for diameters one and 1/4 inch to and including one and one-half inch.

12.16.4.12.1.6.6. In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

12.16.4.12.2. Special attention will be given to the end fastenings. **(T-0)** Ropes will be examined at socketed fittings and when two broken wires are found next to this point, the rope will be re-socketed. **(T-0)** Portions of the rope subjected to reverse bends and operation over small diameter sheaves or drums will be given close attention. **(T-0)**

12.16.4.12.3. A rope which has been in service, but idle for one month or more, will be thoroughly examined before being put back into service. **(T-0)** This examination will be for all types of deterioration, particularly corrosion, and will be performed by a designated person, whose approval will be required for further use of the rope. **(T-0)** The inspection will be documented per **paragraph 12.2.1**. **(T-1)**

12.16.4.12.4. All replacement rope will be of proper size, grade, and construction for its required function on the machine. **(T-0)** **Note**: Discarded or repaired rope will not be used for slings. **(T-0)**

12.16.4.12.5. A continuing inspection record will be maintained to establish a basis for judging when to replace wire rope. **(T-0)** This record will cover points of deterioration listed in paragraphs **12.16.9.12.1** and **12.16.9.12.2**.

12.16.4.13. Chains.

12.16.4.13.1. Welded Link Chain Inspection.

12.16.4.13.1.1. 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.

12.16.4.13.1.2. 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.

12.16.4.13.1.3. 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:

12.16.4.13.1.3.1. Select an unworn, unstretched length of the chain from the slack end.

12.16.4.13.1.3.2. 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.

12.16.4.13.1.3.3. 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.

12.16.4.13.1.3.4. 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 the center of the sprocket.

12.16.4.13.1.4. Inspect hoist chains, including end connections, for excessive wear, twist, and distorted links interfering with proper function or stretched beyond manufacturer's recommendations. A thorough inspection of all hoist chains will be made at least once each month. **(T-0)** 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 will be kept on file by the user for a minimum of one year and made readily available. **(T-0)**

12.16.4.13.1.5. When the chain is replaced, mating parts (chain sprockets, guides, stripper) will be disassembled and inspected for wear and replaced if necessary. **(T-0)**

12.16.4.13.1.6. For non-load bearing drive (slack) chains, inspect for cracks, weld

splatter, burrs, or other damage. Repair or replace as required.

12.16.4.13.2. Roller Link Chain Inspection.

12.16.4.13.2.1. 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.

12.16.4.13.2.2. If the 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.

12.16.4.13.2.3. If possible, inspect roller link chain while in the hoist. With hoist suspended in normal position, apply a light load of approximately 50 pounds.

12.16.4.13.2.3.1. 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.

12.16.4.13.2.3.2. Check the chain for twists. Replace the chain if the twist in any 5-foot section exceeds 15^{o}.

12.16.4.13.2.3.3. Check for camber. Replace chain which has a side bow exceeding 1/4-inch in any 5-foot section.

12.16.4.13.2.3.4. Inspect the chain more thoroughly by removing the chain from hoist and cleaning it thoroughly in an acid-free solvent. Then check for the following deficiencies:

12.16.4.13.2.3.4.1. Pins turned from their original position.

12.16.4.13.2.3.4.2. Rollers that do not turn freely with light finger pressure.

12.16.4.13.2.3.4.3. Joints that cannot be flexed by easy hand pressure.

12.16.4.13.2.3.4.4. Link plates that are spread open. A visual check of the pin extension at the free end of chain can determine the amount of spread and the condition of the chain.

12.16.4.13.2.3.4.5. Corrosion, pitting or discoloration of chain, which is generally indicative of serious impairment.

12.16.4.13.2.3.4.6. Gouges, nicks, or weld spatter.

12.16.4.13.3. Maintenance. All chains will be kept clean and free from rust, or any coating deposit build up and any change in dimensions or reduced flexibility. **(T-0)** Excessively dirty chains will be soaked in a clean acid-free solvent and agitated to ensure all joints are free from grit and foreign matter. **(T-0)** Hand chain normally needs no lubricant. Roller and load chain will be lubricated according to the hoist manufacturer's recommendations. **(T-1)** In absence of recommendations, the chain

may be lubricated with a good grade of SAE 20 or SAE 30 automotive motor oil. Grease will never be applied to a chain.

12.16.4.14. Sheaves and Equalizers.

12.16.4.14.1. Sheaves.

12.16.4.14.1.1. Sheave grooves will be smooth and free from surface defects which could cause rope damage. **(T-0)**

12.16.4.14.1.2. Sheave-carrying ropes, which can be momentarily unloaded, will be provided with close-fitting guards or other suitable devices to guide the rope back into the groove when the load is applied again. **(T-0) Note**: Equalizers where ropes are terminated will be specified to have sufficient adjustment space for block leveling as the rope stretches. **(T-0)**

12.16.4.14.1.3. Sheaves in the bottom block will be equipped with close-fitting guards to prevent ropes from fouling when the block is lying on the ground with loose ropes. **(T-0)**

12.16.4.14.1.4. Pockets and flanges of sheaves used with hoist chains will be sized so the chain does not catch or bind during operation. **(T-0)**

12.16.4.14.1.5. All running sheaves will be equipped with means for lubrication. **(T-0)** Permanently lubricated, sealed bearings meet this requirement.

12.16.4.14.1.6. When the chain is replaced, mating parts (chain sprockets, guides, stripper) will be disassembled, inspected for wear, and replaced if necessary.

12.16.4.14.2. Equalizers.

12.16.4.14.2.1. If a load is supported by more than one part of rope, the tension in the parts will be equalized. **(T-0)**

12.16.4.14.2.2. Equalizers will be readily accessible for maintenance, lubrication, and inspection. **(T-0)**

12.16.5. Hooks. Refer to manufacturer documentation for additional guidance and ASME B30.10, *Hooks*, for additional information.

12.16.5.1. Inspection.

12.16.5.1.1. Hooks will be examined for the following (See **Figure 12.3**.):

12.16.5.1.1.1. Distortion such as bending, twisting or increased throat opening. **(T-0)**

12.16.5.1.1.2. Any apparent bend or twist from the plane from the original measurements. **(T-0)**

12.16.5.1.1.3. Any wear exceeding 10 percent (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin. **(T-0)**

12.16.5.1.1.4. Any distortion causing an increase in throat opening of five percent, not to exceed ¼ inch (or as recommended by the manufacturer). **(T-0)**

12.16.5.1.1.5. Cracks, severe nicks, or gouges. **(T-0)**

12.16.5.1.1.6. 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. **(T-0)**

12.16.5.1.1.7. Hook attachment and securing means. Hook retaining nuts on collar and pins, welds or riveting will be used to secure the retaining member. **(T-0)**

12.16.5.2. Lubrication of swivel point. **(T-0)**

12.16.5.2.1. Hooks will not be painted. **(T-0)** Unless specifically permitted by TO or other technical guidance, DAF-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 will be replaced. **(T-0) Note**: Painted hooks will not be used on nuclear-certified hoists or lifting equipment or equipment used to lift critical loads. **(T-1) Note**: Hooks with protective coatings applied by the manufacturer that do not affect or interfere with NDI may be used in applications requiring hook NDI. **(T-1) Note**: Existing painted hooks may have the paint removed for NDI but may not be repainted unless authorized above.

12.16.5.2.2. Repairs by welding or reshaping are not recommended as a standard practice. If such repairs are attempted, they will only be accomplished by a person qualified to make such repairs, and the hook will be tested to the load requirements of the specific equipment in use. **(T-0) Note**: Hooks repaired by welding or reshaping are not authorized on nuclear-certified hoists or lifting equipment.

12.16.5.2.3. Rated capacity for a hook, when used as intended, will be equal to other suspension members to which it is attached. **(T-0)** When this is not feasible, special precautions will be taken to ensure the hook's rated capacity is not exceeded. **(T-0)**

12.16.5.2.4. Compliance should not preclude the possibility of consulting a person qualified to evaluate such compliance 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 such a person will not be to avoid contacting the manufacturer and obtaining the information supplied by the manufacturer. **(T-0)** Use of means to identify chains for tool control must meet manufacturer requirements and not change the load capacity. **(T-1)**

12.16.5.2.5. If manufacturer's data is not available and a person qualified to conduct an inspection cannot determine whether the hook is safe to use, the hook will be removed from service. **(T-0) Note**: The manufacturer's original specifications will be used as the baseline. **(T-1)** 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 person.

12.16.5.3. Intervals of Inspections. All hooks in service will be visually inspected daily or prior to use. **(T-0)** The inspection will be documented and maintained in accordance with **paragraph 12.2.1** **(T-1) Note**: If the hook is part of a hoist, the frequent inspection will be recorded on the hoist inspection documentation in accordance with **paragraph 12.2.1**. **(T-0)**

12.16.5.4. Where operations require removal or replacement of hooks and/or lifting fixtures, the lifting capacity of the hooks/lifting fixtures will 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. **(T-0)**

12.16.5.5. Hooks, rings, oblong or pear-shaped links, welded or mechanical coupling links or other attachments will have a rated capacity at least equal to that of the alloy steel chain with which they are used. **(T-0)** The sling will not be used more than the rated capacity of the weakest component. **(T-0)**

12.17. Portable Automotive Lifting Devices and Related Equipment.

12.17.1. Requirements. All personnel will observe all safety precautions in this chapter and those recommended by the manufacturers of portable automotive lifting devices. **(T-1)** Always read the owner's manual before operating portable automotive lifting devices. **(T-1)** 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.

12.17.2. Maintenance and Inspection.

12.17.2.1. Maintenance. The portable automotive lifting devices will be maintained IAW the manufacturer instructions. **(T-0)**

12.17.2.2. Inspection.

12.17.2.2.1. Visual inspection will be made before each use of portable automotive lifting devices by checking for abnormal conditions, such as cracked welds, leaks and damaged, loose, or missing parts. **(T-1)**

12.17.2.2.2. Other inspections will be made per product operating instructions. **(T-1)**

12.17.2.2.3. Each portable automotive lifting device will be inspected immediately if the lift is believed to have been subjected to abnormal load or shock. **(T-1)** It is recommended that this inspection be made by a manufacturer or supplier's authorized repair facility.

12.17.2.2.4. 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 portable automotive lifting device be made by a manufacturer or supplier's repair facility and that any defective parts, decals or safety labels or signs are replaced with manufacturer or supplier's specified parts. A list should be maintained of repair facilities that are available from the manufacturer or supplier to maintain for reference.

Table 12.1. Quick Reference Guide for Material Handling Equipment.

QUICK REFERENCE GUIDE FOR MATERIAL HANDLING EQUIPMENT **Note:** This Table is not all-inclusive.		
MHE	**OSHA Standard**	**ANSI/ASME Standard**
Materials Handling Equipment	29 CFR § 1910, Subpart N, Materials Handling and Storage	ASME B30.16, Material Handling

Hooks and Related Hoisting Equipment	29 CFR § 1910.244, Other Portable Tools and Equipment 29 CFR § 1926.1413, Wire Rope—Inspection 29 CFR § 1926.1414, Wire Rope—Selection and Installation Criteria	ASME B30.10, Hooks – Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings
Manual Hoists	29 CFR § 1926.552, Material Hoists, Personnel Hoists and Elevators	ASME B30.21, Lever Hoists
Overhead and Gantry Cranes	29 CFR § 1910.179, Overhead and Gantry Cranes 29 CFR § 1926.554, Overhead Hoists 29 CFR § 1926.1438, Overhead and Gantry Cranes	ASME B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
Powered Industrial Trucks	29 CFR § 1910.178, Powered Industrial Trucks	American National Standards Institute/Industrial Truck Standards Development Institute Foundation (ANSI/ITSDF) B56.1, Safety Standard for Low Lift and High Lift Trucks
Slings	29 CFR § 1910.184, Slings	ASME B30.9, Slings
Below-the-Hook Devices		ANSI/ASME B30.20, Below-the-Hook Lifting Devices
Mobile and Locomotive Cranes	29 CFR § 1910.180, Crawler Locomotive and Truck Cranes 29 CFR § 1926.1400, Cranes and Derricks in Construction 29 CFR § 1926.1433, Design, Construction and Testing	ASME B30.5, Mobile and Locomotive Cranes
Derricks	29 CFR § 1910.181, Derricks 29 CFR § 1926, Subpart CC, Cranes and Derricks in Construction 29 CFR § 1926.1436, Derricks	ASME B30.6, Derricks
Overhead Hoists (Underhung)	29 CFR § 1926.554, Overhead Hoists	ASME B30.16, Overhead Hoists (Underhung)
Cranes and Monorails	29 CFR § 1926.406, Specific Purpose Equipment and Installations	ASME B30.17, Cranes and Monorails (With Underhung Trolley or Bridge)
Cableways and Conveyors	29 CFR § 1926.555, Conveyors	ASME B30.19, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings
Personnel Hoists	29 CFR § 1926.552, Material Hoists, Personnel Hoists and Elevators 29 CFR § 1926.1431, Hoisting Personnel	ASME B30.23, Personnel Lifting Systems
Aircraft Equipment Management	DAFI 21-101, Aircraft and Equipment Maintenance Management	
Lifting Equipment Design for Nuclear Weapon Systems	DAFMAN 91-118, Safety Design and Evaluation Criteria for Nuclear Weapon Systems	
Operators Training	AFI 24-301, Ground Transportation	
MHE for Aircraft Loading/Unloading	TO 36M-1-141, Operator and Operation Instruction—Material Handling Equipment System Components of 463	

	TO 36M2-3-35-11, Operation and Operator Maintenance Instructions, Truck, Aircraft Cargo Loading/Unloading 60,000 Pound Capacity TO 36M2-3-45-1, Halvorsen 25K Aircraft Cargo Loaders
MHE in Weapons and Explosive Areas	DESR 6055.09_DAFMAN 91-201, Explosives Safety Standards
Lockout/Tagout Procedures	**Chapter 21**
Sling Guidance	OSHA's Tables and Figures: Guidance on Safe Sling Use

Table 12.2. Synthetic Web Slings. 1,000 Pounds per Inch of Width – Single Ply (Rated in 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

Notes:
1. All angles shown are measured from the vertical.
2. Capacities for intermediate widths not shown may be obtained by interpolation.

Table 12.3. 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					
	Vertical	**Choker**	**Vertical Basket**	**30° Basket**	**45° Basket**	**60° Basket**
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
Sling Body Width (inches)	**Endless Slings, type V**					
	Vertical	**Choker**	**Vertical Basket**	**30° Basket**	**45° Basket**	**60° Basket**
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
Sling Body Width (inches)	**Return Eye Slings, type VI**					
	Vertical	**Choker**	**Vertical Basket**	**30° Basket**	**45° Basket**	**60° Basket**
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

Notes:
1. All angles shown are measured from the vertical.
2. Capacities for intermediate widths not shown may be obtained by interpolation.

Table 12.4. Synthetic Web Slings. 1,600 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	1,600	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
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
Sling Body Width (inches)	**Endless Slings, type V**					
	Vertical	**Choker**	**Vertical Basket**	**30° Basket**	**45° Basket**	**60° Basket**
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
Sling Body Width (inches)	**Return Eye Slings, type VI**					
	Vertical	**Choker**	**Vertical Basket**	**30° Basket**	**45° Basket**	**60° Basket**
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

Notes:
1. All angles shown are measured from the vertical.
2. Capacities for intermediate widths not shown may be obtained by interpolation.

Table 12.5. 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)
1/8	3	3-1/4	4.5	3
¼	3	4-3/4	15	3
½	3	11-1/2	65	3
5/8	3	12	95	3-3/4
¾	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
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	

Notes:
1. Apply the initial load and retighten nuts to the recommended torque. The rope will stretch and shrink in diameter when loads are applied inspected periodically, and retightened.
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.
3. 1 in. = 2.54 cm. / 1 ft-lb = 1.36 Newton-meter.
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, Improved Plow Steel or Extra Improved Plow Steel. 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.
5. The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fiber core, Improved Plow Steel, nominal sizes 1-1/2 in. and smaller; and right regular lay wire rope, 18 x 7 class, fiber core, Improved Plow Steel or Extra Improved Steel, nominal sizes 1-3/4 in. and smaller.
6. For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.
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.
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 12.6. 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)**
¼	13/64
3/8	19/64
½	25/64
5/8	31/64
¾	19/32
7/8	4564
1	13/16
1 1/8	29/32
1 ¼	1
1 3/8	1 3/32
1 ½	1 3/16
1 ¾	1 13/32

Figure 12.1. Hand Signals for Controlling Overhead and/or Gantry Crane Operations.

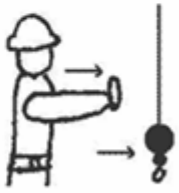
STOP – With arm extended horizontally to the side, palm down, arm is swung back and forth.	**EMERGENCY STOP** – With both arms extended horizontally to the side, palms down, arms are swung back and forth.	**HOIST** – With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.
RAISE BOOM – With arm extended horizontally to the side, thumb points up with other fingers closed.	**SWING** – With arm extended horizontally, index finger points in direction that boom is to swing.	**RETRACT TELESCOPING BOOM** – With hands to the front at waist level, thumbs point at each other with other fingers closed.
RAISE THE BOOM AND LOWER THE LOAD – With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.	**DOG EVERYTHING** – Hands held together at waist level.	**LOWER** – With arm and index finger pointing down, hand and finger make small circles.
LOWER BOOM – With arm extended horizontally to the side, thumb points down with other fingers closed.	**EXTEND TELESCOPING BOOM** – With hands to the front at waist level, thumbs point outward with other fingers closed.	 **TRAVEL/TOWER TRAVEL** – With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.

Figure 12.2. Hand Signals for Controlling Overhead and/or Gantry Crane Operations (con't).

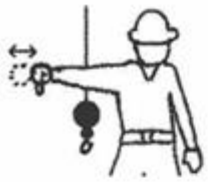
 **LOWER THE BOOM AND RAISE THE LOAD** – With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.	**MOVE SLOWLY** – A hand is placed in front of the hand that is giving the action signal.	**USE AUXILIARY HOIST** (whipline) – With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.
CRAWLER CRANE TRAVEL, BOTH TRACKS – Rotate fists around each other in front of body; direction of rotation away from body indicates travel forward; rotation towards body indicates travel backward.	**USE MAIN HOIST** – A hand taps on top of the head. Then regular signal is given to indicate desired action.	**CRAWLER CRANE TRAVEL, ONE TRACK** – Indicate track to be locked by raising fist on that side. Rotate other fist in front of body in direction that other track is to travel.
TROLLEY TRAVEL – With palm up, fingers closed and thumb pointing in direction of motion, hand is jerked horizontally in direction trolley is to travel.		

Figure 12.3. Hook Inspection Areas.

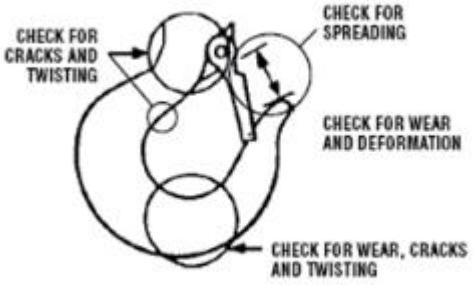


Figure 12.4. Right and Wrong Way of Using Cable Clips.

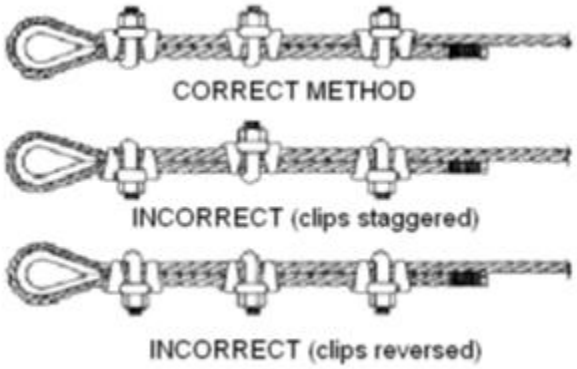


Figure 12.5. Proper Method of Installing Cable Clips.

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 12.6. Double Base Clamp.

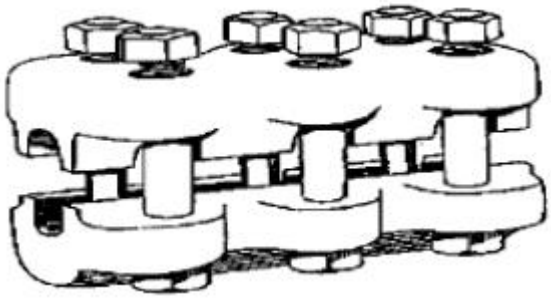


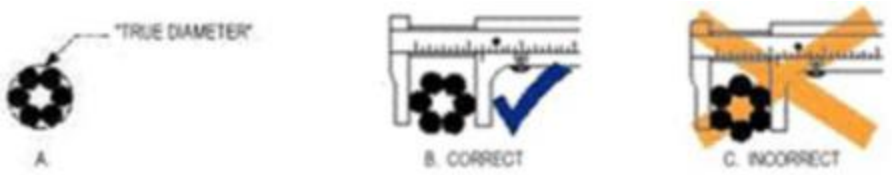
Figure 12.7. Joining Wire Ropes.

CORRECT

INCORRECT

Figure 12.8. Dead-Ending Rope in a Socket.

Figure 12.9. Correct and Incorrect Way to Measure Wire Rope. (Note: Always read the widest diameter.)



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 12.10. Wire Rope Wear and Damage (con't).

A "bird cage" caused by sudden release of tension and results at rebound of rope from overload condition. These strands and wires will not return to their original position.

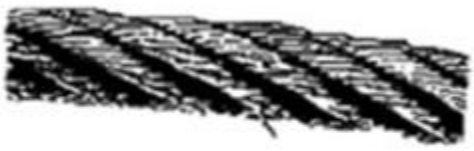
Figure 12.11. Wire Rope Wear and Damage (con't).

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.

Figure 12.12. Wire Rope Wear and Damage (con't).

A wire rope which has been kinked. A kink is caused by pulling down on a loop in a slack line during improper handling, installation, or operation. Note the distortion of these strands and individual wires. Early rope failure will undoubtedly occur at this point.

Figure 12.13. Wire Rope Wear and Damage (con't).



A wire rope which has been subject to repeated bending over sheaves under normal loads. This results in "fatigue" breaks in individual wires – these breaks are square and usually in the crown of the strands.

Chapter 13

FALL PROTECTION

13.1. Scope. This chapter provides the requirements to implement an effective fall protection program where employees are exposed to fall hazards while assigned to work at height. Fall protection program requirements include program policies, duties, and responsibilities, fall hazard survey, fall protection procedures, rescue procedures, training, equipment selection, inspections and maintenance, incident investigation, and evaluating program effectiveness. Most DAF operations fall under the following industries:

13.1.1. General Industry. Fall protection requirements will be followed whenever employees are exposed to fall hazards greater than four feet or any height where a fall would land an employee onto or in hazardous machinery/equipment. **(T-0)** Refer to 29 CFR § 1910, Subpart D – *Walking-Working Surfaces,* for additional requirements. The following requirements will be referenced first and areas not prescribed in these chapters will be covered by this chapter. **(T-0)**

13.1.1.1. Telecommunications Work. Refer to **Chapter 28** of this instruction and 29 CFR § 1910.268, *Telecommunications,* for additional requirements and guidance.

13.1.1.2. Electrical Power Generation, Transmission and Distribution Work. Refer to 29 CFR § 1910.269, *Electric Power Generation, Transmission, and Distribution*, for additional requirements and guidance.

13.1.1.3. Aircraft Flightline Operations. Flightline fall protection operations will meet the requirements of this chapter and **Chapter 24**. **(T-1)**

13.1.2. Construction Operations. Fall protection requirements will be followed whenever employees are exposed to fall hazards greater than six feet or any height where a fall would land an employee onto or in hazardous machinery/equipment. **(T-0)** Refer to 29 CFR § 1926, Subpart M – *Fall Protection,* for additional requirements.

13.1.3. This chapter does not apply to the following:

13.1.3.1. Portable Ladders. Refer to **Chapter 7** of this instruction**,** 29 CFR § 1910.23, *Ladders*, and 29 CFR § 1926.1053*, Ladders*, for additional requirements and guidance.

13.1.3.2. When employers are inspecting, investigating, or assessing workplace conditions or work to be performed prior to the start of the work or after all work has been performed. Refer to 29 CFR § 1910.28. **Note:** This exemption does not apply when fall protection systems or equipment meeting the requirements of 29 CFR § 1910.29 have been installed and are available for employees to use for pre-work and post-work inspections, investigations, or assessments.

13.1.3.3. To fall hazards presented by the exposed perimeters of entertainment stages and the exposed perimeters of rail-station platforms.

13.1.3.4. Powered Platforms, Aerial Lifts and Scaffolding. Refer to **Chapter 16** of this standard, 29 CFRs § 1910.66(j), *Powered Platforms for Building Maintenance,* 1910.67(c)(2)(v), *Vehicle-Mounted Elevating and Rotating Work Platforms*, and 1910.27, *Scaffolds and Rope Descent Systems*, for additional requirements and guidance.

13.1.4. Fire and Emergency Services. Fall protection will be provided for F&ES personnel when exposed to falls greater than four feet during routine operations as stipulated by General Industry standards (29 CFR § 1910, Subpart D) when not working as a rescue service. **(T-0)** When acting as a rescue service, F&ES personnel will adhere to requirements from NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications,* NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents,* NFPA 101, *Life Safety Code,* and other applicable standards. **(T-0)**

13.2. Fall Protection Program.

13.2.1. Fall Protection Policy. A policy statement will be developed that states the commander's commitment to providing a safe workplace for employees working at heights. **(T-1)** The policy will also provide general goals, guidance, and responsibilities for the fall protection program. **(T-1)**

13.2.2. Duties and Responsibilities.

13.2.2.1. Commander. The commander is ultimately responsible for the development and implementation of the fall protection program that promotes a safe and healthy workplace. The commander must ensure that the individuals selected to administer the organization's fall protection program, or act as a qualified or competent person have the required education, training, and experience to safely conduct their duties. **(T-1)**

13.2.2.2. Fall Protection Program Administrator. The fall protection program will be coordinated by a member identified as a qualified or competent person as defined in paragraphs **13.2.2.3** and **13.2.2.4**. **(T-1)**

13.2.2.2.1. This person acts as an administrative liaison between the organization and the occupational safety office to ensure fall protection program compliance and will be identified in writing by the commander. **(T-1)**

13.2.2.2.2. The program administrator advocates for needed fall protection training, and equipment identified by supervisors, qualified persons, and competent persons to the commander. Additionally, they maintain the currency of fall protection requirements and ensure self-evaluation of organizational compliance and coordinate incident investigations. **(T-1)**

13.2.2.3. Qualified Person will:

13.2.2.3.1. Be a person, who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project. **(T-0)**

13.2.2.3.2. Supervise the design, selection, installation, use, and inspection of certified anchorages and horizontal lifelines. **(T-0)**

13.2.2.3.3. Participate in incident investigations for falls while working under this chapter. **(T-1)**

13.2.2.3.4. Be designated in writing by the commander. **(T-1)** If the qualified person comes from outside the organization, documentation of the service agreement will be kept on file. **(T-1)**

13.2.2.4. Competent Person will:

13.2.2.4.1. Be a person who can identify existing and predictable hazards in any personal fall protection system or any component of it, as well as in their application and uses with related equipment, and who has authorization to take prompt, corrective action to eliminate the identified hazards. **(T-0)**

13.2.2.4.2. Supervise use of fall protection equipment and ensure that the equipment has been installed, inspected, and used to meet manufacturer's instructions, OSHA requirements, and this standard. **(T-0)**

13.2.2.4.3. Conduct fall hazard survey IAW **paragraph 13.3**. **(T-1)**

13.2.2.4.4. Prepare, review, update, and approve fall protection and rescue procedures IAW **paragraph 13.4**. **(T-1)**

13.2.2.4.5. Verify that authorized persons have completed fall protection training and remain knowledgeable of current procedures. **(T-1)**

13.2.2.4.6. Inspect fall protection equipment at least quarterly, and ensure defective or damaged equipment is removed from service. **(T-1)**

13.2.2.4.7. Participate in incident investigations related to falls from heights. **(T-1)**

13.2.2.4.8. Be designated in writing by the commander. **(T-1)**

13.2.2.5. Authorized Person will:

13.2.2.5.1. Know the nature of the fall hazards in their work area and how to recognize them. **(T-0)**

13.2.2.5.2. Follow the procedures required in the installation, inspection, operation, maintenance, and disassembly of personal fall protection systems used. **(T-0)**

13.2.2.5.3. Correctly use the assigned personal fall protection systems. **(T-0)**

13.2.2.5.4. Follow the instructions of competent persons and know how to report all unsafe or hazardous conditions. **(T-0)**

13.2.2.5.5. Conduct pre-use inspections of personal fall protection equipment for defects or damage and notify the competent person of any discrepancies. **(T-1)** Defective or damaged equipment will be properly disposed of per competent person direction and not used. **(T-0)**

13.2.2.6. Occupational Safety. The occupational safety staff (or applicable tenant safety staff) will provide advice and guidance to the Fall Protection Program Administrator of the organizational fall protection program elements. **(T-1)** **Note**: Occupational safety professionals do not fully meet the requirements of a qualified or competent person and will not be used to fulfill those roles in an organization's program. **(T-1)** These duties include:

13.2.2.6.1. Assisting in fall hazard surveys and development of written fall protection and rescue procedures to ensure rescue procedures, equipment, and training meet fall protection requirements in **paragraph 13.4**. **(T-1)**

13.2.2.6.2. Identifying unabated fall hazards and providing a RAC and tracked IAW DAFI 91-202. **(T-1)**

13.2.2.6.3. Conducting thorough annual review of fall protection program elements and documenting results annually in safety inspection/assessment reports. **(T-1)**

13.2.2.7. F&ES Flight. The F&ES Flight will assist in the fall hazard surveys and development of written fall protection and rescue procedures. The F&ES Flight will ensure equipment and training meet fall protection requirements in **paragraph 13.3** and **paragraph 13.4**. **(T-1)** The F&ES Flight may also act as the competent rescuer when trained and equipped to meet the needs to perform rescues at height under the organization's specific requirements, when included in the organizational rescue plan and agreed to by the fire chief.

13.2.2.8. Authorized Rescuers will:

13.2.2.8.1. Be trained to evaluate and recognize the hazards that may endanger them during rescue operations at height. **(T-1)**

13.2.2.8.2. Inspect the rescue equipment prior to a rescue event, verify that all equipment is in operable condition, and ensure the equipment is securely stored until needed. **(T-1)**

13.2.2.8.3. Verify that a rescue procedure has been developed for the fall arrest system(s) in use and review the procedure prior to use to properly implement the procedure. **(T-1)**

13.2.2.9. Supervisors. Supervisors will: (**Note**: Refer to DAFI 91-202 for additional responsibilities.)

13.2.2.9.1. Ensure each authorized, qualified, and 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. **(T-1)** A supervisor may also be a qualified, competent and/or authorized person if they meet the requirements of **Chapter 13.6.**

13.2.2.9.2. Be familiar with the shop's typical work assignments and where fall protection/fall arrest systems are required. **(T-1)**

13.2.2.9.3. Be responsible for the procurement of fall protection and fall arrest systems required by the organization or shop as directed by the qualified person. **(T-1)**

13.2.2.9.4. Be able to provide recommendations for qualified and competent personnel in the organization to the commander. **(T-1)**

13.2.2.10. Trainers. Trainers will be designated in writing by the commander. **(T-1)** Trainers will have the required experience and knowledge to deliver training at the level they are expected to instruct and be qualified, as an instructor, to train personnel on fall protection requirements. **(T-1) Note**: If the trainer comes from outside the organization, documentation of the service agreement will be kept on file. **(T-1)**

13.3. Fall Hazard Survey. A fall hazard survey will be conducted in all work areas where employees are exposed to fall hazards. **(T-1)** The survey team will be led by the organization's competent/qualified person(s) and be made up of the work center supervisors, authorized persons,

occupational safety office, and F&ES Flight. **(T-1)** Team composition allows all personnel to provide input identifying fall hazards and how to protect against those hazards. Proper identification of fall hazards and appropriate controls for each work area and/or task will ensure that the best solutions are used. **(T-1)**

13.3.1. A fall hazard survey will include:

13.3.1.1. Identification of fall hazards and include details of each hazard such as: **(T-1)**

13.3.1.1.1. Means of access to the fall hazards.

13.3.1.1.2. Locations of the fall hazards.

13.3.1.1.3. Tasks that create exposure to fall hazards.

13.3.1.1.4. Hidden fall hazards that are not always readily apparent.

13.3.1.2. Pertinent information about the fall hazards to include showing its basic configuration. **(T-1) Note**: Use of graphics, drawings and/or photographs are highly encouraged.

13.3.1.3. Identification of environmental factors that will affect the installation, use, inspection, maintenance, and dismantling of any fall protection system. **(T-1) Note:** This is not an all-inclusive list of fall or environmental hazards:

13.3.1.3.1. Electrical. Wire rope or rope covered wire lanyards, some plastics (such as nylon), and wet lanyards are conductive and will not be used near electrical hazards.

13.3.1.3.2. Thermal. Heat that can damage equipment or injure employees, such as welding splatter.

13.3.1.3.3. Chemical. Some chemicals can degrade the PPE material and/or injure an employee.

13.3.1.3.4. Sharp edges and abrasive surfaces can cut lanyards and/or injure employees.

13.3.1.4. Conduct a risk assessment to determine the level of risk for each fall hazard identified. **(T-1)** Each hazard will be assigned a RAC, as necessary. **(T-1)** Refer to DAFI 91-202 for additional guidance on RACs.

13.3.1.5. Appropriate abatement actions, as required by DAFI 91-202. **(T-1)**

13.3.1.6. Selected fall protection method(s) for each identified hazard. **Note**: If PFAS are selected, the calculation of all clearances will be included in the written fall protection procedures. Employees will not use PFAS until adequate clearances are available.

13.3.1.7. Appropriate PPE based on hazards identified will be addressed in the Fall Hazard Survey. Refer to **Chapter 14** for additional information.

13.3.2. Competent or qualified person will prepare the fall hazard survey report and submit copies to the fall protection program administrator, F&ES Flight, and occupational safety office. **(T-1)**

13.3.3. Fall hazard surveys will be updated or re-accomplished when changes occur in the work center. **(T-1)** Copies of completed fall hazard surveys will be maintained by the fall

protection program administrator and be available to all qualified, competent, and authorized employees for reference. **(T-1)**

13.3.4. When fall hazards are identified resulting from item or equipment upgrades, modification or replacements, the DAF item managers (depot level) will perform necessary functions (e.g., describing planned upgrades, costs, timetables, and prioritization), for DAF equipment not meeting fall protection standards. **(T-1)**

13.4. Written Fall Protection and Rescue Procedures. Fall protection and rescue procedures will be documented specifically for each workplace (location) and/or task they are applied to when the use of fall protection is required. **(T-1)** If a procedure can be effectively used in multiple workplaces/tasks, then the same procedure can be used. Procedures will be prepared and modified by a qualified or competent person as defined in this chapter. **(T-1)** Fall protection and rescue procedures will be reviewed at least annually for currency and accuracy. **(T-1) Note:** Fall protection equipment/procedures that are effective in one location or for a specific task, can be completely unacceptable in another location or for other tasks.

13.4.1. Written procedures will include:

13.4.1.1. Purpose of the fall protection procedure. **(T-1)**

13.4.1.2. Location and photographs/diagrams of the fall hazard(s) and fall protection system setup. **(T-1)**

13.4.1.3. Appropriate standards, regulations or requirements for the task(s) conducted at height. **(T-1)**

13.4.1.4. Training requirements for the fall protection procedure based on the fall protection equipment required. **(T-1)**

13.4.1.5. Fall protection system design parameters that assure 100% protection from fall hazards. **(T-1) Note**: Include fall calculations based on identified equipment and equipment design parameters, which include a detailed list of PPE, who developed the procedure, when it was developed, system certifications, and inspection logs.

13.4.1.6. Equipment requirements, to include: **(T-1)**

13.4.1.6.1. Identification of acceptable anchorages and tie off techniques. **(T-0)**

13.4.1.6.2. Validation of clearance requirements. **(T-0)**

13.4.1.6.3. Procedure to safely access and egress from the system. **(T-1)**

13.4.1.6.4. Identification of limitations in the use of the fall protection system. **(T-1)**

13.4.1.7. Procedures documenting how to safely erect, use and dismantle the fall protection equipment. **(T-1)**

13.4.1.8. Preparatory actions to be conducted by the supervisor to ensure authorized persons know the fall protection and rescue procedures. **(T-1)**

13.4.1.9. Steps to take when work is completed, e.g., clean up, storage. **(T-1)**

13.4.1.10. Fallen employees will be rescued in a prompt manner to prevent physical injury or death. **(T-0)** A detailed rescue plan will ensure rescue meets this standard, which includes:

13.4.1.10.1. Coordination with outside rescue agencies (F&ES Flight, contracted rescue, organization, etc.) to determine requirements to ensure prompt rescue of fallen personnel as part of preplanning. **(T-1)** Competent person will ensure pre-planning with the outside rescue agency is completed prior to work start. **(T-1)**

13.4.1.10.2. Procedures to contact the rescue agency if a fall occurs. **(T-1)**

13.4.1.10.3. Training on actions an authorized person can take to attempt self-rescue, when possible. **(T-1)**

13.4.1.10.4. Actions to be taken by the organization to rescue fallen authorized personnel who are unable to self-rescue. **(T-1)**

13.4.1.10.5. Location of rescue anchorage. **(T-1)**

13.4.1.10.6. Appropriate rescue equipment to use based on pre-identified requirements. **(T-1)**

13.4.1.10.7. Location of attachment to fallen employee's harness. **(T-1)**

13.4.1.10.8. Specific actions to achieve successful rescue. **(T-1)** Rescue training will include specific first aid requirements to prevent further injury/death when employee is removed from suspension after a fall. **(T-1)**

13.4.1.10.9. Required training for rescuers. **(T-1)**

13.4.2. The organization will establish good lines of communication with the F&ES Flight or a contracted rescue agency for prompt rescue of a fallen employee. **(T-1)** When rescue by the F&ES Flight or contracted agencies is unavailable, then the organization will ensure a rescue team is available or hold operations until available. **(T-1)** (**Warning**: Hanging in a harness for extended time periods can be fatal. Consideration should be given to purchasing and utilizing suspension trauma prevention devices to extend the time to ensure prompt rescue.)

13.5. Fall Protection Plans. Fall protection plans will be used only in construction, for residential roofs, leading edge work and precast concrete erection work. **(T-0)** The written plan will be coordinated with the occupational safety office (or applicable tenant Safety office) before the plan and its procedural controls are used. **(T-1)** When it is determined to not be feasible to use fall protection systems while on residential roofs as identified in 29 CFR § 1910.28(b)(1)(ii), a written fall protection plan, meeting the requirements of 29 CFR § 1926.502(k) and coordinated with the occupational safety office, will be developed by a qualified person. **(T-0)** Training for the fall protection plan must meet the requirements of 29 CFR § 1926.503(a) and (c). **(T-0) Note**: A corrective action plan will be accomplished describing planned upgrades (equipment, cost, and timetable, prioritized by the shop) and appropriate RACs, to eliminate need, partially or totally, for procedural controls. **(T-1)** Consistent with OSHA guidelines, cost will not be a consideration for selecting the fall protection plan's procedural controls versus implementing fall protection. **(T-0)**

13.6. Training. Before employees are exposed to a fall hazard, training will be completed IAW 29 CFR § 1910.30, *Training Requirements,* and for construction use IAW 29 CFR § 1926.503, *Training Requirements*. **(T-0)**

13.6.1. Authorized personnel will be trained by a competent or qualified person trained to instruct authorized personnel in their duties under the fall protection program. **(T-0)** Trainers conducting fall protection and rescue training must be qualified to train in the following areas:

13.6.1.1. The nature of the fall hazards in the work area and how to recognize them. **(T-0)**

13.6.1.2. The procedures to be followed to minimize those hazards. **(T-0)**

13.6.1.3. The correct procedures for installing, inspecting, operating, maintaining, and disassembling the personal fall protection systems that the employee uses. **(T-0)**

13.6.1.4. The correct use of personal fall protection systems and equipment, including, but not limited to, proper hook-up, anchoring, and tie-off techniques, and methods of equipment inspection and storage, as specified by the manufacturer. **(T-0)**

13.6.1.5. The employer must train each employee who uses a dock board to properly place and secure it to prevent unintentional movement. **(T-0)**

13.6.1.6. The employer must train each employee who uses a rope descent system in proper rigging and use of the equipment IAW 29 CFR § 1910.27. **(T-0)**

13.6.1.7. The employer must train each employee who uses a designated area in the proper set-up and use of the area. **(T-0)**

13.6.2. Qualified and competent persons will be trained by an instructor who has the level of knowledge and is qualified to instruct to ensure the employee who completes the training can perform their duties as a qualified or competent person, as applicable. **(T-0)** The instructor will ensure the employee who completes the training can perform their duties as a qualified or competent person, as applicable. **(T-0)** Personnel trained as a qualified person must also meet the training requirements of a competent person before applying fall protection system principles. **(T-1)**

13.6.3. Program administrators will be trained on all equipment and practices applicable to the scope of work in the organization's program. **(T-1)**

13.6.4. Retraining. Supervisors will ensure authorized persons are retrained in fall protection when: **(T-0)**

13.6.4.1. Changes in the workplace render previous training obsolete or inadequate. **(T-0)**

13.6.4.2. Changes in the types of fall protection systems or equipment to be used render previous training obsolete or inadequate. **(T-0)**

13.6.4.3. Inadequacies in an affected employee's knowledge or use of fall protection systems or equipment indicate that the employee no longer has the requisite understanding or skill necessary to use equipment or perform the job safely. **(T-0)**

13.6.5. Recurring Training. Recurring training will be performed and documented for example, use an attendance sheet, at least annually, to maintain employee proficiency. **(T-1)** Recurring training will include an in-depth review of current procedures and introduce any new or revised control methods and procedures, as necessary. **(T-1)**

13.6.5.1. Competent and authorized persons who are also identified as rescuers must meet requirements as identified in paragraphs **13.2.2.8** and **13.6.2**. **(T-1)**

13.6.5.2. Program administrators will also attend annual recurring training to maintain currency. **(T-1)**

13.6.6. Training Documentation. All training, e.g., initial, retraining, and recurring, will be documented with the following information:

13.6.6.1. Name of the employee trained. **(T-0)**

13.6.6.2. The date(s) of the training. **(T-0)**

13.6.6.3. The signature of the person who conducted the training or the signature of the employer. **(T-0)**

13.7. Fall Protection Equipment and General Information. After conducting fall hazard surveys and identifying the fall hazards involved, the next step is to evaluate the appropriate control(s) to implement to protect the employees. The following provides a not all-inclusive reference to appropriate controls and equipment to use when having employees work at height.

13.7.1. Hierarchy of Controls.

13.7.1.1. Elimination. The preferred method of protecting employees from falls at height is to remove the hazard completely. Evaluate whether it is necessary to put an employee at height to do the work or can the operation be restructured to allow an employee to do the same task at ground level.

13.7.1.2. Prevention. Many fall hazards are controlled using prevention techniques that include guardrails, walls, covers, or parapets to prevent exposure to the fall. Specific requirements for these items can be found in **Chapter 7,** *Walking – Working Surfaces.*

13.7.1.3. Engineering Controls. The use of engineering controls requires the consideration of design changes to equipment or different techniques while working at height such as reaching the work location using an aerial lift, scaffold, or powered platform/manlift/vehicle mounted work platform. Guidance on requirements to safely use this equipment is found in **Chapter 16,** *Mobile Elevating Work Platforms and Scaffolding.*

13.7.1.4. Personal Protective Systems and Equipment. This control includes the equipment used for work positioning, travel restraint, and fall arrest. This control sits low on the list due to variations of compliance in how well an employee dons, doffs, cleans, and maintains their equipment; how well supervisors enforce the use of PPE; and how well suited the PPE selected is to the hazard identified.

13.7.1.5. Administrative Controls. This is the least protective of the controls as it does not prevent exposure to the fall hazard or arrest the fall of an employee. Administrative controls are only allowed in very limited situations.

13.7.2. Types of Fall Protection. Fall protection systems are designed to protect employees from fall hazards. When determining specific requirements to address fall hazards refer to 29 CFR § 1910, Subpart D, *Walking – Working Surfaces,* 29 CFR § 1910, Subpart I, *Personal Protective Equipment,* and manufacturer's documentation.

13.7.2.1. Passive fall protection, such as guardrails, work stands, and platforms (aircraft maintenance stands, e.g., B-1, B-4, B-5), safety nets, and other devices can prevent an employee from falling but are not directly connected to the employee. If passive fall protection is not feasible, active fall protection is next, the preferred option. **Note:** Nets do

not prevent an employee from falling but do prevent an employee from hitting the next level.

13.7.2.2. Active fall protection devices include, but are not limited to, ladder climbing devices and personal fall arrest, positioning, and restraint systems with each described below:

13.7.2.2.1. Ladder safety systems ensure personnel can safely climb fixed ladders and prevent falls to the next level. A typical system contains an anchorage, lifeline, harness, and connectors.

13.7.2.2.2. Positioning systems allow an employee to be supported while working on an elevated, vertical working surface with both hands free. The positioning equipment includes a body harness, connectors, and an anchorage.

13.7.2.2.3. Travel restraint systems restrict an employee's range of movement to prevent the possibility of an employee falling off the walking/working surface. The travel restraint system contains an anchorage, full body harness, and a lanyard (or other means of connection).

13.7.2.2.4. Personal fall arrest systems (PFAS) arrest an employee's fall and limits arresting loads to generally safe levels to prevent the employee from falling to the next lower level. A PFAS includes an anchorage, body harness, and connectors.

13.7.3. Equipment Inspections and Maintenance.

13.7.3.1. PFAS users will comply with manufacturer's instructions or use TO 00-25-245, *Operations Instructions - Testing and Inspection Procedures for Personnel Safety and Rescue Equipment,* for inspection, maintenance, cleaning, and storage requirements. **(T-1)** When defects or damage to equipment is found due to inadequate maintenance of equipment, improper storage, improper use, or from wear on the system, the equipment will be immediately tagged unserviceable and removed from service. **(T-1)** Unserviceable PFAS will be destroyed to prevent further use. Inspections will be documented IAW TO 00-25-245 or manufacturer's instructions, whichever is more restrictive. **(T-1)**

13.7.3.2. Authorized person(s) will inspect PFAS prior to use. **(T-0)**

13.7.3.3. Qualified/competent persons will ensure all PFAS components receive a thorough inspection at least quarterly. **(T-1)** This inspection will be documented and maintained. **(T-1) Exception**: Components of a PFAS that have been professionally installed and certified will be inspected IAW manufacturer's instructions, at the interval recommended by the manufacturer, and by a person qualified to perform the inspection. Inspection will be documented and maintained. **(T-1)**

13.7.3.4. Supervisors will maintain manufacturer's instructions and performance testing information for PFAS used by their employees. **(T-1)**

13.7.3.5. For overseas locations, the use of anchorage points is authorized when the host country provides documentation of applicable testing and inspections.

13.7.3.6. Fall protection anchorage connectors attached to overhead rail systems (i.e., I-beams and trolley) will be completely inspected by a qualified person per manufacturer

data. **(T-0)** The anchorages (i.e., I-beam, trolley) will be inspected by a qualified person at least every five years or dependent on results of annual qualified person inspections. **(T-0)**

13.8. Incident Investigation. Falls from heights where the employee utilized active fall protection equipment as described in **paragraph 13.7.2.2,** regardless of whether an injury or damage has occurred, will be investigated by a qualified or competent person. **(T-1)** The qualified or competent person can request assistance from occupational safety personnel in completing their investigation. A copy of the completed investigation will be reported to the servicing occupational safety office. **(T-1)** The incident investigation is an organizational level process to determine the cause of the fall and is used to correct any issues found in procedures, equipment, or rescue, as applicable. Where the fall results in required mishap investigation, due to injuries and/or property damage, per DAFI 91-204, then the safety mishap investigation will take priority. **(T-1)**

13.8.1. The incident report will be provided to the fall protection program administrator to review the team's findings and recommendations for corrections to the organization's program. **(T-1)**

13.8.2. Final report will be routed to the commander for review and signature within 10 days of report completion. **(T-1)**

13.8.3. The program administrator will then develop a corrective action plan to ensure the approved corrective actions are acted upon in the timeline established. **(T-1)**

13.8.4. The fall protection program administrator will maintain a minimum of three years of completed incident reports. **(T-1)**

13.8.5. The occupational safety office will annually conduct review of incident reports to determine any trends. **(T-1)**

13.9. Fall Protection Assessments.

13.9.1. At least annually, the fall protection program administrator, with assistance from each affected workplace supervisor, will conduct an internal assessment of the organization's program to evaluate.

13.9.1.1. Training curriculum and documentation are current. **(T-1)**

13.9.1.2. Fall hazard surveys are current. **(T-1)**

13.9.1.3. Policy statement and documentation of identified personnel are current. **(T-1)**

13.9.1.4. Review of written fall and rescue procedures to ensure currency. **(T-1)**

13.9.1.5. Review of all fall protection equipment and anchorages to ensure they are serviceable, current on required inspections, properly stored and maintained, and reviewed to determine if still appropriate to address fall hazards. **(T-1)** Reviewing new options to currently used equipment to address identified fall hazards provides the opportunity to find and evaluate new solutions that better address the fall hazards and better protect employees by using higher level hierarchy of controls such as elimination versus continuing to use PPE.

13.9.1.6. Review of incident investigations. **(T-1)**

13.9.1.7. Provide a report, with recommendations where identified, to the commander for review and approval within 10 days of completion. **(T-1)**

13.9.2. The occupational safety office or tenant occupational safety office(s) will complete an annual assessment of fall protection program requirements for each organization and document results as required in DAFI 91-202. **(T-1)**

Chapter 14

PERSONAL PROTECTIVE EQUIPMENT (PPE)

14.1. Scope. This chapter establishes DAF specific PPE requirements, to include the use, selection, care, and maintenance for protective equipment for eyes, face, head and extremities, protective clothing, respiratory devices, and protective shields/barriers. Additional OSHA requirements are found in 29 CFR § 1910, Subpart I, *Personal Protective Equipment,* and 29 CFR § 1926, Subpart E, *Personal Protection and Life Saving Equipment.* For issues involving Radio Frequency or laser radiation, refer to AFI 48-109*,* AFI 48-139 and AFMAN 48-148. **Note**: A cross-reference of host nation and US standards is not available. On a case-by-case basis, when procuring PPE outside of the DAF supply system, each wing/delta/installation should conduct a product risk assessment to determine if the product meets or exceeds the US standards. If the product does not meet or exceed the US standards, then purchase a product within US standards, if possible.

14.2. Training.

14.2.1. Training will be provided to each affected employee who is required to use PPE when accomplishing any work activity. **(T-0)** Supervisors will train each employee IAW 29 CFR § 1910.132(f), *Training,* and applicable manufacturer's instructions. **(T-0)** Respiratory protection training will be IAW 29 CFR § 1910.134, *Respiratory Protection,* and AFI 48-137. **(T-0)** Hearing protection will be IAW AFI 48-127.

14.2.2. Retraining. Affected employees will be retrained IAW 29 CFR § 1910.132(f)(3) when:

14.2.2.1. There is a change in their job assignment(s). **(T-0)**

14.2.2.2. There is a change in the work processes that present a new hazard. **(T-0)**

14.2.2.3. There is a change in the type of PPE required to be used. **(T-0)**

14.2.2.4. Other conditions as specified in 29 CFR § 1910.132(f)(3) require retraining. **(T-0)**

14.2.3. Supervisor will document training IAW **paragraph 1.7** and DAFI 91-202. **(T-1)** Respiratory training will be documented IAW AFI 48-137. **(T-1)**

14.3. Job Hazard Analysis (JHA) and Equipment Selection. The use of PPE is the least preferred method and not a replacement for other, more effective controls, such as elimination, substitution, engineering, and administrative controls. If a JHA reveals PPE is the best solution, or until controls can be implemented, PPE, e.g., hard hats, gloves, hearing protection, will be the primary means to protect personnel against hazards. **Note**: If PPE is required for the performance of a task, the commander and/or functional manager will provide it. **(T-1)** Subordinates are not responsible for providing their own PPE. A documented JHA will be conducted to determine if hazards are present and take actions necessary to protect employees from injury, illness, or death IAW 29 CFR § 1910.132(d), *Hazard the Assessment and Equipment Selection: Personal Protective Equipment – General Requirements.* **(T-0)** Occupational health PPE will be identified during the BE HRA process. **(T-1)** PPE recommendations will be provided on the final HRA report. **(T-1)** Organizations will consult with the occupational safety office and installation BE for questions regarding PPE. **(T-1) Note:** PPE will be inspected, used, cleaned, and maintained per manufacturer's documentation included with the equipment. **(T-1)**

14.3.1. Supervisors will:

14.3.1.1. Conduct and document JHAs IAW 29 CFR § 1910.132(d). **(T-0)** Refer to **paragraph 1.5** and DAFI 91-202 for additional guidance on JHA.

14.3.1.2. Contact installation BE and occupational safety 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. **(T-1)**

14.3.1.3. If PPE is required, the supervisor will ensure that PPE is provided, used, and maintained in a sanitary and serviceable condition IAW manufacturer's instructions. **(T-0)**

14.3.2. DAF personnel will comply with PPE requirements and:

14.3.2.1. Ensure PPE is used when required, serviceable, and properly adjusted or fitted. **(T-0)**

14.3.2.2. Notify their supervisors if they wear contact lenses. **(T-0)** This information is vital to emergency medical personnel who may need to remove a lens from the individual's eye. The use of contact lenses can present additional hazards, e.g., chemical environments, welding operations. A JHA should be conducted to ensure that the use of contact lenses does not expose employees to additional risks.

14.3.2.3. 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. **(T-0)**

14.3.2.4. 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. **(T-0)**

14.3.3. Eye and Face Protection. Only protective eye and face devices that are certified by the manufacturer to meet ANSI/ISEA Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices,* will be used. **(T-0)** Refer to 29 CFR § 1910.133, *Eye and Face Protection,* for additional requirements. **Note**: Eye protection is required to protect against small particles of debris when performing a task above eye level that could be expected to create such a hazard. **Note**: Face shields are considered face protection only and must always be worn with appropriate eye protection. **(T-0)**

14.3.4. Respiratory Protection. Installation BE, as the OPR for the installation respiratory protection program, recommends and approves all respiratory protection devices and will be consulted on respiratory protection required for specific shop activities and job sites, if required. **(T-1)** AFI 48-137 and 29 CFR § 1910.134, *Respiratory Protection,* provide guidance on prevention of occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, vapors, or in oxygen-deficient environments.

14.3.5. 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, proper protective head gear will be provided and used. **(T-0)** Typical examples of these areas are construction sites, flightlines and warehouses. Protective helmets must be certified by the manufacturer to comply with ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection,* and 29 CFR § 1910.135, *Head Protection.* **(T-0)**

14.3.5.1. Hair Protection (Includes Facial Hair). Employees who work around chains, belts, rotating devices, suction devices, blowers, etc., will secure their hair, especially long hair, to prevent it from being caught in moving equipment. **(T-0)** While such equipment is normally guarded, long hair can fit between the mesh of guards and be drawn into the moving parts.

14.3.5.2. Safety Helmets (Hard Hats). Commanders, supervisors, and team members will ensure employees working on or near underground or aerial installation, construction and certain maintenance-related jobs always wear an approved safety helmet (as determined by a JHA). **(T-1)** The chinstrap will be worn during work aloft or anytime the helmet may fall off the employees' head while performing a specific task possibly resulting in injury to Employees or damage to property. **(T-1)** Refer to ANSI/ISEA Z89.1 for additional information. **(T-0)**

14.3.5.3. 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 will not be used as a substitute for safety helmets, where applicable. Their use will be determined by the supervisor's hazard assessment, in conjunction with the occupational safety office. **(T-0)**

14.3.6. 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. AFI 48-127 is the primary guidance on hazardous noise exposure policies, responsibilities, and procedures, including hearing protective device information. Contact installation BE for information on the hearing protection program. Refer to AFI 48-127 for additional guidance and information.

14.3.7. Electrical Workers' Clothing and Equipment. Electrical clothing will be used IAW UFC 3-560-01, NFPA 70E, AFMAN 32-1065, and manufacturer's instructions. **(T-0)** Rubber insulating PPE such as blankets, matting, covers, line hose, gloves, and sleeves will be used IAW 29 CFR § 1910.137, *Electrical Protective Equipment,* and manufacturer's instructions. **(T-0)**

14.3.8. 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 will be provided and used. **(T-0)** Sleeves, padded arm protectors, hand pads, and other items will be worn to protect the hands and arms when hot or sharp materials are handled. **(T-0)** There is a wide assortment of gloves, hand pads, sleeves, and wristlets for protection against various hazardous situations. Before purchasing any chemical protective equipment, contact installation 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. **(T-1)** Supervisors will 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. **(T-0)**

14.3.9. 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. Back support belts are only worn with supervisory approval and proper training of safe lifting techniques. They will 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.

14.3.10. Foot and Leg Protection (e.g., Safety Shoes, Toe Caps, Leggings, etc.). Protective footwear will be provided and worn when there is a reasonable possibility of foot injuries from heavy or sharp objects and electrical and/or static electricity. **(T-0)** Use appropriate foot guards, safety shoes or boots, and leggings for protection of feet and legs from crushing hazards, falling, rolling, 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.

14.3.10.1. Shop JHA will identify those areas, operations, and occupations which require protective leg or footwear. **(T-1)** All individually issued safety footwear used in DAF operations will be certified by the manufacturer to meet the requirements found in ASTM F2412, *Standard Test Methods for Foot Protection,* and ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear.* **(T-0)**

14.3.10.2. Safety shoes will be sturdy and have an impact-resistant toe. **(T-0)** Only shoes certified by the manufacturer, to meet or exceed the requirements found in ASTM F2412 and F2413 international standards, as incorporated by reference in 29 CFR § 1910.6, *Incorporation by Reference,* are approved for the DAF. Refer to 29 CFR § 1910.136, *Foot Protection*, for additional guidance. Metal insoles in shoes protect against puncture wounds. Additional protection, such as metatarsal guards, may be necessary for some job tasks. Nonskid shoes will be worn where floors may be wet or slippery. **(T-0)** 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 will be issued footwear which protects against the possibility of frostbite. **(T-0)**

14.3.11. Knee Protection. Knee pads may be used by employees who are required to kneel while performing most of their work or by employees with known knee problems that could be compounded by working in a kneeling position.

14.3.12. 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 elimination, substitution, engineering, or administrative controls, will be used to limit chemical contact before considering use of PPE. **(T-0)**

14.3.12.1. Chemical Protective Clothing Selection. Workplace supervisors will contact installation BE to determine the appropriate PPE for all processes involving chemical exposures. **(T-1)**

14.3.12.2. Ensemble Selection Factors:

14.3.12.2.1. 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.

14.3.12.2.2. Requirements. The proper type of chemical protective clothing or equipment depends on job requirements, and includes requirements from TOs, SDS and manufacturer's instructions. Check with installation BE before purchasing chemical protective clothing or equipment.

14.3.12.3. Chemical Protective Clothing Limitations. Many chemicals can have adverse effects on protective clothing and gloves. Permeation, a process by which a chemical can pass through PPE, and degradation, a reduction in the physical properties of PPE, are two examples. Chemicals allowed to remain on protective clothing or equipment can be absorbed into the material. Chemical protective clothing that is reused must be cleaned before storage. **(T-0)** In some cases, it may be more cost effective to select chemical protective clothing with a relatively short breakthrough time (see definitions, **Attachment 1**) and decontaminate and discard it properly after one use.

14.3.12.3.1. Duration of Exposure. Maximum duration of exposure to a chemical will be considered when selecting chemical protective clothing. **(T-0)** Review the SDS and contact installation BE to determine the appropriate PPE.

14.3.12.3.2. Performance Characteristics.

14.3.12.3.2.1. Resistance to abrasions, cuts, heat, ozone, and punctures or tears will be considered to maintain the integrity of the material. **(T-0)**

14.3.12.3.2.2. Flexibility may be an important factor if inflexible equipment interferes with the employee's ability to successfully accomplish the task.

14.3.13. Welding, Cutting and Brazing Specific PPE. Welding, cutting and brazing PPE requirements and usage will be IAW 29 CFR § 1910.252, *Welding, Cutting and Brazing – General Requirements,* 29 CFR § 1910.132 and AFI 48-137. **(T-0)**

14.3.14. Light Reflective Products.

14.3.14.1. Light reflective and luminescent materials should be utilized during hours of decreased visibility. These items are also available in the primary safety code colors and should be used for standard signs and markings. Reflective or luminescent materials must remain reflective when wet.

14.3.14.2. Personnel exposed to traffic environments or flightline operations during hours of darkness or reduced visibility, or as part of construction, will be provided and use reflective equipment or will use organizational clothing with sewn-on reflective tape. **(T-3)** Refer to ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel and Accessories,* for additional information. **Note**: Personnel whose job requires them to

perform some function in the traffic/flightline environment will be provided reflective equipment to enhance their visibility, except as previously stated for Security Forces. **(T-1)**

14.3.15. 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 will be used when necessary to prevent heat stress and physical injury. **(T-0)** Frequent breaks and drinking plenty of water are also critical to prevent heat-related injuries. Refer to DAFI 48-151 for additional guidance. **Note**: If metallic coating on heat reflective clothing is conductive, it will not be worn where there is the possibility of electrical shock.

14.3.16. Cold Testing and Clothing. Protective clothing used in cold testing or cold storage areas must be adequate to protect employees from hazards involved with the task and cold temperatures. **(T-0)** Supervisors will coordinate with the Occupational Safety and installation BE offices to determine proper equipment for the task. The JHAs should identify approved protection for working in cold temperatures. **(T-1)** Frostbite can be avoided by wearing appropriate protective clothing and by taking frequent breaks to warm extremities. Supervisors will ensure cold weather clothing is provided when needed for work in cold temperatures. **(T-1)**

14.3.17. Personal Fall Arrest Systems (Safety Harnesses, Lanyards, Lifelines and Straps. Refer to **Chapter 13** of this standard for guidance on PFAS.

14.4. Proper Care and Maintenance. Employees will maintain all PPE IAW manufacturer's instructions to include being kept clean and in good repair. **(T-0)** Previously used PPE will be disinfected before reissue to another employee. **(T-0)** Contaminated PPE that cannot be decontaminated will be disposed of in a manner that protects employees from exposure to hazards. **(T-0)** Contact installation BE and/or installation CE to determine the appropriate disposal measures of contaminated PPE. Functional managers will ensure disposal of contaminated PPE is consistent with applicable environmental regulations. **(T-1)** Reusable PPE that can be decontaminated can be stored in resealable or drawstring type bags. Refer to the PPE manufacturer's instructions, UFC 3-560-01, AFMAN 32-1065, 29 CFR § 1910.137, Table I, and 29 CFR § 1910.141, *Sanitation,* for additional guidance on cleaning specific equipment.

14.4.1. Shop supervisors will ensure shop personnel use protective clothing and equipment that will protect them from work hazards. **(T-0)**

14.4.2. Employees will 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. **(T-0)** No food or drink will be brought into or consumed in areas exposed to toxic materials, chemicals, or industrial shop contaminants nor will drinking water sources such as water fountains be in those areas. **(T-0)** Industrial hygiene surveys will be reviewed for shop hazards. **(T-1)** Refer to 29 CFR § 1910.141 for additional information.

14.4.3. Shop supervisors will provide on-site laundry and shower facilities IAW 29 CFR § 1910.141. **(T-0)** The shower and laundry facilities will be provided when the occupational safety office or installation BE determines an occupational hazard warrants them. **(T-0) Note**: Contractors who perform laundry services will comply with 29 CFR § 1910.141.

Chapter 15

TRAINING SYSTEMS

15.1. Scope. This chapter provides guidance on fire protection engineering criteria, fire prevention requirements, and housekeeping procedures for the system safety and risk management of all training devices in AFI 10-217, *Management of Air Force Operational Training and Undergraduate Aircrew Training Systems.* It also applies to all training systems regardless of the stage of design, development, or date of installation. Air Force Civil Engineer Center (AFCEC) will determine the fire prevention requirements for trainers not covered in AFI 10-217.

15.1.1. Hazards. Protective measures, such as grounding, conductive floors and benches, humidity control, antistatic packaging of spare components, and other controls will be used as needed to prevent electrostatic discharge. **(T-1)** Refer to **Chapter 2** for guidance on hazards and human factors.

15.1.2. Fire, Injury and Equipment Damage Hazards. Refer to MIL-STD-1472H*, DoD Design Criteria Standard: Human Engineering,* for additional guidance on damage to training systems equipment.

15.2. General Requirements.

15.2.1. Fire Extinguishers. Listed Class C carbon dioxide, clean agent, or water mist fire extinguishers with a minimum rating of 10B:C located IAW NFPA10, *Standard for Portable Fire Extinguishers,* must be provided within all facility areas containing permanently installed electronic equipment such as motion bays, model boards, visual display rooms, computer bays, etc. **(T-0)** Similar fire extinguishers may be provided in cockpit and/or other crew stations. Dry and wet chemical agent fire extinguishers are prohibited.

15.2.2. Fire and Emergency Procedures. The training system operator and/or instructor will provide a fire safety briefing to trainees at the start of each training session. **(T-0)** Prompt action during a fire will protect personnel and minimize damage.

15.2.3. Housekeeping.

15.2.3.1. Combustible materials will be disposed of in suitable noncombustible containers, conspicuously labeled as to contents, and with self-closing lids. **(T-0)** These containers will be emptied when full and at least at the end of each working shift. **(T-0)** Contact installation CE for disposal procedures for combustible hazardous waste. Refer to **Chapter 22** for additional guidance.

15.2.3.2. Building floors, especially raised floors, will be kept smooth, clean, and free of obstructions and slippery materials. **(T-0)**

15.2.3.3. Floors will not be cleaned with flammable or combustible liquids. **(T-0)** Follow the manufacturer's instructions and SDS guidelines when using cleaning agents for floors and facilities.

15.2.3.4. To prevent buildup of trash and foreign objects, sub-floors will be visually inspected and cleaned, as needed, but not less than once every 60 days. **(T-1)** Sub-floors will 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 or

where no water intrusion is possible. **(T-1) Note**: Any change in facility or room use or configuration will require reassessment of the cleaning schedule and the need to check for water intrusion. **(T-1)**

15.2.3.5. Utility trenches will be kept clean of foreign objects and inspected at least every 60 days. **(T-1)** If cleaning history shows a longer period between cleanings is feasible, the F&ES Flight may allow extending the time between cleanings.

15.2.3.6. Hot Work. Hot work permits will not be issued until the requirements of **Chapter 20** are met. Additional information can be found in NFPA 51B, *Fire Prevention During Welding, Cutting and Other Hot Work.* **(T-0)** Consult with F&ES Flight for additional guidance.

15.3. Facility Requirements.

15.3.1. 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 Occupational Safety office, installation CE, F&ES Flight, and installation BE will coordinate on all plans. **(T-1)**

15.3.2. Location. Training systems will be in facilities protected by automatic sprinkler systems. **(T-1)** Piloted and unpiloted aircraft flight trainers must be in spaces with additional ultra-sensitive smoke detection as well. **(T-1)** Electronic procedures training must also be in spaces with additional ultra-sensitive smoke detection.

15.3.3. Existing facilities that house training devices with internal fire detection and alarm systems do not require ultra-sensitive systems but will be provided with a standard smoke detection system. **(T-1)**

15.3.4. Training system spaces will 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. **(T-0)**

15.3.5. 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 will be provided to shut off the space from the remainder of the facility upon any facility fire alarm activation. **(T-0)** Facility fire alarm activations originating outside the training system space do not require deactivation of the air handling system that serves an individual training system.

15.3.6. Communications and interconnecting cable and wiring in training system and raised floor spaces will comply with NFPA 70, Article 645, *Information Technology Equipment.* **(T-0)** Communications and interconnecting cable and wiring in training system spaces and other areas of the facility or other facilities will comply with NFPA 70, Article 725, *Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits.* **(T-0)**

15.3.7. Electrical.

15.3.7.1. Surge protection will be provided for all incoming power to the training system. **(T-0)** New training system facilities will have surge protection for the entire facility. **(T-0)**

15.3.7.2. All power and distribution circuits will comply with NFPA70 and UFC 3-520-01, *Interior Electrical Systems*. **(T-0)**

15.3.8. Drainage. Drainage will be provided in utility trenches and motion bays. **(T-0)**

15.3.9. Hydraulic Pump Rooms. Hydraulic pump rooms will be of 1-hour fire rated construction, except rooms which contain more than 250 gallons of hydraulic fluid, which will be of 2-hour fire rated construction. **(T-0)**

15.3.10. Emergency Lighting. Emergency lighting will be provided IAW NFPA 101, *Life Safety Code.* **(T-0)**

15.3.11. Fire protection features installed in the facility, or the trainers must be maintained and comply with the requirements of UFC 3-600-01. **(T-0)**

15.4. Training Systems Requirements.

15.4.1. General Flammability Requirements. Only fire resistant and non-hazardous (when exposed to fire) materials will be used in cockpits, seats, shrouds, cable ties, cable coverings and auxiliary insulation for heat, electrical, sound, etc. **(T-0)** Manufacturers will certify that the flame spread rating for these materials will not exceed 75 and smoke development will not exceed 100 when tested IAW ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials.* **(T-0)** Alternately, materials certified by the manufacturer will be considered acceptable that meet one of the following: certification under California State Fire Marshal will Title 19; listing under Underwriters Laboratories (UL) 94, *Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances,* or equivalent OSHA-recognized NRTL certification; or successful testing under NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.* **(T-0)** 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.

15.4.2. General Hydraulic System Features.

15.4.2.1. Hydraulic pump controls will be designed to automatically shut down sudden or excessive flow in the hydraulic lines when the fluid level is low or when excessive hydraulic fluid temperature is sensed. **(T-0)**

15.4.2.2. Flexible hoses will be shielded to prevent leaking hydraulic fluid from spraying on potential ignition sources, trainees, and staff personnel. **(T-1)** Braided shielding integral to the flexible hoses will be used whenever the hoses are not located in covered trenches. **(T-1)**

15.4.2.3. Upon loss of power or shutdown of the hydraulic pumps, the training device will automatically return to the rest position within 10 seconds. **(T-1)**

15.4.2.3.1. 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. **(T-1)**

15.4.2.3.2. 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. **(T-1)** The number of doors and locations will comply with the requirements in NFPA 101. **(T-0)**

15.4.2.3.3. For aircraft flight and similarly high value training systems, access ramps will automatically deploy after motion is stopped — even when power is removed. **(T-1)**

15.4.2.4. Hydraulic pump controls will be designed so the operation of the facility fire alarm or training system fire alarm system shuts down the pumps. **(T-1)** This feature is not required for wheeled vehicle egress assistance trainers.

15.4.3. Emergency Lighting. Emergency lighting will be provided in all enclosed occupied training spaces IAW NFPA 70, Article 700, *Emergency Systems.* **(T-0)**

15.5. Requirements of Wheeled Vehicle Egress Assistance Trainers.

15.5.1. Safety Zone. A safety zone will be provided to keep observers at a safe distance when the unit is rotating. **(T-1)**

15.5.2. Head Strike Hazard. Projections inside the unit will be padded and loose objects secured that could present a head strike hazard to trainees during unit rollover. **(T-0)** Padding will comply with flammability requirements in **paragraph 15.4.1**. **(T-0)**

15.5.3. Walkways. Walkways will be padded where the trainees egress to minimize the potential for injury to personnel should a trainee fall from the vehicle doors. **(T-1)** Padding will comply with flammability requirements in **paragraph 15.4.1**. **(T-0)**

15.5.4. Fire Extinguisher. A portable fire extinguisher with a minimum rating of 10B:C will be located within immediate vicinity of the instructor/operator. **(T-1)**

15.5.5. Power Failure. A means will 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. **(T-1)**

15.5.6. Egress Procedures. Procedures will be established to provide safe emergency occupants egress from the unit, such as when the unit fails to fully rotate to the design rollover position. **(T-1)**

15.5.7. Loading and Seating. Approved occupant seating and loading limits will be posted in the immediate vicinity of the unit. **(T-1)** Prohibited seating arrangements will also be posted, such as any unbalanced seating arrangements that could prevent manual rotation of the unit during an emergency. **(T-1)**

15.5.8. Retractor Mechanisms. Trainees will not be assigned to any location in the trainer (such as the gunner's hatch in the roof of a HMMWV Egress Assistance Trainer 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. **(T-1)** 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. **(T-1)**

15.6. Requirements for Aircraft Flight and Similarly High Value Training Systems.

15.6.1. Fire Detection and Alarm Systems.

15.6.1.1. 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 15.3.2**.

15.6.1.2. Existing training systems in spaces protected by a standard smoke detection system will have an internal fire detection and alarm system. **(T-1)** This system will interconnect all detection and annunciation devices with the various training system components (e.g., cabinets, instructor operator station, cockpit, motion base, etc.). **(T-1)** This system will be either of the dual fixed-temperature type or the ultra-sensitive type. **(T-1)**

15.6.1.2.1. Dual fixed-temperature type fire detectors will be installed in electrical, electronic, hydraulic and computer cabinets. **(T-1)** Activation of the first detector, e.g., the one calibrated to the lower activating temperature will produce a distinctive audible signal. **(T-1)** Activation of the second detector, e.g., the one calibrated to the higher activating temperature, will activate the facility detection system through the training system fire alarm panel and de-energize the simulator and all peripheral equipment. **(T-1)**

15.6.1.2.2. Ultra-sensitive smoke detection systems will be provided to protect electrical, electronic, and computer cabinets. **(T-1)** A minimum two-stage warning capability will be provided. **(T-1)** The first, more sensitive stage will produce a distinctive audible signal. **(T-1)** Activation of the second, less sensitive stage will activate the facility detection system through the training system fire alarm panel and de-energize the simulator and all peripheral equipment. **(T-1)**

15.6.1.2.3. If detection equipment is in an unoccupied area, e.g., computer rooms, a means will be provided to positively alert operators at the instructor operator station. **(T-1)** If multiple unoccupied computer areas are present, then a means will be provided to inform the instructor operator station which unoccupied area has the activated alarm. **(T-1)**

15.6.1.3. A fire alarm graphic annunciator or display panel, to identify training system fire detection systems signals, will be installed IAW NFPA 72, *National Fire Alarm and Signaling Code.* **(T-0)** Each detection device will be identified by light emitting diodes, or other readily visible means, in the graphic annunciator or display panel. **(T-1)**

15.6.1.4. The fire detection system will be powered by a dedicated circuit with backup battery power and connected to the facility electrical supply ahead of the training system disconnect switch. **(T-1)**

15.6.1.5. The fire detection system will be capable of operating from both 50 and 60 hertz. **(T-1)**

15.6.1.6. The system fire detection and alarm control panel will 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. **(T-0)** This may be through the facility fire alarm transmitter or an independent fire alarm transmitter. Contact F&ES Flight for fire alarm and receiving equipment requirements. **(T-1)**

15.6.1.7. Interface of Facility and Training System Fire Protection Systems.

15.6.1.7.1. Required functions upon activation of the facility fire alarm system (without activation of any suppression system in the facility):

15.6.1.7.1.1. Occupants in the training spaces will be notified of the alarm

condition through audible (e.g., siren, horn, bell, etc.) and visual (strobe) cues. **(T-1)** Occupants of the facility (including those in the training spaces) will exit the facility immediately without delay, following the facility's preexisting emergency evacuation plan. **(T-1)**

15.6.1.7.1.2. For training systems meeting the requirements of **paragraph 15.4,** the instructor may place the training system in a standby mode, system freeze or other appropriate conditions prior to evacuation. **(T-1)**

15.6.1.7.1.3. For existing facilities and training systems awaiting upgrade to comply with **paragraph 15.4,** the training system power source will be shut down. **(T-1)** This shutdown may be accompanied by an automatic emergency power off or by an automatic, rapid, sequenced shutdown. **(T-1)** Also see **paragraph 15.7**.

15.6.1.7.2. The training system power source will shut down. **(T-1)** This shutdown may be accomplished by an automatic emergency power off or by an automatic, rapid, sequenced shutdown.

15.6.1.7.3. Required functions upon activation of a training system fire detection system only (without activation of any fire suppression system):

15.6.1.7.3.1. Training staff will 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. **(T-1)**

15.6.1.7.3.2. The training system will automatically emergency power off 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 **paragraph 15.4**. **(T-1)**

15.6.1.7.4. Required functions upon activation of a training system fire suppression system — the training system power source will automatically turn emergency power off. **(T-1)**

15.6.1.7.5. Training staff will be provided with means to manually emergency power off whenever necessary for the safety of the staff, students, or the equipment, prior to exiting the facility. **(T-1)**

15.6.1.7.6. Following an emergency power off, the training system fire alarm system will notify occupants throughout the facility of the alarm condition through audible (siren, horn, bell, etc.) and visual (strobe) cues. **(T-1)**

15.6.2. Fire Stops. All cable trays, utility trenches, etc., that connect to spaces outside training system spaces will have fire stops installed every 25 feet. **(T-1)**

15.6.3. 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, will have automatic smoke and fire dampers to shut off the space from the remainder of the facility on any facility fire alarm indication. **(T-1)** Facility fire alarm activations originating outside the training system space do not require deactivation of the air handling system that serves an individual training system.

15.6.4. Specifications for Cable and Wiring.

15.6.4.1. Polyvinyl chloride coated wire will not be used in the cockpit areas of non-commercial-off-the-shelf hardware and/or training systems. **(T-1)** Plenum rated cable and wiring meeting the requirements of NFPA 70, Article 300.22, *Wiring Methods,* will be used. **(T-0) Note**: Polyvinyl chloride coated wire is allowed in the cockpit areas of commercial-off-the-shelf 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.

15.6.4.2. Communications and interconnecting cable and wiring between components within the training system space and raised floor space will comply with NFPA 70, Article 670, *Industrial Machinery,* and those in the training system space and other areas of the facility or other facilities will comply with NFPA 70, Article 725. **(T-0)**

15.6.4.3. Power and signal cable groups in which heat cannot quickly dissipate will contain a heat sensor wire or other heat sensing device. **(T-1)**

15.6.4.4. Cable and wiring for the training system fire alarm system will comply with NFPA 70, Article 760, *Fire Alarm Systems.* **(T-0)**

15.6.5. Power Disconnect Means. A means to disconnect electrical power to the entire training system will be provided at all instructor operator stations and at other key locations on the training system. **(T-1)**

15.6.6. Computer and/or Electronic Cabinets.

15.6.6.1. Self-contained air conditioning systems will include a product of combustion detector capable of sounding an audible alarm and activating the facility detection system. **(T-1)**

15.6.6.2. Cabinets near a motion base water fog or spray deluge system will be water resistant or shielded from water discharge. **(T-1)** Cabinets near a motion base wet pipe sprinkler system do not require special protection.

15.6.6.3. 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. **(T-1)**

15.6.7. Instructor Operator Station.

15.6.7.1. A means to activate the facility fire detection system will be provided in easy reach of the operators at the instructor operator station. **(T-1)** Normally, a standard manual fire alarm station will be provided on the operator's console with provision to interconnect to the facility alarm and detection system, and to initiate a training system emergency power off. **(T-1)**

15.6.7.2. Smoke detection devices will be provided in the instructor operator station when located in an enclosed container and/or space not part of the facility. **(T-1)** Activation of this system will alert the training system occupants and the operators at the instructor operator station. **(T-1)**

15.6.7.3. A facility alarm annunciator will be installed when the instructor operator station is in an enclosed container and/or space not part of the facility. **(T-1)**

15.6.8. Cockpit and/or Other Crew Stations.

15.6.8.1. Single station smoke detection devices will be provided in cockpits and other enclosed crew stations. **(T-1)** Battery powered detectors will not be used.

15.6.8.2. The cockpit will be designed to preclude or restrict passage of smoke and gases through the cockpit floor or sides. **(T-1)**

15.6.8.3. A means will be provided to alert cockpit and/or other crew station occupants of a positive activation of the local and facility detection systems. **(T-1)**

15.6.8.4. Training station ventilation will be shut down if the training system fire detection is activated. **(T-1)**

15.6.9. Motion Base.

15.6.9.1. The motion system will return to the rest position within 10 seconds of activation of either the system fire detection system or the facility fire suppression system. **(T-1)** Access ramps will automatically deploy after motion is stopped, even when power is removed. **(T-1)**

15.6.9.2. Hydraulically powered motion bases will comply with **paragraph 15.4.2** and the following:

15.6.9.2.1. Rate-compensated type thermal fire detection devices will be provided under each motion platform. **(T-1)** These rate-compensated type thermal fire detection devices are not required when all the following conditions are met:

15.6.9.2.1.1. The training system is in a facility fully protected by a wet pipe sprinkler system.

15.6.9.2.1.2. Flight training devices and associated controls are in spaces protected by ultra-sensitive smoke detection systems as defined in UFC 3-600-01.

15.6.9.2.1.3. The cockpit/crew stations located on the motion base fully comply with the cockpit/crew station requirements listed in **paragraph 15.6.8**. **(T-1)**

15.6.9.2.2. A wet pipe sprinkler system (sprinkler heads and piping) will be provided as part of each motion base. **(T-0)** 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; flight training devices and associated controls are located in spaces protected by ultra-sensitive smoke detection systems as defined in UFC 3-600-01; and the cockpit/crew stations located on the motion base fully comply with the cockpit/crew station requirements listed in **paragraph 15.6.8**. The exact position for each sprinkler and number of sprinklers will be defined for each motion base to ensure complete coverage and prevent interference with each hydraulic actuator's range of motion. **(T-1)** The system will deliver a minimum of 0.35 gallons per minute per square foot of area under the motion base. **(T-0)** Normally, sprinkler piping is interconnected with the facility sprinkler system, but a separate system riser with separate flow detection is acceptable.

15.6.9.2.3. A pre-action sprinkler system is permitted for the motion base in lieu of the wet pipe sprinkler system listed in **paragraph 15.6.9.2.2** when approved in writing by the DFPE per UFC 3-600-01. The rate-compensated type thermal fire detection devices

listed in **paragraph 15.6.9.2.1** will be used to activate the pre-action functions of the system. **(T-1) Note**: Increased procurement, operational and maintenance expenses are associated with the use of pre-action sprinkler systems.

15.7. Upgrade of Existing Aircraft Flight and Similarly High Value Training Systems. Existing facilities and training systems may continue in use while awaiting an upgrade to comply with **paragraph 15.4,** if they comply with all the following:

15.7.1. Facilities. No Category I or II fire safety deficiencies exist.

15.7.2. 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 OSH standards or previous (superseded) revisions of this DAFMAN. Training systems currently identified to be upgraded to previous (superseded) editions of this DAFMAN may be upgraded as programmed provided Halon 1301 or other gaseous agents are not part of the upgrade.

15.7.3. Maintenance. All installed fire protection features will be regularly serviced and maintained in operational condition.

15.7.4. Halon. Existing Halon fire suppression systems will be placed on manual activation and automatic discharge mechanisms disabled. **(T-1)** Existing Halon fire suppression systems will not be re-serviced following discharge, and the training device will remain operational. **(T-1)** Training systems developed with Halon fire suppression systems will transition to current standards during any major modification. **(T-1)**

Chapter 16

MOBILE ELEVATING WORK PLATFORMS AND SCAFFOLDING

16.1. Scope. This chapter applies to vehicle-mounted elevating and rotating platforms, including work platforms and aircraft maintenance equipment used for elevating employees and scaffolding requirements. 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 DAF 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.

16.1.1. Refer to 29 CFR § 1910, Subpart D – *Walking-Walking Surfaces,* 29 CFR § 1910, Subpart F – *Powered Platforms, Manlifts and Vehicle-Mounted Work Platforms,* and 29 CFR § 1910.27, *Scaffolds and Rope Descent Systems,* for additional guidance. All fall prevention and protection options must be evaluated and approved by a qualified person before use.

16.1.2. Modifications to mobile elevating work platforms and scaffolding must be approved and certified in writing by the manufacturer. **(T-0)** 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. **(T-0)**

16.2. Hazards. Mobile elevating work platforms and scaffolding hazards examples include:

16.2.1. Falls from elevation.

16.2.2. Getting struck by falling objects.

16.2.3. Electrical shock.

16.2.4. Faulty/broken equipment, e.g., loose/bad planking.

16.2.5. Working surface hazards, such as holes that cause the platform/scaffolding to fall over.

16.3. Training.

16.3.1. Training will be provided to each affected employee who is required to perform work on mobile elevating work platforms and scaffolding. **(T-0)** Supervisors will train each employee on the requirements found in **Attachment 3** of this standard, 29 CFR § 1910.30, *Training Requirements – Walking-Working Surfaces,* and manufacturer's requirements. **(T-0)** Hands-on training will be provided as part of on-the-job training. **(T-1)**

16.3.2. Retraining. Affected employees will be retrained:

16.3.2.1. When an employee fails to demonstrate the required level of understanding and skill to safely operate the equipment or has an accident or near miss while operating the equipment. **(T-0)**

16.3.2.2. Where changes to the workplace create new hazards that render the previous training obsolete or inadequate. **(T-0)**

16.3.2.3. When there are changes to the type of equipment used that make the previous training obsolete or inadequate.

16.3.2.4. When the operator is required to operate equipment at a new duty location. **(T-0)**

16.3.3. Supervisors will document training IAW **paragraph 1.8** of this standard and DAFI 91-202. **(T-1)**

16.4. Vehicle-Mounted Elevating and Rotating Work Platforms.

16.4.1. Procurement. All vehicle-mounted elevating and rotating aerial devices will be maintained to the requirements of the manufacturer. **(T-0)**

16.4.2. Modifications. Modifications will conform to ANSI/SAIA A92.2 and 29 CFR § 1910.67, *Vehicle-Mounted Elevating and Rotating Work Platforms,* and will be documented on the appropriate form. **(T-0)** 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. **(T-0)**

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 will be at least 10 feet. **(T-0)**

16.4.3.1.2. For lines rated over 50 kV, the minimum clearance between lines and any part of the aerial lift will be at least 10 feet plus 4 inches for each 10 kV over 50 kV. **(T-0)** Refer to 29 CFR § 1910.333, *Selection and Use of Work Practices,* for additional information.

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 work and work is performed by trained telecommunications employees, line clearance tree-trimming employees, 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, Operations and Maintenance (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 uninsulated parts of the aerial lift and power line may be reduced to the distance in UFC 3-560-01, 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 will be considered energized. **(T-0)** Personnel standing on the ground will not contact any part of the lift unless using protective

equipment rated for the voltage. **(T-0)** Refer to **Chapter 28,** *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. Refer to the operator's manual or applicable TO for specified wind limits.

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**. **(T-0)**

16.4.5. Inspection and Test Procedures.

16.4.5.1. Aerial ladders will 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. **(T-0)** Refer to manufacturer's instructions 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 24-302, *Vehicle Management*. **(T-1) Note:** Aerial devices used for firefighting will be inspected and tested at least annually IAW NFPA 1914, *Standard for Testing Fire Department Aerial Devices.* **(T-1)** Qualified F&ES 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 will be documented IAW AFI 24-302. **(T-1)** Refer to ANSI/SAIA A92.2 for additional information.

16.4.5.2. Articulating and extendible boom platforms will be inspected and tested annually. **(T-0)** Special inspections and tests will 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. **(T-0)** Refer to the manufacturer's manual for inspection requirements. Inspections will be a joint effort by the principal operator and a vehicle mechanic qualified to perform annual inspections of the vehicle. **(T-1)** The inspection and test will be documented IAW AFI 24-302. **(T-1)** 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 will not apply and testing will be accomplished in accordance with applicable TOs or manufacturer's maintenance manual. **(T-1)**

16.4.5.3. Refer to 29 CFR 1926.1431, *Hoisting Personnel*, for information on use of cranes or derricks to hoist personnel work platforms during construction activities.

16.4.6. Operations.

16.4.6.1. ANSI/SAIA A92.2 requires aerial device manufacturers to provide manuals to dealers and direct sale purchasers. DAF users will ensure manuals are readily available (stored in weather-resistant compartments provided by manufacturers) to employees. **(T-1)** These manuals will contain:

16.4.6.1.1. Description, specifications, and ratings of the aerial device. **(T-1)**

16.4.6.1.2. Operating instructions for aerial devices and their auxiliary systems. **(T-1)**

16.4.6.1.3. Precautions relating to multiple configurations such as performing aerial work from a moving vehicle. **(T-1)**

16.4.6.1.4. Instructions regarding routine maintenance and frequency of recommended maintenance. **(T-1)**

16.4.6.1.5. Replacement part information. **(T-1)**

16.4.6.1.6. Instruction markings per **paragraph 16.4.6.2**. **(T-1)**

16.4.6.2. Each aerial device will 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. **(T-1)**

16.4.6.2.2. Rated capacity. **(T-1)**

16.4.6.2.3. Platform height. **(T-1)**

16.4.6.2.4. Maximum recommended operating pressures of hydraulic and/or pneumatic systems. **(T-1)**

16.4.6.2.5. Hazards that are inherent in operation of an aerial device. **(T-1)**

16.4.6.2.6. Manufacturer's marking which describes the function of each control. **(T-1)**

16.4.6.2.7. Insulated or non-insulated. **(T-1)** **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. **(T-1)**

16.4.6.2.9. Year of manufacture. **(T-1)**

16.4.6.2.10. Number of platforms. **(T-1)**

16.4.6.2.11. Category of aerial devices. **(T-1)**

16.4.6.2.12. Manufacturer's rated line voltage. **(T-1)** 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 will not be removed from the device, painted over or otherwise made unavailable for reference by the operator. **(T-1)** **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. The plate will not be removed or painted over. **(T-1)**

16.4.6.3. Employees required to use vehicle-mounted elevating and rotating work platforms will be thoroughly trained in all aspects of the job before using this equipment. **(T-0)** Refer to **paragraph 16.3.**, *Training,* and **Attachment 3** for more information.

16.4.6.4. Aerial devices will be secured in the specified lower traveling position (to prevent rotation) using cradles or locking devices IAW manufacturer's instructions before moving the equipment as cargo. **(T-0)**

16.4.6.5. The unit will 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. **(T-0)** The override feature explained in **paragraph 16.4.6.6** will be tested at this time**. (T-0)** IAW ANSI/SAIA A92.2, a record of this test will only be documented if a discrepancy was found with the unit during the inspection. **(T-1)**

16.4.6.6. Articulating and extendible boom platforms, primarily designed as personnel carriers, will have both platform (upper) and lower controls. **(T-0)** Upper controls will be in or beside the platform within easy reach of the operator. **(T-0)** In order to prevent inadvertent actuation of the platform boom positioning controls, operation of an unlocking device will precede use of the control itself and will be maintained simultaneously during use of the controls. **(T-0)** The unlocking device may be incorporated into each control. Lower controls will override upper controls. **(T-0)** Controls will be plainly marked with their function. **(T-0)** The override mode will prevent boom movement with the lower control station unattended. Lower-level controls will not be operated without permission from the employee in the lift, except in an emergency. **(T-0)** Whenever an employee is in or on an elevated work platform, at least one person qualified to operate the equipment will be stationed near the lower-level control panel. **(T-0) Exception**: Personnel working in or on an elevated boom without a qualified person near the lower-level control panel is permitted if manufacturer's instructions allow for such operations.

16.4.6.6.1. Emergency Stop. The platform will have an emergency stop control which will stop all platform movement. **(T-0)** This control must not require continuous operator actuation to stop movement. **(T-0)**

16.4.6.6.2. Outrigger Controls. Aerial device outrigger controls will be guarded to protect against inadvertent operation and will return to neutral when released by the operator. **(T-0)** These controls will be located so the operator can see the outrigger being operated. **(T-0)**

16.4.6.7. Boom and basket load limits specified by the manufacturer will not be exceeded. **(T-0)**

16.4.6.8. Aerial lift trucks will not be moved with the boom elevated and personnel in the basket unless the lift truck is specifically designed for such operation. **(T-0)** In all cases, the manufacturer's operating instructions will be followed. **(T-1)**

16.4.6.9. Vehicle-mounted elevating and rotating work platforms will not be used during high winds, thunderstorms or any other adverse or mission-limiting weather conditions which could endanger employees using the platform. **(T-0)** Refer to the operator's manual or applicable TO for specified wind limits.

16.4.6.10. Platforms other than buckets or baskets will include a guardrail system which will:

16.4.6.10.1. Include a top rail, 42 inches high and at least one rail approximately midway between top rail and platform surface around its upper periphery. **(T-0)** Both rails will withstand 200 pounds of force applied in any direction. **(T-0)**

16.4.6.10.2. Include toeboards on all sides of platforms. **(T-0)** Toeboards will be securely fastened in place and with no more than 1/4-inch clearance above floor level.

(T-0) Exception: A toeboard is not required at the access opening. Where there is exposure to personnel or electrical wires below the platform, removable toeboards or the equivalent will be provided IAW 29 CFR § 1910.28, *Duty to Have Fall Protection and Falling Object Protection.* **(T-0)** The minimum toeboard height will be three and a half (3.5) inches. **(T-0)**

16.4.6.10.3. Include access for personnel entering the platform in the lowered position. **(T-0)** Access steps or rungs will have a slip-resistant surface. **(T-0)**

16.4.6.11. A full body harness and lanyard, sized to limit free fall distance to six feet or less, or the free fall distance permitted by the system, whichever is less, will be worn by each bucket or platform occupant. **(T-0)** Each lanyard will be attached to a designated anchor point on the boom or basket. **(T-0)** Fall restraint will be used when there is insufficient clearance for a PFAS. **(T-0) Note:** Fall restraint lanyards/connecting devices, whether fixed length or adjustable, must be short enough to prevent the employee from climbing out or being ejected from the basket. **(T-0)** Refer to 29 CFR §§ 1910.67 or 1910.140 for additional information.

16.4.6.12. Belting off to an adjacent pole, structure or equipment while working from an aerial lift will not be permitted. **(T-0)**

16.4.6.13. Employees will 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. **(T-0)**

16.4.6.14. Climber's equipment will not be worn while performing work from an aerial lift. **(T-0)**

16.4.6.15. Aerial devices, including insulated aerial devices, will not be brought into contact with energized or potentially energized conductors. **(T-0)** Employees will not rely on dielectric capabilities of aerial devices. **(T-0)**

16.4.6.16. Consult installation BE prior to work near suspected sources of non-ionizing radiation, e.g., radar and microwave equipment. **(T-1)** Refer to **Chapter 28** for additional guidance.

16.4.6.17. Before using an aerial device, the worksite will 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. **(T-0)**

16.4.6.18. Before and during each use, the operator will:

16.4.6.18.1. Check for overhead obstructions and electrical conductors. **(T-0)**

16.4.6.18.2. Ensure load weight does not exceed manufacturer's rated capacity. **(T-0)**

16.4.6.18.3. Ensure outriggers and stabilizers are used if required by manufacturer's instructions. **(T-0)**

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. **(T-0)**

16.4.6.18.5. Use outrigger pads when necessary to provide firm footing. **(T-0)**

16.4.6.18.6. Set brakes. **(T-0)**

16.4.6.18.7. Chock wheels before using the lift on an incline. **(T-0)**

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 will immediately be removed from service until repaired. **(T-0)** The manufacturer's recommended maintenance procedures will be followed, and tests outlined in **paragraph 16.4.5** will be conducted prior to returning an aerial device to service following repairs to the ladder, boom, or work platform. **(T-0)**

16.4.7.2. All repairs will be accomplished by qualified personnel. **(T-0)**

16.5. Manually Propelled and Self-Propelled Mobile Work Platform and Scaffolds (Towers).

16.5.1. Work platforms with work levels four feet or higher accessed by a ladder or stairway at an angle over 60º, will have guardrails, midrails and toeboards IAW **paragraph 16.4.6.10** on all four sides of the work platform. **(T-0) Exception**: A toeboard is not required at the access opening.

16.5.2. Working Loads.

16.5.2.1. Work platforms and scaffolds will carry their designed load under all conditions of use. **(T-0)** Aircraft maintenance work platforms will support design loads listed in their TOs. **(T-1)** Parts, additions, or accessories for safe use of platforms and scaffolds will be part of the design. **(T-1)**

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 will produce a mobile ladder stand or scaffold that will safely hold specified loads. **(T-1)** Materials selected will be strong enough to meet test requirements and protected against corrosion and deterioration. **(T-1)**

16.5.2.2.1. The design working load of ladder stands will be calculated based on one or more 250-pound persons with 50 pounds of equipment each. **(T-0)** Ladder stands and scaffolds will support at least 4 (four) times the design workload. **(T-0)**

16.5.2.2.2. Scaffold design workloads will be calculated based on:

16.5.2.2.2.1. Light – Designed and constructed for a workload of 25 pounds per square foot. **(T-0)**

16.5.2.2.2.2. Medium – Designed and constructed for a workload of 50 pounds per square foot. **(T-0)**

16.5.2.2.2.3. Heavy – Designed and constructed for a workload of 75 pounds per square foot. **(T-0)**

16.5.2.3. Mobile ladder stands and scaffold materials will meet strength, dimension and weight specifications in this standard to safely support the design workload. **(T-0)**

16.5.2.4. Bolts or other fasteners used to assemble ladders, scaffolds, and towers will be large enough and in sufficient quantity at each connection to develop designed strength. **(T-0)**

16.5.2.5. The operator must ensure there are no sharp edges, burrs, or other hazards to personnel on exposed surfaces. **(T-0)**

16.5.3. Work Levels.

16.5.3.1. Maximum work level height will not exceed four times the minimum or least base dimension (width) of any mobile ladder stand or scaffold. **(T-0)** Where the basic mobile unit does not meet this requirement, suitable outrigger frames will be used to obtain this least base dimension, or the unit will be tied with guy wires or braced to keep the unit from tipping. **(T-0)**

16.5.3.2. The minimum platform work level width for mobile scaffolds (towers) will not be less than 20 inches. Ladder stands will have a minimum step width of 16 inches. **(T-0)**

16.5.3.3. The supporting structure for the work level will be rigidly braced, using cross bracing or diagonal bracing with rigid platforms at each work level. **(T-0)**

16.5.3.4. Ladder stand steps will have slip-resistant treads or a slip-resistant coating. **(T-0)**

16.5.3.5. The work level platform of scaffolds will be wood, aluminum, plywood planking, steel or expanded metal, for the scaffold's full width, except for necessary openings. **(T-0)** Work platforms will be secured to the support structure. **(T-0)** Planking will be 2-inch (nominal) scaffold grade minimum 1,500 fiber (f) (stress grade) lumber or equivalent. **(T-0)**

16.5.3.6. Scaffold work platforms four feet or higher will have guardrails, mid-rails, and toeboards IAW **paragraph 16.4.6.10**. **(T-0)**

16.5.3.7. Scaffolds will have a climbing ladder or stairway (for access and egress) affixed or built into the scaffold. **(T-0)** The ladder or stairway will be located so it will not tip the scaffold. **(T-0)** A landing platform will be provided at intervals not exceeding 30 feet. **(T-0)**

16.5.3.8. Self-propelled elevating work platforms and manually propelled mobile work platforms will not be moved with personnel on the working platform unless allowed by manufacturer's instructions. **(T-0)** Locking pins or other devices, as required, must be in place IAW equipment-specific TOs or manufacturer's specifications before anyone is allowed to ascend the stairs or ladder. **(T-0)** If allowed by manufacturer's instructions the following requirements need to be accomplished prior to any movement with personnel on the working platform:

16.5.3.8.1. Guardrails, mid-rails, and toeboards will be installed on all exposed sides IAW **paragraph 16.4.6.10**. **(T-0)**

16.5.3.8.2. The floor or surface will be within 3° (0.6288 inches of rise in 12 inches of run) of level, smooth (the equivalent of broom-finished concrete) and free from pits, holes, or obstructions. **(T-0)**

16.5.3.8.3. The minimum dimension of the scaffolding base when ready for rolling will be at least one-half of the height. **(T-0)** Outriggers, if used, will be installed on all four sides of the scaffold, and then can be included as part of the base dimension. **(T-0)** **Note**: Measure at the widest width of the base.

16.5.3.8.4. All tools and materials are secured or removed from the platform before the mobile scaffold is moved. **(T-0)**

16.5.3.8.5. Employees on the mobile scaffold will be advised by a spotter and be aware of each movement in advance. **(T-0)**

16.5.3.8.6. Employees on the work platform of the mobile scaffold may move the scaffold when the mobile scaffold is equipped with a manual system in which the propelling force is applied to the wheels only and cannot exceed normal walking speed.

16.5.3.8.7. The force necessary to move the mobile scaffold will be applied as close to the base as practicable and provision will be made to stabilize the tower during movement from one location to another. **(T-0)**

16.5.3.9. Full-body harnesses will be worn with lanyard attached to the manufacturer-installed structural anchor point when using self-propelled mobile work platforms, with guardrails removed, and the platform elevated four feet or more above the surface. **(T-0)** Self-propelled work platforms manufactured without an approved structural anchor point will have protective guardrails, mid-rails and toeboards installed on all open sides IAW **paragraph 16.5.1** **(T-0)** When within 14 inches of the work surface, e.g., 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 will be provided and used on all removable railings and attachments. **(T-0)**

16.5.3.10. Personal fall arrest equipment anchorages will be capable of supporting at least 5,000 pounds (22.2 kilonewton [kN]) per worker attached or will be designed, installed, and used as part of a complete PFAS which maintains a safety factor of two, under the supervision of a qualified person. **(T-0)** Refer to **Chapter 13,** *Fall Protection,* and 29 CFR § 1910.140, *Personal Fall Protection Systems,* for additional guidance.

16.5.3.11. Lanyards, D-rings, snap-hooks, and all fall arrest system components will maintain a minimum breaking strength of 5,000-pounds (22.2 kilonewton [kN]) IAW 29 CFR § 1910.140. **(T-0)**

16.5.4. Operations.

16.5.4.1. Training requirements in **paragraph 16.3** also apply to all manually propelled elevating aerial platforms and self-propelled elevating work platforms.

16.5.4.2. Operators will know the location of operating and safety manuals, including the manual defining dealer, owner, lessor, lessee, user, and operator responsibilities on the aerial platform. **(T-1)** Operators will be familiar with and use these manuals when questions arise.

16.5.4.3. Aerial platforms will 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. **(T-0)**

16.5.4.3.2. Safety devices. **(T-0)**

16.5.4.3.3. Personal protective devices, including fall protection. **(T-0)**

16.5.4.3.4. Air, hydraulic and fuel system leaks. **(T-0)**

16.5.4.3.5. Cables and wiring harness. **(T-0)**

16.5.4.3.6. Loose or missing parts. **(T-0)**

16.5.4.3.7. Tires and wheels. **(T-0)**

16.5.4.3.8. Placards, warnings, and control markings. **(T-0)**

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. **(T-0)**

16.5.4.3.11. Any special items required by the manufacturer. **(T-0)**

16.5.4.3.12. Inspection deficiencies will be documented IAW applicable TO or local procedure for stands not covered by a TO. **(T-1)** A visible indicator, i.e., AF Form 981 or other means will be affixed to stands removed from service until repaired and returned to service. **(T-1)**

16.5.4.4. Refer to **paragraph 16.4.6.17** for workplace inspection information.

16.5.4.5. The operator will 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. **(T-0)**

16.5.4.5.2. Outriggers, stabilizers, extendable axles, or other stability enhancing means are used as required by the manufacturer. **(T-0)**

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. **(T-0)**

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. **(T-0)**

16.5.4.5.5. There is adequate clearance from overhead obstructions. **(T-0)**

16.5.4.5.6. Minimum safe approach distances to energized power lines and parts are maintained. **(T-0)**

16.5.4.5.7. All personnel on the platform will wear required fall protection devices and other safety gear when guardrails are removed. **(T-0)**

16.5.4.6. Users will inspect and maintain aerial platforms to ensure proper operation. **(T-0)** The frequency of inspection and maintenance will be based on the manufacturer's recommendations and compatible with operating conditions and severity of the operating environment. **(T-0)** Aerial platforms not in safe operating condition will be immediately removed from service until repaired. **(T-0)** A qualified person will make repairs IAW manufacturer's recommendations. **(T-0)** This periodic inspection will include those requirements in paragraphs **16.5.4.3** and **16.5.4.5**. **(T-1)**

16.5.4.7. Controls for manually elevated platforms will be clearly marked for direction and function. **(T-0)** Controls for platform elevating and lowering mechanisms will be self-holding and readily accessible from the ground. **(T-0)** Controls at the platform are optional.

16.5.4.8. Upper controls of power elevated platforms will be:

16.5.4.8.1. Clearly marked as to direction and function. **(T-0)**

16.5.4.8.2. A type that automatically returns to the off or neutral position when released. **(T-0)**

16.5.4.8.3. Protected against inadvertent operation. **(T-0)**

16.5.4.8.4. Readily accessible to the operator. **(T-0)**

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. **(T-0)**

16.5.4.9. Aerial platforms with a powered elevating assembly will have a clearly marked emergency lowering means readily accessible from ground level. **(T-0)**

16.5.4.10. The aerial platform will have a readily identifiable emergency stop device at upper control and lower control stations that will stop powered functions and platform movement. **(T-0)**

16.5.4.11. The control system will be designed so a single control system malfunction will not cause unintended platform movement. **(T-0)**

16.5.5. Wheels and Casters.

16.5.5.1. Wheel and casters will be sized to support four times the design working load. **(T-0)**

16.5.5.2. Scaffold casters will have a positive wheel and/or swivel lock to prevent movement. **(T-1)** Two of the four casters on ladder stands will swivel and be lockable. **(T-0)**

16.5.5.3. Screw jacks or other means for adjusting height will be provided where leveling of the elevated work platform is required. **(T-0)**

16.5.5.4. At least two brakes, wheel locks or permanently installed jacks will be operable on all mobile work platforms. **(T-0)**

16.5.6. Mobile Work Platforms.

16.5.6.1. Design. Units will be designed IAW paragraphs **16.5.1**, **16.5.2** and **16.5.4**. **(T-0)**

16.5.6.2. Base Width. The minimum base width will conform to **paragraph 16.5.3.1**. **(T-0)**

16.5.6.3. Bracing. Rigid diagonal bracing to vertical members will be provided. **(T-0)**

16.5.7. Mobile Ladder Stands.

16.5.7.1. Design. Units will comply with applicable requirements of paragraphs **16.5.1**, **16.5.2** and **16.5.4**. **(T-0)**

16.5.7.2. Base Width. Minimum base width will be IAW **paragraph 16.5.3.1** **(T-0)** Maximum base section length will be the total length of combined steps and top assembly, measured horizontally, plus 5/8 inch per step of rise. **(T-0)**

16.5.7.3. Steps. Steps will be uniformly spaced, with a rise of 9 to 10 inches, and a depth of at least 7 inches. **(T-0)** Slope of the steps section will be 55 to 60°, measured from the horizontal. **(T-0)** Refer to 29 CFR § 1910.23, *Ladders,* for more information.

16.5.7.4. Handrails. Units with at least 3 treads and 4 risers, or rising more than 30 inches, will be equipped with a stair rail and handrails IAW 29 CFR § 1910.28 and 29 CFR § 1926.1052, *Stairways.* **(T-0)** Handrails will be at least 29 inches high and the same height all along the step, measured vertically from the center of the step. **(T-0)**

16.5.7.5. Load design will meet requirements of **paragraph 16.5.2.2.1**. **(T-0)**

16.5.8. Mobile Work Platforms and Ladder Stands will:

16.5.8.1. Meet criteria in paragraphs **16.5.9 and 16.5.10 (T-0)** If these mobile work platforms have steps, they will meet mobile ladder stand criteria for step dimensions and handrails. **(T-0)**

16.5.8.2. Be maintained free of grease, oil, ice, snow, mud, or any other slippery substance or object which could cause slips and falls. **(T-0)** Step treads and walking surfaces will be in good repair. **(T-0)** Repair worn surfaces with suitable materials or make safe using abrasive or non-slip materials. **(T-0)**

16.5.8.3. Removable guardrails may be used on all open sides of aircraft maintenance platforms. Guardrails removed for material handling, will be replaced as soon as material handling is complete. **(T-0)** Protective guardrails are not required at the platform entrance if there is a ramp or stairway (angle less than 60º) IAW **paragraph 16.5.1**. Protective guardrails will 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 another working surface. **(T-0)** Guardrails will be installed on all open sides if platform levels are four feet or higher above ground or floor. **(T-0)** Bolts, pins or other locking devices will be provided and used on all removable railings and attachments. **(T-0)** Only guardrails and toeboards meeting criteria in **paragraph 16.4.6.10** will be used. **(T-0)**

16.5.8.4. Ensure prior to any user ascending a raised mobile platform: all locking devices (e.g., pins, collars) will be installed, hydraulic pressure will be released, the platform will be slowly lowered until locking devices are securely engaged, and hydraulic pressure valve(s) will be closed. **(T-0)** 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 will be met prior to starting any task or work. **(T-0)**

16.5.8.4.1. Ascending/descending work platform. The climbing apparatus will 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 60º from horizontal. **(T-0)** Personnel ascending/descending ladders will face the ladder and maintain a firm hold on the ladder. **(T-0)** Personnel ascending/descending stairs (less than or equal to 60º) will face the direction of travel and use handrails as depicted in **Figure 16.1**. **(T-0)**

Figure 16.1. Ascending/Descending Work Platform.

Note: Angle less than or equal to 60°, personnel ascending/descending stairs will face the direction of travel and use handrails. If the angle is greater than 60°, the climbing device will be considered a ladder and accessed like a ladder.

16.5.8.4.2. Refer to **Chapter 7,** *Walking – Working Surfaces,* for additional guidance on ladder safety.

16.5.8.5. Mark mobile work platforms with reflective materials to the maximum extent authorized by appropriate TOs, such as TO 35-1-3, *Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE)*. **(T-0)** When not being transported, mobile work platforms will be secured to prevent collision with aircraft, vehicles, or other equipment. **(T-1)** Designated flightline storage areas for mobile work platforms will be determined by AGE flight commander and airfield manager and approved by the Maintenance Group Commander. **(T-1)** Refer to **Chapter 24**, *Aircraft Flightline – Ground Operations and Activities,* for further guidance.

16.5.8.6. Mobile work platforms will be operationally inspected IAW the manufacturer's instructions, equipment TO, and TO 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures.* **(T-0)** Maintenance work stands will have four (in any combination) of the following: operational brakes, wheel locks or permanently installed jacks (e.g., two operational brakes and two permanently installed jacks). **(T-1)** No stand will be used unless all brakes are set and all wheels' casters locked. **(T-1)** Wheel will be locked either 90 or 180° from the caster lock pin if it interferes with the wheel brake handle. **(T-1)** 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.* All wheels and casters will be locked, and all brakes or jacks will be set on mobile work platforms when not in use to avoid rolling down slanted surfaces or being moved by wind. **(T-1)** Stands with defects will be tagged as unserviceable. **(T-0) Note 1**: Some maintenance work stands may only have two operational brakes and no permanently installed jacks. Both brakes are required to be set. **Note 2**: A daily inspection is not required for days the stand is not used.

16.5.8.7. When mobile work platforms are being moved:

16.5.8.7.1. Personnel and equipment may remain on self-propelled and manually propelled work platforms when moved if manufacturer's instructions allow such activity and the requirements of **paragraph 16.5.3.8** and subparagraphs are followed.

16.5.8.7.2. Platforms to be towed will be equipped with hitches designed for such purpose. **(T-0)**

16.5.8.7.3. The following rules apply when platforms are towed by vehicles:

16.5.8.7.3.1. Maximum towing speed for 1 maintenance stand is 10 miles per hour (MPH) and 5 MPH for 2 or more maintenance stands. **(T-1)** However, when surfaces and terrain make it necessary, speed will be reduced accordingly. **(T-1)**

16.5.8.7.3.2. 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 will be towed singly on a center mounted hitch. **(T-1)** Four-wheeled units will not be towed behind two-wheeled units. **(T-1)** Large pieces of AGE, when towed in tandem, will not block the driver's vision of the last item being towed. **(T-1)**

16.5.8.7.3.3. Safety pins will be used to secure pintle hooks and trailer hitches. **(T-1)**

16.5.8.8. Mobile work platforms used where static electricity is hazardous to the work operation, such as fuel cell repair or refueling vehicle maintenance, will be grounded and equipped with static discharge plates for personnel to dissipate accumulated static electricity. **(T-0)**

16.5.8.9. Maintain mobile work platforms and ladder stands IAW appropriate 35-series TOs. **(T-1)**

16.5.9. High Line Docks. High line docks are designed to be loaded by MHE to provide greater flexibility in loading and unloading operations. Due to the design of a high line dock, falls from them can create serious injury.

16.5.9.1. Inspection. Prior to use, high line docks will be inspected to ensure structural soundness of the equipment, that all safety equipment is in place and functioning, e.g., guardrails, and all attached equipment is functioning per manufacturer documentation. **(T-1)**

16.5.9.1.1. Pre-use inspections will be conducted to ensure serviceability. **(T-1)**

16.5.9.1.2. Quarterly, high line docks will be thoroughly inspected and documented on the AFTO Form 95. **(T-1)**

16.5.9.1.3. High line docks found in unserviceable condition will be marked IAW **paragraph 17.5** and removed from use. **(T-1)** Supervisors will ensure all affected personnel are made aware of unserviceable high line docks. **(T-1)**

16.5.9.2. Manufacturer instructions or training plans developed from instructions will be used to train personnel on proper use, safeguards, and inspection procedures. **(T-1)**

16.6. Scaffolding. This section applies to all scaffolding used in the DAF, except rolling scaffolds (mobile towers), which are covered in **paragraph 16.5**. With the many different brands, categories, and varieties of scaffolds, 29 CFR § 1910.27 provides the most practical criteria regarding the assembly, erection, storage, and safe use of scaffolding. Refer to **paragraph 16.5** for information on manually propelled mobile ladder stands, mobile work platforms, or mobile towers. Refer to **Table 16.1** for a list of typical types of scaffolding.

16.6.1. General Requirements.

16.6.1.1. Scaffolds will be provided when work cannot be done safely from the ground or from solid construction and will be erected, moved, dismantled, or altered only under the supervision and direction of a competent person trained in these activities. **(T-0)** Such work will only be performed by experienced, trained personnel under the direction of the competent person. **(T-0)** When ladders are used, they will conform to requirements in 29 CFR § 1926.451, *General Requirements – Scaffolds.* **(T-0)**

16.6.1.2. The footing or anchorage for scaffolds will be designed to support the maximum intended load without settling or displacement. **(T-0)** Unstable objects such as barrels, boxes, loose bricks, or concrete blocks will not be used to support scaffolds or planks. **(T-0)**

16.6.2. Guarding requirements. All guarding for scaffolding will meet the requirements specified in 29 CFR § 1910.27. **(T-0)**

16.6.3. Scaffolds and their components will be capable of supporting at least four times the maximum intended load. **(T-0)**

16.6.4. Scaffolds will not be altered or moved horizontally while in use or occupied. **(T-0)**

16.6.5. Scaffolds, their accessories and other devices prescribed in this chapter will be maintained in good condition. **(T-0)** Scaffold parts will be inspected by a competent person prior to use. **(T-0)** If any deficiencies are found, the scaffold must not be used until repaired or replaced. **(T-0)**

16.6.6. A ladder or equivalent safe access will be provided. **(T-0)**

16.6.7. Where swinging loads are being hoisted onto or near a scaffold, they will have a tag line or equivalent measures to control the loads and prevent contact with the scaffold. **(T-0)**

16.6.8. Employees will wear appropriate head protection (e.g., hard hats) during erection, while working on maintenance and teardown of scaffolding. **(T-0)** Protective gloves are also recommended.

16.6.9. Clearance Between Scaffolds and Power Lines. Scaffolds will 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. **(T-0) (Exception**: Scaffolds and materials may be closer to power lines, if the lines are de-energized, the lines are relocated, or a protective covering is installed to prevent accidental contact with the lines.) Verification of de-energization, relocation or insulation installation must be done prior to beginning work on erecting scaffolding. **(T-0)**

16.6.10. Adverse weather conditions such as ice, snow, rain, and wind can create a hazardous working surface. A plan will be established addressing adverse weather conditions and measures to be taken to protect employees performing work under adverse weather conditions. **(T-1)** The following rules will apply to work under adverse weather.

16.6.10.1. Personnel will not work on scaffolds covered with ice or snow. **(T-0)** If the work surface remains slippery after ice or snow removal, it will be sanded or otherwise treated to prevent employees from slipping. **(T-0)**

16.6.10.2. Personnel will not work on scaffolds during storms or high winds. **(T-0)** Due to the many types and uses of scaffolding, it is impractical to determine specific wind criteria

for work stoppage. The designated competent persons are responsible for assessing unsafe environmental and climatic work conditions and will take necessary preventive measures to protect employees. **(T-1)**

16.6.11. Tools, materials, and debris will not be allowed to accumulate in quantities that could cause a hazard. **(T-0)** When possible, containers will be provided on scaffolds for storage of loose materials. **(T-0)** Supervisors will ensure good housekeeping practices are followed to prevent tripping hazards. **(T-1)**

16.6.12. 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 will be consulted for assistance in determining the proper type of rope to use. **(T-0)**

16.6.13. Wire or fiber rope used for scaffold suspension will support at least six times the intended load. **(T-0)**

16.6.14. The use of shore scaffolds or lean-to scaffolds is prohibited.

16.6.15. Lumber sizes, when used in this publication, refer to nominal sizes except where otherwise stated.

16.6.16. Scaffolds will be secured to permanent structures by anchor bolts, reveal bolts or other equivalent means. **(T-0)** Window cleaners' anchor bolts will not be used. **(T-0)**

16.6.17. Special care will be taken to protect scaffold members, including wire or fiber ropes, when using heat-producing processes. **(T-0)**

16.6.18. A covered storage area is recommended to protect scaffolding from damage and deterioration.

16.6.19. Wooden parts of scaffolding will not be painted as paint can hide defects. **(T-0)** Clear varnish, lacquer, shellac, or linseed oil will be used when wood protection is needed. **(T-0)**

16.6.20. Individual employees will not attempt to manually lift or move scaffold members which are excessively heavy, or because of their shape or size, cannot be safely handled. **(T-0)** In these cases, assistance will be obtained from other employees or mechanical handling equipment will be used. **(T-1)**

16.6.21. Hand tools used to assemble scaffolding will be in good condition. **(T-0)** When powered hand tools are used, they will be electrically grounded or of double insulated construction. **(T-0)**

16.7. Tubular Welded Frame Scaffolds.

16.7.1. Scaffolds will be designed to comply with 29 CFR § 1910.27. **(T-0)** The installation CE office is the authorizing agency for scaffold erection. **(T-0)**

16.7.2. Scaffold vertical members will be properly braced by cross or diagonal braces. **(T-0)** Braces will automatically square and align vertical members, so the erected scaffold is always plumb, square and rigid. **(T-0)**

16.7.3. Spacing of panels or frames will be consistent with loads imposed. **(T-0)** Frames will be placed one on top of the other with coupling or stacking pins to provide vertical alignment of legs. **(T-0)**

16.7.4. Panels will be locked together vertically by pins or equivalent if uplift can occur. **(T-0)**

16.7.5. Scaffold over 50 feet in height will be erected IAW manufacturer's instructions and under the supervision of a qualified professional engineer. **(T-0)**

16.8. Tubular Welded Sectional Folding Scaffolds.

16.8.1. General. Scaffolds, including sectional stairway and sectional ladder scaffolds, will be designed and erected IAW **paragraph 16.5.6**. **(T-0)**

16.8.2. Stairway. Each section of folding stairway scaffold will include a stairway, detachable work platform and a sist of pivoting and hinged folding diagonal and horizontal braces. **(T-0)**

16.8.3. 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 will be reduced. **(T-0)** Sectional folding stairway scaffolds will not exceed 4 ½ feet in width and 6 feet in length. **(T-0)**

16.8.4. Sectional Folding Ladder Scaffolds. Sectional folding ladder scaffolds are light duty scaffolds, including special base (open end) sections designed for high clearance over obstructions. For special applications, six-foot folding ladder scaffolds, except high clearance base sections, will be designed as medium duty scaffolds. **(T-0)** A sectional folding ladder scaffold will not exceed 6 feet 6 inches in width for a 6-foot-long unit, 8 feet 6 inches for an 8-foot-long unit, 10 feet 6 inches for a 10-foot-long unit. **(T-0)** End frames of sectional ladder and stairway scaffolds will be designed so horizontal bearers provide support for multiple planking levels. **(T-0)**

16.9. Tube and Coupler Scaffolds.

16.9.1. Scaffolds will be designed and erected IAW 29 CFR § 1910.27. **(T-0)**

16.9.2. Couplers will be made of structural type material, such as drop-forged steel, malleable iron, or structural grade aluminum. **(T-0)** Use of gray cast iron is prohibited.

Table 16.1. Types of Scaffolding (not all inclusive).

Tube and Coupler Scaffolds
Tubular Welded Frame Scaffolds
Masons' Adjustable Multiple-Point Suspension Scaffolds
Two-Point Suspension Scaffolds (Swinging Scaffolds)
Stone Setters' Adjustable Multiple-Point Suspension Scaffolds
Single-Point Adjustable Suspension Scaffolds
Boatswains' Chairs
Carpenters' Bracket Scaffolds
Bricklayers' Square Scaffolds
Horse Scaffolds
Needle Beam Scaffolds
Plasterers, Decorators and Large Area Scaffolds
Interior Hung Scaffolds
Ladder-Jack Scaffolds
Window-Jack Scaffolds

Roofing Brackets
Crawling Boards or Chicken Ladders Float or Ship Scaffolds

Chapter 17

MISHAP PREVENTION SAFETY SIGNS, TAGS AND LABELING

17.1. Scope. This chapter outlines DAF requirements for safety, health, fire prevention signs and tags, piping systems and compressed gas cylinders safety color coding, labeling, and marking. **Table 17.1** lists the regulatory guidance that governs safety signs, tags, labeling and markings. These requirements apply to all work environments, except for the following:

17.1.1. Signs or tags unique to aircraft, motor vehicles, and railroad or marine operations.

17.1.2. Piping system sections buried underground, in concrete or part of vehicles or field mobility equipment/systems, etc.

Table 17.1. Regulatory Guidance for Mishap Prevention Safety Signs, Tags and Labeling.

Specific Area	Regulatory Guidance
Safety color coding	29 CFR § 1910.144, Safety Color Code for Marking Physical Hazards
Preventions signs and tags	29 CFR § 1910.145, Specifications for Accident Prevention Signs and Tags
Bulk petroleum products systems	Current MIL-STD-161, DoD Standard Practice: Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels
Color code for pipelines, piping systems and compressed gas cylinders	Current MIL-STD-101, DoD Standard Practice: Color Code for Pipelines and for Compressed Gas Cylinders ASME A13.1, Scheme for the Identification of Piping Systems
Signs design	UFC 3-120-01, Design: Sign Standards
Exit signs	NFPA 101, Life Safety Code UFC 3-600-01, Fire Protection Engineering for Facilities
Fire hazards signs	NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response
Electrical equipment labeling	UFC 3-560-01, Operation and Maintenance: Electrical Safety
Signs and symbols for explosive materials	DESR 6055.09_DAFMAN 91-201, Explosives Safety Standards
Laser hazard warning signs	AFI 48-139, Laser and Optical Radiation Protection Program
Radio frequency radiation warning signs	AFI 48-109, Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program
Ionizing radiation warning signs	AFMAN 40-201, Radioactive Materials (RAM) Management AFMAN 48-148, Ionizing Radiation Protection 10 CFR § 20, Standards for Protection Against Radiation
Toxic and hazardous substances warning signs	29 CFR § 1910, Subpart Z – Toxic and Hazardous Substances
General environmental controls signs	29 CFR § 1910.145, Specifications for Accident Prevention Signs and Tags
Hazardous noise	29 CFR § 1910.95, Occupational Noise Exposure

17.2. Hazards and General Information.

17.2.1. Work Hazards. Preventive signs, tags, color coding, labeling or markings will be used wherever a hazard is present in the workplace. **(T-0)** The following are examples of workplace hazards (This is not an all-inclusive list):

17.2.1.1. Physical hazards, e.g., electricity, radiation, high exposures to sunlight/ultraviolet rays, temperature extremes, noise, flying or falling particles, sharp edges.

17.2.1.2. Chemical and dust hazards, e.g., cleaning products, paints, acids, solvents, welding fumes, gases, flammable materials, pesticides, respirable crystalline silica.

17.2.1.3. Biological hazards, e.g., blood/other body fluids, fungus (mold), bacteria, viruses, plants, insect bites, animal/bird droppings.

17.2.2. Signs, tags, color coding, labeling and markings are an effective means for communicating hazard information to employees to prevent injuries and illnesses.

17.2.2.1. Signs and tags are not substitutes for abatement action using the hierarchy of controls, such as elimination, substitution, engineering controls and administrative controls.

17.2.2.2. Wording on signs and tags will be concise, accurate, easy to read, contain sufficient information to be easily understood. **(T-0)**

17.2.2.3. Interior and other installation specific signs will be designed IAW UFC 3-120-01, where applicable. **(T-1)** Where OSHA has specific requirements, they will be followed in addition to applicable federal, state, or municipal regulations. **(T-0)**

17.2.3. Availability of Safety Signs and Tags. The functional manager or supervisor will ensure an adequate supply of safety signs and tags is available to employees. **(T-1)**

17.2.4. Other signs or tags prescribed by DAF directives for site-specific hazards will be brought to the attention of HQ AFSEC/SEG, e.g., signs or tags that may be included in this instruction or clarification of usage. **(T-1)**

17.2.5. Identification of Hazards.

17.2.5.1. Employees will immediately advise supervisors of unsafe conditions. **(T-0)**

17.2.5.2. Supervisors will evaluate the situation, ensure an appropriate preventive sign, tag, color coding, labeling and/or marking is attached/applied. **(T-0)**

17.2.5.2.1. The supervisor will coordinate placement of tags and assignment of RACs with the Occupational Safety office, F&ES Flight, and installation BE. **(T-1)**

17.2.5.2.2. The supervisor, or person in charge at the time, is responsible for issuing tags. If they have questions, contact the Occupational Safety office, F&ES Flight, or installation BE. **(T-1)**

17.3. Training.

17.3.1. All exposed employees will be instructed in the classification and use of safety, health and fire prevention signs and tags, to include, piping systems safety color coding, labeling and markings IAW 29 CFR § 1910.144 and 1910.145. **(T-0)** Supervisors will ensure training is accomplished and that employees are knowledgeable of the requirements. **(T-0)**

17.3.2. Retraining. Employees will be retrained when:

17.3.2.1. Changes in their job assignments occur, such as a change in machinery, equipment or processes that present a new hazard. **(T-0)**

17.3.2.2. Changes in the workplace may result in a new hazardous condition. **(T-0)**

17.3.2.3. Inadequacies in an employee's knowledge indicate that the employee has not retained the requisite understanding of the purpose of safety signs, tags, and labels. **(T-0)**

17.4. Sign Requirements.

17.4.1. Signs will be uniform and properly worded and located. **(T-0)** The meaning will be immediately and clearly understood as an automatic warning, caution or notice to all personnel no matter where they work IAW 29 CFR § 1910.145(c) through (e). **(T-0)**

17.4.1.1. To prevent confusion, avoid grouping too many signs together in the same location.

17.4.1.2. Signs will not be placed on moveable objects or adjacent to moveable objects like wheeled equipment, removable partitions, doors, etc., which, if moved, will obscure the sign.

17.4.1.3. Signs will have adequate illumination. **(T-0)** Where illumination is inadequate under emergency conditions, signs will be equipped with means of illumination, such as battery operated power source, be luminescent or both. Consult installation CE for lighting guidance concerning specific locations.

17.4.1.4. Multi-lingual Signs. Use multi-lingual signs in the languages understood by employees to ensure all employees understand warnings. **(T-0)** 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.

17.4.1.5. Criteria for Color Coding for Signs and Tags. Safety color coding for warning signs and tags alerts employees to the presence of hazards. Color specifications in this publication are IAW 29 CFR §§ 1910.144 and 1910.145.

17.4.2. Types of Signs – Color Identification and Use.

17.4.2.1. Danger, warning, and caution signs will be followed and used IAW 29 CFR § 1910.145. **(T-0)**

17.4.2.2. DAF Form 1118, *Notice of Hazard,* is considered a sign. DAF Forms 1118 are issued only by Occupational Safety office, F&ES Flight, or installation BE to notify employees of a hazardous condition that could result in serious injury, disability, or death. **Note**: AF Form 979*,* equivalent DoD, or commercial Danger Tags may be used temporarily until an DAF Form 1118 is issued. These 8" x 10" red bordered forms identify hazardous conditions, any interim control measures in effect and permanent corrective actions underway or programmed. Refer to DAFI 91-202 for instructions on RACs and preparing the DAF Form 1118.

17.4.2.3. Signs for Fire Hazards or 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 Materials for Emergency Response,* used by the F&ES Flights. F&ES Flight can provide additional information on fire hazards of materials.

17.4.2.4. Signs and Symbols Used to Identify Explosive Materials. DESR 6055.09_DAFMAN 91-202 provides reference to North Atlantic Treaty Organization (NATO) and Standardization Agreements (STANAG) to address items and substances

assigned to United Nations dangerous goods Class I (explosives, munitions, propellants, and pyrotechnics) according to the hazard they present.

17.4.2.5. Electrical equipment labeling and placarding will comply with UFC 3-560-01. **(T-0)**

17.4.2.6. Exit signs will clearly identify the means of egress from facilities IAW NFPA 101. **(T-0)** Refer to UFC 3-600-01 for further guidance.

17.4.2.7. Directional signs, other than emergency exit signs, indicate the way to stairways, medical offices, health stations, emergency showers, etc., and will be designed IAW UFC 3-120-01. **(T-0)**

17.4.2.8. Instruction and identification signs designed IAW UFC 3-120-01 will be used to convey general instructions or identify PPE or systems. **(T-0)**

17.4.2.9. Laser hazard warning signs and labels will conform to and be used IAW AFI 48-139. DoDI 6055.01, *DoD Safety and Occupational Health (SOH) Program,* outlines the military exemption for laser hazard communication. **(T-0)**

17.4.2.10. 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 will be followed and used IAW AFI 48-109. **(T-1)**

17.4.2.11. Biological hazard signs will conform to and be used IAW 29 CFR § 1910.145. **(T-0)**

17.4.2.12. Ionizing radiation warning signs, placards and forms will conform to and be used IAW AFMAN 48-148 and AFMAN 40-201. **(T-1)** Ionizing radiation warning signs, placards, and forms will also meet the requirements of 29 CFR § 1926.53, *Ionizing Radiation.* **(T-0)** Electrical equipment labeling and placarding will comply with UFC 3-560-01. **(T-1)**

17.4.2.13. Toxic and hazardous substances warning signs will conform and be used IAW 29 CFR § 1010, Subpart Z, *Toxic and Hazardous Substances,* e.g., asbestos, lead, respirable crystalline silica. **(T-0)**

17.5. Safety, Fire Prevention and Health Tag Requirements. Tags are a temporary means of warning employees 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 will only be used until a positive means can be used to eliminate the hazard. **(T-1)** For example, a "Do Not Start" tag is affixed to a machine until the machine can be locked out, de-energized or inactivated.

17.5.1. The following apply to all DAF safety, fire prevention and health tags prescribed by this publication. Requirements unique to a particular tag appear in the tag's instructions.

17.5.1.1. RACs will be assigned by the Occupational Safety office, F&ES Flight, or installation BE. **(T-1)** A RAC will not be assigned to equipment issued during routine maintenance or servicing. **(T-1)** For example, TO-directed tagging of the starter switch during engine maintenance does not require a RAC.

17.5.1.2. Notification requirements do not apply when Danger Tags are installed IAW applicable TOs, DAF publications, or other-directed requirements, including routine

maintenance functions on aircraft or missile systems. For example, occupational 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.

17.5.1.3. Equipment records will be annotated to reflect current tag status. **(T-1)** Tag logs may be maintained to identify tags currently in use in a work area.

17.5.1.4. Local commanders will implement internal procedures to ensure coordination of tags between supervisors and the Occupational Safety office, F&ES Flight, and installation BE. **(T-1)**

17.5.1.5. Removal of Danger and Caution Tags. The supervisor, with coordination from the Occupational Safety office, F&ES Flight, or installation BE is responsible for removing the tag after the hazardous condition has been corrected. Maintenance logs, where maintained, will be annotated that the hazardous condition has been corrected and tag removed. **(T-1)** The Occupational Safety office will be notified during normal duty hours that the tag has been removed. **(T-1)** Notification will not be later than the following duty day. **(T-1)** **Note**: Removal of danger tags prescribed by TOs, DAFIs, DAFMANs, AFMANs or AFIs for routine aircraft or missile/munitions maintenance actions need not be coordinated with the Occupational Safety office, F&ES Flight, or installation BE.

17.5.1.6. Removal of *Warning: Do Not Start* Tags. The supervisor is responsible for removing the tag after the condition has been corrected.

17.5.2. Mishap prevention tags prescribed below (Danger, Warning, Caution, Out of Order and Do Not Start) will meet requirements of DAFI 91-202 and 29 CFR § 1910.145. **(T-0)** Tag text will be provided by, and the reverse side completed by, the responsible on-duty supervisor. **(T-1)** Refer to **paragraph 17.5.2.4** for additional information when using the AF Form 981, AF Form 982, equivalent DoD, or commercial tag. **Note**: RACss assigned by the Occupational Safety office, F&ES Flight, or installation BE will be included in the "Hazard" description block on the front side of the tag. **(T-1)**

17.5.2.1. AF Form 979, *Danger Tag.* Danger tags, including equivalent DoD and commercial danger tags, will 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. **(T-1)** A Danger tag will be placed on damaged equipment and immediate arrangements will be made to take the equipment out of service until repaired. Tag wording will read, "DO NOT USE THIS EQUIPMENT" or "DEFECTIVE EQUIPMENT, DO NOT USE." **(T-1)**

17.5.2.2. Warning tags, including equivalent DoD and commercial warning tags, will identify items which could cause damage to equipment or death or serious injury to personnel. **(T-1)** 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 supervisor or the Occupational Safety office, F&ES, or installation BE for guidance on the appropriate tag to use.

17.5.2.3. AF Form 980, *Caution Tag.* Caution tags, including equivalent DoD and commercial caution tags, will only be used where a hazard can damage equipment, or a potential hazard or unsafe practice presents a lesser threat of an employee injury. **(T-1)**

17.5.2.4. AF Form 981, *Out of Order Tag.* Out of Order tags, including equivalent DoD and commercial tags, will only be used to indicate a piece of equipment, machinery, utility, or system is out of order and its use might be hazardous. **(T-1)** If reparable, a TO-prescribed green tag may be used in place of the Out of Order tag. Applicable equipment records, when available, will be annotated in addition to completing the Out of Order tag. The energy source will be controlled per **Chapter 21** if turning on the equipment could result in an injury or damage. **(T-1)**

17.5.2.5. AF Form 982, *Danger Tag: Do Not Start.* Do Not Start tags, including equivalent DoD and commercial tags, will 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 attached. **(T-1)** Do Not Start tag will be placed in conspicuous locations or in a manner that notifies employees that the equipment will not be energized. **(T-1)** The Do Not Start tag may be used in conjunction with AF Form 979. If a Danger tag is attached to equipment, it is not always necessary to 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 Occupational Safety office, F&ES Flight, or installation BE.

17.5.2.6. Biohazard tags, including equivalent DoD and commercial tags, will 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. **(T-1)**

17.5.2.7. 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.

17.6. Administrative Devices. Locks/tags used for purposes other than hazardous energy control are considered administrative devices. Administrative devices and tags will be clearly distinguishable from an issued/assigned authorized lockout device. **Note**: If red band locks are used for lockout/tagout (LOTO), they will not be used as an administrative device. The AF Form 983 will not be used as an administrative tag. **(T-1)**

17.6.1. Application of Administrative Devices. When machinery/equipment is placed in an "out of service" status for business or production purposes, e.g., poor efficiency, recycled, sold, and not related to servicing or maintenance, an administrative device and tag will be attached by the work center/shop supervisor or supervisor's appointed employee. **(T-1)** If an appointed employee applies the administrative device, the employee will inform and transfer the key to the work center/shop supervisor. **(T-1)**

17.6.1.1. The administrative tag (can be integrated on the lock) will contain the supervisor's contact information, the purpose of the lock, and the authorized person's organization. Use appropriate tags for the hazard type, e.g., Danger, Do Not Start or Out of Order.

17.6.1.2. Administrative devices and tags will not be transferred at shift change. **(T-1)**

17.6.2. Removal of Administrative Devices for Servicing/Maintenance. When servicing/maintenance of machinery/equipment is to begin (active service/hazardous energy control) by an authorized employee, the work center/shop supervisor or appointed employee

will remove the administrative device and the authorized employee will place the authorized LOTO device on the machinery/equipment IAW **paragraph 21.6**. **(T-1)**

17.7. Safety Color Coding, Labeling and Marking for Piping Systems.

17.7.1. This section 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. Piping systems require a color code and lettered legend identification system, positioned in a distinctive manner as a visual aid, for marking. **(T-0)** Color marking will not be substituted for elimination of hazards by safety engineering but will be used to supplement other established mishap prevention practices. **(T-0)**

17.7.2. A uniform system for identification of piping contents will be used to warn personnel of potentially hazardous piping system contents before turning valves on or disconnecting pipes. **(T-0)**

17.7.3. Essential regulatory requirements are contained in ASME A13.1, *Scheme for the Identification of Piping Systems,* MIL-STD-101C, *DoD Standard Practice: Color Code for Pipelines and for Compressed Gas Cylinders,* MIL-STD-161, *DoD Standard Practice: Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels,* and 29 CFR § 1910, Subpart J – *General Environment Controls.* **Note**: Follow MIL-STD-101C for agents not identified in ASME A13.1.

17.7.4. MIL-STD-101C contains detailed requirements for piping systems. Labels and paint will flake off pipes carrying cryogens (typically liquid oxygen and nitrogen). Metal signs with identification markings will be attached above or hung below cryogen piping by metal bands. **(T-0)**

Chapter 18

HYRDROCARBON FUELS

18.1. Scope. This chapter covers the hazards, applications, and safety protocols associated with hydrocarbon fuels.

18.1.1. Hydrocarbon fuels consist of aviation fuels, rocket propellants, diesel fuels, gasoline, and natural gas composites used by the DAF. Hydrocarbon fuels are fat soluble, 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.

18.1.2. TO 42B-1-1, *Quality Control of Fuels,* provides specifications for fuels. Refer to TO 42B-1-1-14, *Fuels for USAF Aircraft,* for a complete description of aircraft fuel classifications, characteristics, and use.

18.1.3. Fuel Spill Classifications. Fuel spill classification and emergency procedures are described in TO 00-25-172. Cleaning procedures will be established IAW installation CE guidance. **(T-1)**

18.2. Hazards. Fuel can ignite unexpectedly and cause fires or 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 will meet the requirements of DAFI 24-301 and TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenance.* **(T-3)**

18.2.1. Chemical Properties. Hydrocarbon fuels are insoluble in water and soluble in many organic components. 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. DAF fuels, although stable over a wide range of ambient storage temperatures, oxidize when exposed to extreme temperatures and will react with strong oxidizers, accelerating at higher pressures and/or temperatures.

18.2.2. Ignition Hazard. Oxygen comprises approximately 21 percent by volume of atmospheric air. Oxygen at concentrations of 16 percent 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 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.

18.2.3. Sources of Ignition.

18.2.3.1. Static Electricity. Static electricity can occur when fuel is stable (not flowing) or flowing. Static electricity can be generated by the slightest movement in a stable environment, e.g., in a fuel tank or cell container. 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 commonly used aviation turbine fuels minimizes static buildup during fuel flow. **Warning**: The additive does not eliminate static electricity in fuel flowing through hoses or pipes but rather facilitates releasing the built-

up static charge. This is why proper grounding and bonding of fuel systems, components and equipment is necessary to mitigate the ignition risk posed by static discharge.

18.2.3.2. Clothing containing more than 65 percent nylon, rayon, wool, or polyester will not be worn as outer garments when working with or around low flash point fuels. **(T-0)**

18.2.3.2.1. Flak vests will not be worn during aircraft fuel servicing operations or during fuel operations where low flashpoint vapors may be present. **(T-1)**

18.2.3.2.2. In all cases, a employee wearing a flak vest will always ground or bond themselves when approaching an aircraft and prior to beginning work. **(T-1)**

18.2.3.2.3. If no spark occurs during bonding or grounding, normal work may begin. However, if a spark does occur during bonding or grounding, the employee will ground or bond themselves frequently during all work phases. **(T-1)** Commanders may authorize the wear of body armor/flak vests and Gortex-type clothing in combat areas. **(T-2)** Outer garments will not be removed or put on in the work area. **(T-0)** Matches or lighters will not be handled or removed from pockets. **(T-0)**

18.2.4. Sources of Static Electricity.

18.2.4.1. Filter separator vessels generate static electricity when fuel flows through filters.

18.2.4.2. Loading Racks and Fill-stands. Line strainers and screens with a pore size less than 300 micron with 50 mesh per inch opening 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.

18.2.4.3. Avoid top loading refueling tank trucks from an overhead spout, whenever possible. An approved waiver will be obtained from the MAJCOM/FLDCOM Occupational Safety office and Air Force Petroleum Office prior to performing top loading operations. **(T-1)** 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.

18.2.4.3.1. Bottom loading refuelers minimizes fuel turbulence and is the preferred method. For this reason, ensure permanent fuel storage tanks systems are designed for bottom loading. **(T-2)**

18.2.4.3.2. 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. **(T-0)**

18.2.4.4. Support equipment can develop a static charge while parked due to movement of dust particles and air currents or during periods of thunderstorm activity.

18.2.4.5. Grounding and/or bonding requirements in TO 00-25-172, TO 42B-1-1, and TO 37-1-1, *General Operation and Inspection of Installed Fuel Storage and Dispensing*

Systems, will be followed. **(T-1)** Remove or replace all static grounds with resistances of more than 10,000 ohms, and repair and retest damaged static grounds.

18.2.4.6. During fuel operations, the liquid fuel movement can build up a high electrical potential, leading to sparks that can ignite explosive fuel vapor-air mixtures. Objects within the tank exacerbate this risk, as they act like capacitors and require less potential to discharge, making ignition more likely. The presence of these objects significantly increases the hazard. The DAF utilizes JAA or JP-8, which includes conductivity additive to decrease the relaxation time of electrostatic charges in order to preclude these problems. For fuel such as JP-5 that does not utilize conductivity additive utilize fuel flow amounts annotated in TO 00-25-172.

18.2.5. 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.

18.2.6. Exposure to Fuel Tank Bottoms. DAF fuels may contain benzene. Benzene is present in both gasoline-based and kerosene-based fuels. **Note**: Jet Petroleum (JP) series fuels do not contain tetraethyl lead. All fuels contain benzene to some degree (0.1 to 5 percent by volume). Aviation gasoline (AVGAS) usually contains higher concentrations of benzene than does heavier distillate fuels. However, benzene is toxic even in low concentrations. This is particularly true in permit-required confined spaces such as petroleum storage tanks.

18.2.7. Asphyxiation and Permit-required Confined Space. Hydrocarbon fuel vapors will displace oxygen in enclosed spaces and pits and may cause death due to asphyxiation. Refer to **Chapter 23** for additional guidance.

18.2.8. Servicing aircraft with the wrong fuel or utilizing untrained fuel servicing personnel can be catastrophic. Fueling personnel will ensure aircraft receive the proper fuel. **(T-0)**

18.2.8.1. All transient alert and maintenance control personnel will state both the type of aircraft and the fuel desired when requesting support from the fuels service center. **(T-1)**

18.2.8.2. Refueling drivers will 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. **(T-1)**

18.2.8.3. Refueling personnel and the maintenance crew chief will 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. **(T-1)** Similar precautions are required when refueling units are refilled from bulk sources.

18.2.9. First Aid. Personnel will take the following steps if hydrocarbon fuels are splashed or spilled onto them:

18.2.9.1. Remove contaminated clothing as soon as possible and wash affected skin areas with soap and water. **(T-0)** 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.

18.2.9.2. If fuel is splashed into the eyes, immediately flush the eyes with water continuously for at least 15 minutes; then seek medical attention. **(T-0)** Refer to **Chapter 9** for guidance on emergency shower and eyewash units.

18.2.9.3. If fuel is swallowed, do not induce vomiting. **(T-0)** Seek medical assistance as soon as possible. If medical assistance is delayed, recommend calling Poison Control at 1-800-222-1222 to initiate treatment until professional help arrives, or they can obtain full medical care.

18.3. Training.

18.3.1. AFI 90-821 provides specific training requirements for personnel engaged in handling or use of hazardous materials. Employees working with fuels will be trained IAW AFI 90-821. **(T-1)**

18.3.2. Ensure individuals exposed to petroleum products understand the hazards of static electricity. **(T-0)**

18.3.3. Ensure fuels handling personnel are trained in fire prevention and protection as it relates to their duties. **(T-0)** Refer to **Chapter 6** for additional guidance and information.

18.3.4. Operations involving the handling, transfer or storage of hydrocarbon fuels require a minimum of two persons who are knowledgeable of fuel safety and operational procedures. **(T-1)** `Refer to DAFI 23-201 for guidance on the two-person policy.

18.3.5. Ensure personnel are trained to prevent hydrocarbon fuels and propellant oxidizers being spilled in the same area. **(T-0)** 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 F&ES Flight when a fuel spill or oxidizer spill occurs. **(T-1)**

18.3.6. Ensure employees are trained on the hazards of handling toxic reagents. **(T-0)**

18.4. Personal Protective Equipment (PPE). Refer to **Chapter 14** for specific PPE requirements, and the installation BE for occupational and environmental health risk assessments.

18.5. Housekeeping.

18.5.1. Make sure all acid solutions are stored in a double container. **(T-0)**

18.5.2. Ensure labels on containers accurately reflect contents. **(T-0)**

18.5.3. Make sure waste fuel containers are emptied daily. **(T-0)** Contact installation CE for additional guidance and information.

18.5.4. Provide plainly marked metal containers with self-closing lids for combustible waste such as rags, paper towels and other flammable solid materials. **(T-0)** Paint these containers yellow with red letters designating: COMBUSTIBLE SOLID WASTE, unless determined to be hazardous waste, in which case, consult installation CE for appropriate markings and management.

18.5.5. Fuel spills can cause fires and create slipping hazards. **(T-0)** Spills will be cleaned up immediately. **(T-0)**

18.5.6. Use only noncombustible absorbent materials to clean up spills of flammable/combustible materials. **(T-0)** Do not use sawdust or wood shavings as an absorbent. **(T-0)**

18.5.7. Do not clean fuels laboratory floors with flammable liquids. **(T-0)** Use nonskid waxes when waxing floors. **(T-0)**

18.5.8. Unplug all lab equipment at the end of the workday, unless instructed by TO, manufacturer's instructions or when allowed by the F&ES Flight. **(T-0)**

18.5.9. Keep outside areas, approximately 25 feet, around fuels laboratories free of weeds, trash, and other combustible materials. **(T-0)**

18.5.10. Ensure aisles in fuels laboratories are clear and permit unobstructed egress of personnel in case of fire. **(T-0)**

18.5.11. Limit waste fuel containers within the laboratory to five gallons each. 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. **(T-0) Note:** Consult installation CE for appropriate markings and management.

18.5.12. Never pour acid into fuel containers. **(T-0)**

18.5.13. A 55-gallon drum, or an equivalent container, may be positioned 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. **(T-0)**

18.6. Fire Prevention and Protection.

18.6.1. Aerospace Ground Equipment (AGE) will be positioned IAW TO 00-25-172 when required for refueling operations. **(T-0)**

18.6.2. Ensure adequate fire protection equipment, e.g., 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.

18.6.3. Fuels operators are responsible for performing the mission in a safe manner. The operator will continually monitor the equipment for sparks and other ignition sources, unusual noises, and other indications of possible malfunctions. **(T-0)** Servicing will be stopped immediately if the operator determines it is unsafe. **(T-0)** When using hydrant systems, all operating personnel will know the location and proper use of the system emergency shutoff switch. **(T-0)**

18.6.4. Have sufficient firefighting equipment (portable or wheeled units) available and strategically located within the parking areas as required by the F&ES Flight.

18.6.5. Refer to TO 00-25-172 for fire guard designation during refueling and defueling operations.

18.6.6. The safety flask will be used to prevent carryover of fuel or solvent into the vacuum system and acts as a crucial safeguard for the vacuum system, protecting it from damage and contamination by fuel or solvent vapors and liquids. **(T-0)** The safety flask acts as a vapor trap and backflow preventer for the vacuum system.

18.6.7. Ensure danger signs are posted on the perimeter fence of fuel storage areas. **(T-0)** If unfenced, post signs 50 feet from the dike area or fuel vents of underground storage tanks, or based on air sampling results from the installation BE. **(T-0)** Signs will state, "No Open Flame or Ignition Source Beyond This Point," and meet requirements in **Chapter 17. (T-0)** Signs may include a second language, if needed.

18.6.8. The Fuels Management Office will develop emergency procedures and coordinate them with the F&ES Flight and Occupational Safety office. **(T-1)** These procedures include, but are not limited to, evacuation, equipment shutdown and notification of the F&ES Flight. Emphasize techniques to extinguish clothing fires. **(T-1)**

18.7. Inspection.

18.7.1. Fuels Laboratory. Supervisors will inspect their facilities and operations to identify and control or eliminate hazards before they cause a mishap. **(T-0)** Personnel will be instructed to notify their supervisors of potential hazards. **(T-0)** Hazards will be categorized according to potential severity and probability of occurrence IAW DAFI 91-202. **(T-1)** Immediate action will be taken to eliminate those hazards in Categories IA, IB, IIA and IIB. **(T-0)** Refer to 29 CFR § 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories,* for additional guidance.

18.7.2. External Support Inspections. Periodic inspections will be accomplished by the F&ES Flight, installation BE and Occupational Safety office. **(T-1)** Installation BE will conduct a HRA whenever there is reason to believe an exposure may be hazardous. **(T-1)** Functional managers will maintain copies of these inspection reports for a minimum of three years or until the next higher headquarters inspection, whichever comes first. **(T-1)**

18.7.3. Internal Inspection of Fuels Laboratory. Internal safety inspections are the responsibility of all assigned personnel. **(T-1)** Potential safety and health hazards must be identified, and hazard abatement plans established as outlined in DAFI 91-202. **(T-1)** Items requiring special attention during daily, weekly, or monthly internal inspections include:

18.7.3.1. Inspecting all electrical connections of equipment for loose or defective connections and frayed insulation. **(T-1)**

18.7.3.2. Visually inspecting all ground wires for frays or loose connections. **(T-1)** Check electrical continuity monthly with a resistance (ohm) meter. **(T-1)** Inspections will be documented on MAJCOM/FLDCOM or locally devised automated systems. **(T-1)**

18.7.3.3. Inspecting electrical grounding of the fuels laboratory building monthly and electrical resistance annually. **(T-1)** Electrode resistance to ground will not exceed 25 ohms under dry conditions. **(T-1)**

18.8. Fuel Storage Systems.

18.8.1. Safety Features.

18.8.1.1. New construction, alteration and/or modification of petroleum facilities will conform to UFC 3-460-01, *Design: Petroleum Fuel Facilities,* as well as all other applicable DAF specifications and directives. **(T-0)** Existing facilities, unless hazards are present, are not required to meet current DAF specifications or directives until a modification or alteration is planned. **(T-1)** All systems will be maintained per TO 37-1-1,

General Operation and Inspection of Installed Fuel Storage and Dispensing Systems, and UFC 3-460-03, *Petroleum Fuels Systems Maintenance.*

18.8.1.2. Access. Where necessary, pit covers will be altered or replaced to provide free and unobstructed access. **(T-0)** Fuels Management will determine which pits are essential to the operation and control of the system. **(T-2)** All pits will be kept clean, dry, and vapor-free. **(T-0)** Pit covers will be closed except when in use or work is being done in the pit. **(T-0)**

18.8.2. Ventilation.

18.8.2.1. Adequate ventilation will be provided IAW American Conference of Government Industrial Hygienists (ACGIH) and be consistent with the BE HRA IAW DAFMAN 48-146. **(T-0)**

18.8.2.2. Entry into permit-required confined spaces will be IAW **Chapter 23.** Contact installation BE for specific ventilation requirements. **(T-1)**

18.8.3. Drainage. Gravity drains or pumps will be provided to control water in pits. **(T-1)** Drains from pits and/or pump house floors will not be connected to sanitary or storm sewer systems, unless permitted by installation CE. **(T-1)** Contact installation BE for an occupational health risk assessment.

18.8.4. Piping System Identification. Piping systems will be color coded to aid in identifying the contents of piping in fuel storage areas. **(T-0)** Refer to MIL-STD-161, MIL-STD-101, and **Chapter 17** for specific guidance. **(T-1)**

18.8.5. Petroleum Storage Tank Entry. UFC 3-460-03 covers this subject in detail and will be used as definitive guidance on all tank entry tasks. **(T-0)** Refer to **Chapter 23** for additional permit-required confined space guidance.

18.9. Fuel Servicing Operations.

18.9.1. After changing a filter separator element, slowly fill the filter vessel by partially opening the inlet and outlet valves to displace trapped air. **(T-1)** The slower flow will reduce static charging of the fuel. Refer to TO 37A-1-101, *General Instructions – USAF Fuel, Water and Lubricant Dispensing Equipment,* for complete details on filling filter separators after element change. **(T-1)**

18.9.2. 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. **(T-0)** To ensure emergency shutdown capability, provide communications throughout the entire receipt. **(T-0)**

18.9.3. Keep the dike basin area free of vegetation. Containment dikes and basins will be constructed and maintained IAW UFC 3-460-01 and UFC 3-460-03. **(T-0)**

18.9.4. Watch draining floating roof water drains to ensure no fuel runs out with the water from a leak in the drainpipe. **(T-0)** When possible, secure roof water drains by lock after draining. **(T-0)**

18.9.5. Provide adequate lighting in petroleum areas for safe night operations. 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*. **(T-0)**

18.9.6. Bond the vehicle IAW TO 00-25-172. **(T-0)** When a hose cart or hydrant servicing vehicle is used as a fill-stand, the hose cart or hydrant servicing vehicle operator will bond the hose cart or hydrant servicing vehicle to the hydrant outlet piping. **(T-0)** The refueling unit operator will bond the refueling unit to the hose cart or hydrant servicing vehicle. **(T-0)**

18.9.7. 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 fill-stand using the grounding/bonding reel installed on the vehicle. **(T-0)**

18.9.8. Push the stop switch on the fill-stand 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. The operator will check the bottom loading automatic shutoff device by pushing the test button on refuelers during the first 500 gallons of fuel pumped into the vehicle, if equipped. **(T-0)**

18.9.9. Railroad Tank Car Operations. When unloading tank cars through bottom valve arrangement into installation bulk storage systems:

18.9.9.1. Isolate railroad tank car off-loading tracks (spur) from main tracks and ground them. **(T-0)** The offloading 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 will be checked to ensure a resistance reading of 10,000 ohms or less. **(T-0)**

18.9.9.2. Tank cars being loaded with aviation fuels or Mogas will be bonded to the loading facilities. **(T-0)**

18.9.9.3. 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. **(T-0)** The insulating and bonding of the tracks relaxes any static buildup.

18.9.10. Fueling Equipment Safeguarding.

18.9.10.1. Fuel servicing equipment parking areas will be treated as above-ground fuels facilities and safeguarded accordingly. **(T-0)**

18.9.10.2. Fuel servicing equipment parking areas will be paved, lighted, and have sufficient slope to control drainage. **(T-0)**

18.9.11. 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,* and UFC 3-460-03. **(T-0)**

18.10. Aircraft Servicing.

18.10.1. Aircraft servicing will be conducted IAW TO 00-25-172, and applicable aircraft and equipment/vehicle technical orders.

18.10.2. When practical, mark support equipment parking locations on the ramp.

18.10.3. Powered support equipment that is not explosion-proof but required for aircraft fueling and defueling will be parked the full length of the approved power cable from the aircraft and kept outside the fuel servicing safety zone. **(T-0)** The full length of the approved cable or air-start duct will be maintained between the fueling point or vents to fighter aircraft. **(T-0)**

18.10.4. Aircraft Fueling and Defueling from Hydrant Systems.

18.10.4.1. Hydrant system fueling and defueling operations will be supervised. **(T-1)** Hydrant system pump houses will be manned IAW TO 37-1-1. **(T-1)** The Fuel Servicing Equipment operator will hold the remote-control switch, magnet lanyard or deadman control throughout the refueling operation. **(T-1)** Before fuel delivery begins, aircraft fuel tank caps will be checked to ensure they are secure. **(T-0)** The Fuel Servicing Equipment hoses and valves are heavy and require more than one person to safely handle, especially during a hose evacuation malfunction. **(T-1)** To prevent damage, do not drag the hose or valve on the ramp. **(T-0)** Other members of the fuel servicing crew will help the cart/hydrant servicing vehicle operator stow the hoses. **(T-1)**

18.10.4.2. The operator will inspect the remote-control cables to ensure they are hermetically sealed and serviceable when used. **(T-0)**

18.10.4.3. All personnel involved in the servicing operations will know the location of hydrant emergency shutoff switches. **(T-0)**

18.10.5. Fueling New or Recently Repaired Aircraft Tanks or Tanks That Have Been Purged.

18.10.5.1. Aircraft fuel tanks/cells with nitrogen inerting systems may be refueled at the normal rate of flow with the nitrogen system activated.

18.10.5.2. Aircraft without a nitrogen inerting system must be fueled at the slowest possible flow rate until each fuel tank or cell is full or to the level dictated by the mission. **(T-0)**

18.10.6. Fueling From Drums. Refuel from drums IAW TO 00-25-172. **Note**: Fueling from drums will be accomplished only as an emergency measure. **(T-0)** Fueling from cans or "topping off" is particularly hazardous due to the potential for spills and static ignition.

18.10.7. 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. **(T-2)** Refueling units in ground servicing operations will be inspected for safety deficiencies per the locally established maintenance program. **(T-2)** Many aircraft operation procedures that contain fuels, vapors and prevent ignition also apply to ground operations.

18.10.8. Service Station Operations. Loading, storage, and handling of fuels will be IAW 29 CFR § 1910.106(g), *Service Stations.* **(T-0)**

18.10.8.1. Static charge may develop when the operator exits and re-enters the vehicle and ignite fuel vapors near the nozzle. Personnel will not re-enter the vehicle during the fueling operation unless they ground themselves prior to returning to the nozzle. **(T-0)**

18.10.8.2. Support equipment and vehicles will be serviced outdoors, with engines turned off and with parking brakes engaged. **(T-0)**

18.10.8.3. During refueling, operators will 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. **(T-0)**

18.10.8.4. Nozzles used at attended/unattended motor vehicle service stations and fleet fueling sites will 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. **(T-0)** Nozzles used at attended and unattended marine motor fuel dispensing facilities/sites will be listed IAW NFPA 30A and have automatic-closing type hose nozzles without a latch open device. **(T-0)** Nozzles used for dispensing by gravity from tanks above the dispensing/delivery point will only be a manually operated nozzle. **(T-0)**

18.10.8.5. Nozzles used on mobile support refueling equipment will be automatic-closing type hose nozzles without a latch open device. **(T-0)**

18.10.8.6. Emergency instructions will also be conspicuously posted in the dispenser area. **(T-0)** The emergency instructions will incorporate the following or equivalent wording:

18.10.8.6.1. Use emergency stop button. **(T-0)**

18.10.8.6.2. Report accidents by calling F&ES Flight and report location. **(T-0)**

18.10.8.7. 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 will be listed or approved for the specific purpose. **(T-0)**

18.10.8.8. All compressed natural gas, liquefied natural gas and liquefied petroleum gas refueling dispensers, hoses, nozzles, breakaway fittings, swivels and flexible connectors, dispenser emergency shutoff valves, vapor recovery systems and pumps will be listed or approved for the specific purpose. Compressed natural gas, liquefied natural gas, and liquefied petroleum gas motor vehicle fuel dispensing will be conducted at an outdoor location. **(T-0)**

18.11. Fuel Laboratory Operations.

18.11.1. Design Requirements. Fuel laboratories will be designed IAW UFC 4-310-03, *DoD Fuels Laboratory Standards,* for new construction. **(T-0)** In case of conflict with national fire codes or building codes, these handbooks take precedence. Installation CE, F&ES Flight, Occupational Safety office and installation BE will make an initial inspection to certify the acceptability of the fuels laboratory. **(T-0)**

18.11.2. Sampling and Analysis Safety. The Fuels Management office will establish guidance for general safety, sampling safety and laboratory safety during laboratory analyses. **(T-1)**

18.11.2.1. Refer to **Attachment 2** for posted safety instructions in fuel laboratories.

18.11.2.2. Label outside of doors of non-explosion proof refrigerators to indicate “NOT FOR FLAMMABLE STORAGE.” **(T-0) Warning**: Do not store food or beverage in the refrigerator.

18.11.2.3. The laboratory supervisor will ensure ovens are equipped with a temperature limiting automatic shutoff control. **(T-0)** Cooking, eating food or drinking beverages in the fuels laboratory is prohibited.

18.11.2.4. The quantity of test fuel in the laboratory will not exceed 10 gallons, including fuel awaiting analysis, unless analysis specifies a larger sample size.

18.11.2.5. Do not pour fuel into sinks connected to a sanitary drain. Contact the installation CE for disposal guidance. **(T-1)**

18.11.2.6. Inspect waste fuel drums located outside the laboratory daily and empty them when full. **(T-0)**

18.11.2.7. Do not use waste fuel to kill vegetation. **(T-0)**

18.11.2.8. Post "No Smoking Within 50 Feet" signs at all laboratory entrances. **(T-0)**

18.11.2.9. Ensure fire extinguishers are readily available in the laboratory. **(T-0)** Contact the F&ES Flight for proper types and sizes. **(T-0)** Refer to **Chapter 6** for additional guidance and information.

18.11.2.10. Ensure at least two people are in the laboratory when tests involving fuels or acids are performed. **(T-0)** One of these people must be a fully qualified lab technician. **(T-0)**

18.11.2.11. Personnel will not introduce or handle spark-producing materials such as matches, lighters, keys, etc., while in the laboratory. **Exception**: Flashpoint laboratory equipment.

18.11.3. When sampling, ensure personnel ground themselves prior to climbing tank ladders by grasping the guardrail with a bare hand. **(T-0)** In extremely cold weather, they will 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. **(T-0)**

18.11.3.1. Do not overfill sampling containers. Allow adequate space for fuel expansion.

18.11.3.2. Be careful when taking fuel samples from crashed aircraft to prevent ignition of residual fuel vapors.

18.11.3.3. Electrical equipment is grounded to the building electrical service ground system when plugged in with a serviceable 3-prong (ground) electrical plug; therefore, no other ground wires are required. **(T-0)** Ground waste fuel containers by extending a ground wire with clamps from the container to the laboratory common ground system. **(T-0)**

18.11.3.4. Do not use fuel analysis thermometers for other purposes.

18.11.3.5. Do not leave waste fuel in the laboratory overnight unless properly stored.

18.11.3.6. Employees will not siphon fuels by mouth.

18.11.3.7. Do not conduct laboratory analyses or allow fuel in the laboratory unless exhaust systems are functioning.

18.11.3.8. Wear approved eye protection when performing or observing fuels analyses. Make sure an approved emergency shower/eyewash is provided IAW **Chapter 9**. **(T-0)**

18.11.3.9. Ensure all facility and equipment electrical repairs meet NFPA 70 requirements. **(T-0)**

18.11.3.10. Electrical receptacles in fuels laboratories will be at least four feet above floor level or working surface. **(T-0)**

18.11.4. Ensure laboratory personnel use correct PPE when handling acids. **(T-0)**

18.11.5. Ensure only authorized personnel are in the laboratory when testing fuels. **(T-0)**

Chapter 19

COMPRESSED GASES

19.1. Scope. This chapter pertains to all employees who store, handle, or use compressed gas cylinders. Mandatory compliance information for each specific gas is contained within its product labeling and SDS. Refer to 29 CFR § 1910, Subpart H, *Hazardous Materials*, 29 CFR § 1910.101 *Compressed Gases (General Requirements),* NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 29 CFR § 1910.253, *Oxygen-Fuel Gas Welding and Cutting,* Defense Logistics Agency Instruction (DLAI) 4145.25, *Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders,* and the Compressed Gas Association (CGA) for additional guidance.

19.2. General Requirements.

19.2.1. For cylinder inspections and tagging, refer to manufacturer requirements and 29 CFR 1910.01. **(T-0)** Employees will ensure valves, hoses, pipes, etc., are compatible with the compressed gases being used and non-compatible with breathing air. **(T-0) 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. **(T-0)** The employee will ensure the cylinder and attached equipment are in proper working condition and any discrepancies are fixed or reported to the supervisor. **(T-0)**

19.2.1.1. Employees will store the cylinder with the newest delivery behind older deliveries to ensure cylinders are used in the sequence received. **(T-0)** Department of Transportation (DOT)-8 and 8AL cylinders must have the cylinder shell and porous filler requalified IAW CGA C-13, *Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders.* **(T-0)** Requalification of cylinders, including DOT-8 cylinders will be IAW 49 CFR § 180.209, *Requirements for Requalification of Specification Cylinders.* **(T-0)**

19.2.1.2. Cylinders will be hydrostatically tested IAW DoD and DOT regulations. **(T-0)** Refer to MIL-STD-1411C, *DoD Standard Practice: Inspection and Maintenance of Compressed Gas Cylinders,* and DLAI 4145.25, *Storage and Handling of Liquified and Gaseous Compressed Gases and Their Full and Empty Cylinders,* for additional guidance on inspection and requalification criteria for cylinders.

19.2.2. Do not use a cylinder if you cannot 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. Color codes vary by manufacturer; therefore, do not rely solely on color coding to determine contents.

19.2.2.1. DAF or DoD-owned cylinders will be color-coded, and contents stenciled on the cylinder IAW MIL-STD-101C. **(T-0)** Color codes for commonly used gases will be posted in the cylinder storage area. **(T-1)**

19.2.2.2. Two DD Form 1574s, *Serviceable Tag—Materiel*, will be placed on all cylinders. **(T-1)** The first tag is used to identify the contents of the cylinder, and the second tag will identify the cylinder. **(T-1)** Additional label requirements can be found in DLAI 4145.25. Refer to TO 42B5-1-2, *Gas Cylinders (Storage Type) Use, Handling, and Maintenance,* for additional guidance and information.

19.2.3. 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.

19.2.4. Secure all cylinders, whether in use or in storage, full or empty, by using a chain or other fastening device to a solid fixture (e.g., wall, stanchion, etc.) to prevent cylinders from falling over. Non-metallic or synthetic straps may be used to secure non-flammable gases, except oxygen.

19.2.5. Moving Cylinders. Appropriate dollies or hand trucks will be used to move cylinders weighing more than 50 pounds. **(T-1)** The cylinder will be secured to the hand-truck prior to and during movement. **(T-1)** Refer to DLAI 4145.25 for guidance on moving cylinders.

19.2.6. Always keep all cylinders in a vertical position, unless the cylinders are designed to work in a horizontal position. **(T-0)**

19.2.7. Do not tamper with cylinder valves or any part of a valve, such as a safety nut or stem-packing nut. **(T-0)**

19.2.8. Use cylinders only with the appropriate equipment. **(T-0)** Do not force connections or use unauthorized adapters. **(T-0)** Never use a cylinder without a regulator. **(T-0)**

19.2.9. Always close the cylinder valve when the cylinder is not in use or when it is empty. Replace safety covers and dust caps. **(T-0)**

19.2.10. Flammable materials, such as oil, paint, or grease, may ignite if exposed to pressurized oxygen gas.

19.2.10.1. Most compressed oxygen is not intended for breathing and will not be substituted for air used in ventilation systems. **(T-0)** Oxygen will not be used as a substitute for compressed air. **(T-0)**

19.2.10.2. Never oil or grease an oxygen regulator. **(T-0)** 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. **(T-0)**

19.2.11. Before attempting to place regulators or other fittings on a cylinder, ensure the threads on the cylinder match those on the fittings. **(T-0)** The type of thread, number of threads per inch and the hand of the thread must match to ensure a satisfactory seal. **(T-0)** If the fittings are hard to turn, do not force them; instead, check the threads. **(T-0)**

19.2.12. Open cylinder valves slowly (cracking) so the gas is not released suddenly into the regulators. **(T-0)** Operate valve hand-wheels only by hand. Do not use cheaters or pipes. **(T-0)** Cylinders without fixed hand-wheels will be equipped with keys, handles or nonadjustable wrenches on the valve stems during the time they are in service. **(T-0)**

19.2.13. Before removing a regulator from a cylinder, close the control valves and allow the gas to escape from the regulator. **(T-0)** Welders will not leave an area with regulators or lines pressurized. **(T-0)**

19.2.14. On oxygen cylinders, do not use a regulator previously used for oil-pumped gases or any combustible gases. **(T-0)** Gauges on oxygen regulators will be marked, USE NO OIL. **(T-0)**

19.2.15. A mixture of acetylene 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. **(T-0)** Refer to 29 CFR § 1910.253 for additional guidance.

19.2.15.1. Avoid contact between acetylene and copper, silver and mercury, their salts, compounds, and high-concentration alloys. **(T-0)**

19.2.15.2. Acetylene cylinders will never be placed on their sides or laid down for any reason. **(T-0)**

19.2.16. Only cylinders that are in use should be in the lab or work area. **(T-0)** Spare or empty cylinders will only be stored in a designated storage area. **(T-0)**

19.2.17. Compressed gas cylinders represent a hazard because the gases may be flammable, asphyxiates, oxidizers, corrosives, toxic or cryogenic.

19.3. Storage.

19.3.1. All cylinders will be secured by a metal chain, straps, braces, or other restraining devices to a solid fixture (e.g., wall, stanchion, etc.) to prevent cylinders from falling over. **(T-0)** Synthetic straps will not be used to secure cylinders of flammable gases or oxygen. **(T-0)** While in storage, cylinder valve protection caps will be firmly in place. **(T-0)**

19.3.1.1. Doors or gates for gas cylinder supply areas will be locked. **(T-0)**

19.3.1.2. Enclosures for gas supply systems will not be used for storage purposes other than for cylinders. **(T-0)**

19.3.1.3. Cylinders attached to a manifold will also be secured to solid fixtures to prevent the cylinder from falling over. **(T-0)**

19.3.1.4. The enclosure will be posted as a "No Smoking Area." **(T-0)**

19.3.2. Do not store cylinders in locations where temperatures may exceed 125 ºF (51.7º C) or near other sources of heat to prevent excessive pressures in the cylinders. **(T-0)**

19.3.2.1. Do not store cylinders where there is danger of accidental damage or in areas where they will be subject to corrosive chemicals. **(T-0)** Do not store flammable gases near electrical wires, batteries, or other conductors or sources of electricity. **(T-0)**

19.3.2.2. Empty cylinders must be plainly marked "EMPTY". **(T-0)** When full and empty cylinders are stored in the same location, cylinders must be stored so that the older cylinders (old stock) can be removed first with minimum handling of other cylinders (newer stock). **(T-0)** Refer to TO 42B5-1-2 for additional guidance and information.

19.3.2.3. Metallic or synthetic nylon straps will not be used to secure cylinders of flammable gases or oxygen. **(T-0)**

19.3.2.4. Cylinders stored in the open will be adequately protected from extreme heat and cold. **(T-0)** Cold weather usually increases the brittleness of the cylinder metal and can rupture if handled roughly. Remove accumulated ice or snow to prevent cylinders from rusting. **(T-0)**

19.3.2.5. When gas cylinders are stored indoors, ventilate the area to prevent accumulation of flammable or asphyxiating gases in the atmosphere. **(T-0)** Cylinders will not be kept in unventilated enclosures. **(T-0)**

19.3.3. Cryogenic cylinders will be fitted with stainless steel or other suitable plumbing only. **(T-0)**

19.3.4. Stored cylinders (either inside or outside) will not obstruct exit routes or other traffic areas. **(T-0)**

19.3.5. All stored cylinders will have their valves closed. **(T-0)** Valve protection caps will always be in place and hand tight except when cylinders are in use or connected for use. **(T-0)**

19.3.6. Oxygen cylinders will not be stored within 20 feet of combustible material (especially oil and grease). **(T-0)** 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 will be removed and the cylinders properly stored. **(T-0)**

19.3.7. Storage facilities will be prominently labeled/posted with the types of gases being stored. **(T-0)** Where gases of different types are stored at the same location, cylinders will be grouped by type of gas and the groups arranged to take into account the gases contained. **(T-0)** Cylinders will be prominently labeled IAW DOT regulations. **(T-0)**

19.4. Disposal and Shipping.

19.4.1. Disposal of Compressed Gas Cylinders. Disposal of compressed gas cylinders will be accomplished IAW DoDM 4160.21, Volume 1, *Defense Materiel Disposition: Disposal Guidance and Procedures.* Refer to TO 42B5-1-2, Section 10.4, *Disposition of Cylinders,* for additional guidance.

19.4.1.1. Non-government owned cylinders will be returned to the owner. **(T-0)** If the owner cannot be determined, cylinders will be processed IAW DoDM 4160.21, Volume 1. **(T-0)**

19.4.1.2. Cylinders rejected for failure to pass hydrostatic testing, or any other reason will be disposed of as condemned property after the identification numbers, symbols and cylinder contents have been destroyed. **(T-0)**

19.4.1.3. 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.

19.4.2. Prior to shipment, empty cylinders will be inspected for dents, bulges, oxidation pits or other damage. **(T-0)** Faulty cylinders will be handled as required by the latest DOT regulations. **(T-0)** Cylinders will be shipped by military airlift IAW the instructions in AFMAN 24-604, *Preparing Hazardous Materials for Military Air Shipments.* **(T-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. **(T-0)**

Chapter 20

WELDING, CUTTING AND OTHER HOT WORK

20.1. Scope. This publication covers the safety requirements for welding, cutting and other hot work in DAF operations. General industry operations must comply with 29 CFR § 1910, Subpart Q, *Welding, Cutting and Brazing*, and construction operations under 29 CFR § 1926, Subpart J, *Welding and Cutting*. In addition, fire prevention requirements will follow NFPA 51B.

20.2. Hazards.

20.2.1. Welding, cutting and brazing operations present hazardous situations which can lead to serious injuries and/or death if the proper precautions are not taken. Employees have received injuries and occupational illnesses when they fail to follow safety precautions to include the appropriate use of personal protective equipment. Protective equipment should be used in conjunction with guards, engineering controls and sound manufacturing practices. If any process has not already been evaluated, contact installation BE for a HRA and guidance of ventilation requirements. **(T-1)**

20.2.2. Numerous hazardous chemicals and metals are used in fluxes, paints, coatings and fillers, and release toxic fumes and/or gases during welding, cutting and brazing operations. 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*.

20.2.3. Brazing and welding filler metals containing cadmium carry the following warning: *WARNING - CONTAINS CADMIUM - POISONOUS FUMES MAY BE FORMED ON HEATING*.

20.2.4. 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 THE eyes, nose, and throat.

20.2.5. Cleaning and other operations involving chlorinated hydrocarbons may generate toxic vapors or mists.

20.2.6. Fires, explosions, and injuries can occur from welding, cutting, brazing and other hot work operations that are:

20.2.6.1. In the proximity of combustible solids, liquids, or dusts.

20.2.6.2. In the presence of possible explosive mixtures of flammable gases and air.

20.2.6.3. In the presence of an oxygen-enriched atmosphere, where hot work is performed.

20.2.6.4. Near explosive hydrogen gas is formed when sulfuric acid contacts mild steel.

20.2.7. 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 installation BE for an HRA if the exposure has not already been assessed during the unit's OH Assessment.

20.2.8. Cylinders or welding sets more than 40 pounds total weight will be transported to and from work sites by cart or motorized vehicle to prevent injury. **(T-1)**

20.2.9. To prevent fire or explosion, if a leak is found around the valve stem when the valve is opened on a fuel-gas cylinder, the valve will be closed, and the gland nut tightened. **(T-1)** 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 Materiel.* **(T-1)** Place the cylinder in an upright manner outdoors in a safe location away from an ignition source, where the leaking gases cannot accumulate and secure it to prevent falling. **(T-1)** 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. **(T-1)** In addition, place similar signs in locations which will notify personnel of the danger before entering the area. **(T-1)** These signs are intended to prevent personnel from entering a danger zone while attempting to read the sign on the cylinder. Refer to **Chapter 17** for danger signs specifications. Immediately notify the F&ES Flight of any fuel gas leaks. **(T-0)**

20.2.10. Other hot work covers any use if open flames not specifically identified, such as flame applied roofing application and vegetation control.

20.3. Acquisition.

20.3.1. Only American Welding Society approved apparatus such as torches, regulators, pressure reducing valves, acetylene generators, machines, manifolds, cables, and hoses, etc., will be used. **(T-1)** In locations where the acquisition of such apparatus is not feasible, contact the occupational safety office or installation CE for guidance.

20.3.2. Compressed gases may be purchased in either government-owned or supplier-owned cylinders. In either case, the purchase agreement will specifically indicate that the compressed gas cylinders meet the marking requirements of 29 CFR § 1910.253, *Oxygen-Fuel Gas Welding and Cutting*. **(T-0)** In addition, they will be inspected and will have a safety relief device installed per the requirements in 29 CFR § 1910.101, *Compressed Gases (General Requirements)*. **(T-0)** Government-owned cylinders which are not in compliance with the above requirements will not be used and will be removed from service. **(T-0)** Gaseous systems and containers will be color coded IAW TO 42B5-1-2 to ensure contents of the system or container are known. **(T-1)** In locations where the adherence of OSHA requirements is not feasible, contact the occupational safety office or installation CE for guidance.

20.4. Training and Qualification.

20.4.1. Trainees may perform welding only under the direct supervision of an instructor. **(T-0)** Trainees will be considered qualified to perform welding operations when they have satisfactorily demonstrated their skill or proficiency to their supervisor/instructor.

20.4.2. Welders performing work on aircraft, aircraft components, missile, or missile components will be certified IAW TO 00-25-252, *Intermediate and Depot Level Maintenance Instructions – Aeronautical Equipment Welding.* **(T-0)**

20.4.3. Commanders and supervisors will ensure employees are trained in the requirements of the DAF Hazard Communication Program and specific hazards they are exposed to during welding, cutting and brazing work. **(T-0)** Refer to AFI 90-821 for additional guidance.

20.5. Precautions.

20.5.1. Operating Precautions. The information listed below provides minimum guidance on operating precautions and procedures. It will be used in conjunction with 29 CFR § 1910, Subpart Q on all matters involving DAF welding operations. **(T-0)** Information in 29 CFR § 1910, Subpart Q may be obtained by contacting the occupational safety office or visiting the OSHA website: **https://www.osha.gov.** Additional information is also available in NFPA 51B.

20.5.1.1. Follow manufacturer's instructions with respect to the sequence of operations in lighting, adjusting and extinguishing torch flames. **(T-0)** Purge hoses in open spaces and away from ignition sources. **(T-0)** Light the torch with a friction lighter or stationary pilot flame, keeping a safe distance between the torch and the welder's hands. **(T-0)** Point the torch away from persons or combustible materials when lighting. **(T-0)** Do not attempt to light a torch from hot metal.

20.5.1.2. Do not place work to be welded or heated on a concrete floor. **(T-0)** Concrete, when heated, may spall, and produce projectiles, exposing the welder to injury from flying hot particles.

20.5.1.3. When working at heights of four feet or greater, welders and helpers will use appropriate fall protection. Keep welding areas neat, clean, and free from tripping hazards. **(T-0)** Provide protection for personnel on the ground or rope off area directly below the operation. **(T-0)** Refer to **Chapter 13** and **Chapter 16** of this manual, and 29 CFR § 1910.28, *Duty to Have Fall Protection and Falling Object Protection,* for additional guidance.

20.5.1.4. Do not perform welding, cutting, brazing or other hot work operations:

20.5.1.4.1. In indoor areas not approved by the F&ES Flight, Occupational Safety office, and installation BE. **(T-1)** This will ensure fire, safety and health protection are considered in the selection of indoor welding, cutting, brazing or other hot work operations.

20.5.1.4.2. 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 F&ES Flight. **(T-0)**

20.5.1.4.3. In explosive atmospheres or where explosive atmospheres may develop. **(T-0)**

20.5.1.4.4. Within 50 feet of flammable liquids, e.g., flashpoint below 100° F. **(T-0)**

20.5.1.4.5. When unable to comply with the above requirements, interim procedures must be established through the Occupational Safety office, F&ES Flight, and installation BE. **(T-1)**

20.5.1.4.6. Outdoor areas within six feet of combustible structures or combustible exterior finish materials without approval by the F&ES Flight.

20.5.2. Welding Equipment Precautions.

20.5.2.1. Protect welding torch hoses from damage caused by contact with hot metal, open flames, corrosive agents, or sharp edges. **(T-1)** 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). **(T-1)** Visually inspect the entire length of welding hose once per shift and prior to use. This inspection is not required when equipment will not be used during that shift. **(T-1)**

20.5.2.2. 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.

20.5.2.3. In case of an emergency, ensure a means to quickly extract the welders is provided. **(T-1)** Refer to **Chapter 14**, **Chapter 23** and AFI 90-821 for additional guidance.

20.5.2.4. 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 will be used to protect personnel from hazardous concentrations of airborne contaminants. **(T-0)** Consult installation BE and AFI 48-137 for additional guidance.

20.5.2.5. Employees 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. **(T-0) Note**: Employees with pacemakers and other electrically active medical devices engaged in this type of work will inform their supervisor. **(T-1)**

20.5.2.6. 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 (IRSO), usually a member of the installation BE staff. **(T-1)** All personnel must comply with DAF requirements for handling and processing radioactive materials. **(T-1)** Refer to AFMAN 40-201 for additional guidance.

20.5.3. Purging and Inert.

20.5.3.1. 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). **(T-1)** 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. **(T-1)** Hazards inherent with steam operations require the use of personal protective equipment. **(T-0)** 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.

20.5.3.2. 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 will be used to eliminate any possible vapor accumulation by the proper venting or positioning of the container during the filling operation. Consult the installation CE for disposal guidelines of purged materials. **(T-2)**

20.5.3.3. Purging with Air. Hazardous vapors may be displaced from inside containers by purging with air. A safe atmosphere will be maintained by continuous ventilation, as prescribed by an installation BE evaluation of the use of ventilation to purge a tank or container and ensure the surrounding area maintains a safe atmosphere. **(T-0)** Every precaution will 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. **(T-0)** The air mover will be electrically bonded to the tank or container being cleaned. **(T-0)** Refer to DAFMAN 48-146 for additional information on ventilation assessment.

20.5.3.4. Inert with Gas. Inert gas may be used to displace flammable gas from the container. Adequate ventilation will be maintained by continuous ventilation as prescribed by an installation BE evaluation of the use of ventilation to purge a tank or container and ensure the surrounding area maintains a safe atmosphere. **(T-0)** Supervisors of this operation will be thoroughly familiar with the limitations and characteristics of the inert gas being used. **(T-0)** Examples of inert gases are carbon dioxide, nitrogen, and argon.

20.5.3.5. Venting. All hollow spaces, cavities, or containers will be vented to permit the escape of air or gases before preheating, cutting, or welding. **(T-0)**

20.5.3.6. 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. **(T-0)**

20.6. Personnel Protective Equipment (PPE). When other hazard controls are not effective or feasible, personnel engaged in or exposed to welding, cutting, or brazing activities will be provided and use the appropriate PPE to protect themselves from injury. **(T-0)** The appropriate protective clothing required for specific welding operations will vary with the size, nature, and location of the work to be performed. **(T-0)** Supervisor will determine the required PPE after conducting a JHA. All personal protective clothing and equipment will be approved by the installation BE and occupational safety office prior to purchase and use. **(T-1)** Refer to 29 CFR § 1910, Subpart Q, 29 CFR § 1910, Subpart I, *Personal Protective Equipment,* AFI 48-137 and **Chapter 14** for additional guidance.

20.7. Types of Welding Equipment.

20.7.1. Oxygen-Fuel Gas Welding and Cutting. 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. Oxygen-fuel gas equipment will meet the requirements found in 29 CFR § 1910.253, *Oxygen-Fuel Gas Welding and Cutting*. Both oxygen and acetylene cylinders are stored IAW TO 42B5-1-2.

20.7.2. Arc-Welding and Cutting. Arc-welding equipment will conform to the design and installation criteria of 29 CFR § 1910.254, *Arc-Welding and Cutting.* **(T-0)** The frame or case of the welding machine, except engine driven machines, will be grounded IAW 29 CFR § 1910, Subpart S, *Electrical.* **(T-0)**

20.7.2.1. 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.

20.7.2.2. 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 contacting with the molten metal and contaminating the weld.

20.7.2.2.1. Tungsten-Inert Gas Welding. Tungsten-inert gas 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.

20.7.2.2.2. Metal-Inert Gas Welding. Metal-inert gas welding is a type of gas-shielded welding like tungsten-inert gas, except it uses a wire fed electrode and is used for heavier gage metals.

20.7.2.2.3. Resistance Welding. Where electric current is passed through metal to generate heat to melt them together. Also known as spot or seam welding. Resistance-welding equipment will conform to the design and installation criteria of 29 CFR § 1910.255, *Resistance Welding.*

20.7.2.2.4. Stir Welding. Friction stir welding is a solid-state joining process that uses frictional heat generated by a rotating tool to join materials. The non-consumable tool, with a profiled probe and shoulder, is rotated and plunged into the interface between two work pieces.

20.7.2.2.5. Laser welding is a technique that uses a high-power laser beam to join materials together. Laser welding is used in many industries, including aerospace, automotive, electronics, and medical.

20.8. Hot Work Locations.

20.8.1. Permits. Daily hot work permits, DAF Form 592, *Hot Work Permit,* are required where welding, cutting, brazing and other hot work are conducted except as prescribed in **paragraph 20.8.1.1**.

20.8.1.1. Approved Hot Work Industrial Shop/Area. A specific area will be designated and approved by the F&ES Flight, Occupational Safety office and installation BE for welding and cutting operations. **(T-1)** It will be of fire resistant or noncombustible construction appropriate for its hazard classification, free of combustible and flammable materials, and segregated from adjacent areas. **(T-0)** This area will be exempt from requiring a daily issued DAF Form 592. **(T-1)**

20.8.1.2. Maintain a copy of the signed DAF Form 592 in the immediate area of the welding, cutting and brazing operations for immediate access. **(T-1)**

20.8.1.3. When fire watchers are required, they will sign Line 12 of the hot work permit and return it to the issuing authority upon completion of their duties. **(T-1)** If work continues for more than one day, the area will be inspected prior to each day's operation to ensure that no conditions have changed, and requirements of the original permit are in effect. **(T-0)** The permit will 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. **(T-1)** Only the tasks authorized by the original permit will be accomplished. Additional tasks will require a new permit to be issued. **(T-1)**

20.8.1.4. Outside Areas.

20.8.1.4.1. The welding operation will be roped off or segregated by physical barrier whenever possible. **(T-1)** Placards reading *"WELDING OPERATIONS IN PROGRESS"* will be prominently displayed for warning purposes. **(T-1)** Protective screens, when possible, will be placed around welding operations. **(T-1)** When screens are not feasible, employees and other personnel adjacent to the welding areas will be required to wear appropriate personal protective goggles. **(T-1)**

20.8.1.4.2. Authorization, including a DAF Form 592, to perform welding, cutting, or brazing will be obtained from the F&ES Flight prior to the start of operations. **(T-1)** Coordinate with installation BE when welding, cutting, or brazing operations require additional employee protection, i.e., when using hazardous chemicals, working in permit-required confined spaces, etc. **(T-1)**

20.8.1.4.3. MAJCOMs, FLDCOMs and 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 F&ES Flight personnel) may issue welding permits. If work continues for more than one day, the area will be inspected prior to each day's operation to ensure no conditions have changed and requirements of the original permit are in effect. **(T-1)** The permit will 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. **(T-1)** Only tasks authorized by the original permit will be accomplished. **(T-1)** Additional tasks will require a new permit to be issued. **(T-1)** The following procedures are applicable:

20.8.1.4.3.1. Personnel certified by the F&ES Flight may authorize welding, cutting, and brazing operations using DAF Form 592 for this purpose. **(T-1)**

20.8.1.4.3.2. The F&ES Flight will instruct and qualify welding shop supervisors and other selected personnel. **(T-1)** Upon completing the required training, the F&ES Flight will certify the individuals in writing. **(T-1)** Upon certification, trained personnel will be qualified to issue permits. **(T-1)**

20.8.2. Permit-Required Confined Spaces.

20.8.2.1. When a welder must enter and/or perform a welding, cutting, or brazing operation in a permit-required confined space, the requirements for permit-required confined space entry in NFPA 51B, 29 CFR § 1910.146, *Permit-Required Confined*

Spaces, 29 CFR § 1910.252, *Welding, Cutting and Brazing,* **Chapter 23** of this standard and AFI 48-137 will be strictly adhered to. **(T-0)** A DAF Form 592 will be obtained from the F&ES Flight, with coordination by the Occupational Safety office and installation BE office, as applicable. **(T-0)** All welding, cutting, or brazing equipment will be inspected for leaks, abrasions, or defective equipment prior to inserting into the permit-required confined space. **(T-1)** Unserviceable equipment will not be authorized within the space. **(T-0)**

20.8.2.2. Hot work permits (DAF Form 592) will not be issued until the requirements in NFPA 51B and 29 CFR § 1910.252 are met. **(T-0)** Consult with the F&ES Flight for additional guidance.

20.8.2.3. Where it is impossible to provide the necessary ventilation inside a permit-required confined space, installation BE will determine the appropriate level of respiratory protection required. **(T-1)**

20.8.2.4. When a welder must enter a permit-required confined space through a manhole or other small opening, a means will be provided for quickly removing the welder in case of emergency. **(T-0)** When safety belts and lifelines are used for this purpose, they will be so attached to the welder's body that their body cannot be jammed in a small exit opening. **(T-0)** An attendant with a preplanned rescue procedure will be stationed outside to always observe the welder and be capable of putting rescue operations into effect. **(T-0)** Refer to **Chapter 23** of this standard, 29 CFR § 1910.252 and NFPA 51B for additional guidance.

20.8.3. Aircraft Welding.

20.8.3.1. Gas shielded tungsten arc-welding is the approved method for welding on aircraft. Welding on aircraft should be performed outside of hangars, if possible. A DAF Form 592 will be issued prior to all aircraft welding operations**. (T-1)** Welding will only be performed on aircraft system components specified in the appropriate aircraft technical data. **(T-1)** Specific hazards associated with the task and emergency procedures will be listed in Block 13 of the welding permit. **(T-1)** If more space is required to list all precautions, a welding fire safety checklist will be prepared and attached to the form. **(T-1)** The welding supervisor will ensure identified precautions and/or checklist items are followed. **(T-1)** The welding supervisor will ensure the senior flightline supervisor (line chief and/or production supervisor) is cognizant of the restrictions in paragraphs **20.8.3.2** through **20.8.3.11** below. **(T-1)**

20.8.3.2. Ensure the senior flightline supervisor (production supervisor) is thoroughly briefed on the planned welding operation. **(T-1)** This supervisor is responsible for informing other senior flightline supervisors if aircraft from different units are on the ramp.

20.8.3.3. Do not weld on an aircraft while work is in progress on any system or component that contains or has contained fuel or other flammable or combustible liquids. **(T-1)**

20.8.3.4. Prior to the start of welding operations, fuel tank, engine fuel vents, and any fuel tank opening will be closed/plugged on all aircraft within 50 feet from the point of any welding. **(T-1)** All fuel lines, valves, manifolds, and other fuel components on the aircraft where welding is being performed will be in place, secured, or capped prior to the start of and during such welding operations. **(T-1)**

20.8.3.5. Do not perform any other work within a 25-foot radius of any gas-shielded arc-welding operation. **(T-1)**

20.8.3.6. 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. **(T-1)**

20.8.3.7. Whenever welding is being performed in the vicinity of flammable vapors, a trained employee will conduct an atmosphere analysis with a combustible gas analyzer to assure that flammable vapors do not reach 20 percent of the lower explosive limit. **(T-1)** Such analysis will be conducted prior to the start of welding and at least every 15 minutes during the welding operation. **(T-1)** For permit-required confined spaces the lower explosive limit is lowered to 10 percent. Additionally, when welding in a hangar, check floor drains in the same manner. Refer to NFPA 410, *Standard on Aircraft,* and 29 CFR § 1910.146 for additional guidance. NFPA standards are normally available for review at the occupational safety office or fire department.

20.8.3.8. Rope off or segregate the welding operation by physical barriers. **(T-1)** Prominently display warning signs reading: "WELDING OPERATIONS IN PROGRESS." Place screens around welding operations, when possible. **(T-1)**

20.8.3.9. Keep electrical welding equipment components (other than flexible lead cables) at least 18 inches above the floor. **(T-1)** Position all ground leads or cables as close as possible to the area being welded. **(T-1)** The ground leads will be as close to the weld area as possible, and clamps used on such ground leads will be of the "C" clamp type. **(T-1)**

20.8.3.10. Assign a trained fire guard to monitor the welding operation and halt the welding operation if a hazardous condition develops. **(T-0)** Provide the fireguard with a 10B:C (minimum) rated fire extinguisher in the immediate area, and a back-up wheeled extinguisher of 80B:C rating. **(T-1)** Ensure the fire watch is maintained for at least 30 minutes after completion of the welding operation to detect and extinguish smoldering fires. **(T-0)** Operations on combustible metals will include the availability of a Class D fire extinguisher. **(T-1)**

20.8.3.11. Aircraft welding operations performed in hangars will conform to **Chapter 6**, *Fire Prevention and Protection,* and NFPA 410. **(T-1)**

20.8.4. Vehicle Equipment Shops. Welding or cutting in vehicle maintenance activities will only be conducted in areas approved by the F&ES Flight. **(T-1)** Maintenance shop supervision will evaluate each welding or cutting task to determine if batteries or fuel tanks require removal and/or need to be made inert. **(T-1)**

20.9. Contractors. The contracting officer, in coordination with the Occupational Safety office and F&ES Flight, will determine the necessity to include specific references to OSHA standards, DAF fire, safety and health standards, and other guidance as necessary in the contract. **(T-1)**

20.10. Hot Work Permit. A DAF Form 592 is required whenever there is cutting, welding, or brazing being accomplished outside of the designated shop area. The hot work permit must be obtained from the F&ES Flight prior to starting welding operations. **Note**: Installation BE assistance and coordination may be required, e.g., BE HRA, PPE listing/recommendation.

Table 20.1. How To Fill Out DAF Form 592, *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 2016.
Block 2.	Date Permit Issued. (Self-Explanatory)
Block 3.	Time Permit Issued. (Self-Explanatory)
Block 4.	Organization/Contractor/Company: Name and Contact Information
Block 5.	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 Hangar? Are munitions present?
Block 6.	Description of Work: Give a brief description of work.
Block 7.	Is Fire Watch required? See chart on back of form. Answer Yes or No. Performed by: Who is performing the Fire Watch?
Block 8.	Permit Authorizing Individual fills out Inspection Checklist prior to execution of hot work. If work is to be performed in a confined space, coordinate with Occupational Safety/installation BE/F&ES Flight & attach to the DAF Form 1024, *Confined Space Entry Permit.*
Block 9.	PAI signature granting permission to execute work.
Block 10.	Operator/On-scene supervisor signature stating understanding of responsibilities under DAFMAN 91-203 and National Fire Protection Association 51B.
Block 11.	BE signature confirming coordination, as required.
Block 12.	Fire Watch signature confirming Final Check completion.
Block 13.	Any additional information.

Chapter 21

HAZARDOUS ENERGY CONTROL

21.1. Scope. This chapter establishes DAF-specific hazardous energy control program requirements in addition to the OSHA requirements found in 29 CFR § 1910.147, *The Control of Hazardous Energy (Lockout/Tagout),* 29 CFR § 1910.331, *Scope,* 29 CFR § 1910.332, *Training,* 29 CFR § 1910.333, *Selection and Use of Work Practice,* 29 CFR § 1910.334, *Use of Equipment,* 29 CFR § 1910.335, *Safeguards for Personnel Protection.* When conducting servicing and maintenance of machinery/equipment, hazardous energy control procedures will be developed to protect against the various sources of hazardous energy. **(T-0)** Refer to **Table 21.1** for a list of common hazardous energy sources. Exceptions to the hazardous energy control program can be found IAW 29 CFR § 1910.147(a)(2).

Table 21.1. Common Hazardous Energy Categories and Corresponding Sources.

Category	Hazardous Energy Sources
Electrical	Power Transmission Lines Generators Machine Power Cords Conductors Motors Capacitors Solenoids Batteries
Mechanical	Blades Materials in supply lines of bins or silos Springs Actuators Counterweights Raised Loads Top or movable part of a press or lifting device Augers Reciprocating Motions Pinch Points
Pressurized Liquids and Gases	Supply Lines Storage Tanks and Vessels
Hydraulic	Presses Rams Cylinders Hammers Shears Punches Drives Hose and Line Failure
Pneumatic	Air Lines Pressure Reservoirs Accumulators Air Surge Tanks Rams Cylinders

	Tools
Note: This table is not all-inclusive and only represents common examples. Wind, gravity and kinetic energy need to be considered when controlling hazardous energy. Hand-operated machinery/equipment may store hazardous energy or pose hazards to employees if broken or defective and require the use of this program. **(T-0)**	

21.2. Hazardous Energy Control Program. Work center/shop supervisors will:

21.2.1. Establish a hazardous energy control program that has energy control procedures, training and periodic inspections that ensures employees conducting servicing or maintenance cannot be injured by the unexpected energizing, startup, or release of stored energy. **(T-0)**

21.2.2. Document the procedures on how the tagout program will provide the same level of safety equivalent to a lockout program when using tagout devices only (for machinery or equipment that does not accept lockout devices). **(T-0)**

21.3. Training.

21.3.1. Authorized and affected employees as defined by OSHA will receive training IAW 29 CFR § 1910.147(c)(7). **(T-0)** Training will include:

21.3.1.1. Instructing authorized employees to recognize the applicable hazardous energy sources, type, and magnitude of the energy available, and the methods and means required to isolate and control that energy. **(T-0)** Only authorized employees perform the hazardous energy control procedures(s) to the machinery or equipment that they will perform servicing or maintenance on. **(T-0)**

21.3.1.2. All affected employees will understand the purpose and use of the energy control procedure. **(T-0)** Affected employees operate or use the machines or equipment that have servicing or maintenance being performed. **(T-0)**

21.3.1.3. Other employees entering or passing through an area where hazardous energy control procedures are in use will be instructed on the procedures in use and the prohibition against restarting or reenergizing the machinery or equipment that is locked out or tagged out for servicing or maintenance. **(T-0)**

21.3.1.4. Employees will understand the limitations of tags, when tagout systems are used. **(T-0)** Refer to **paragraph 21.4.1.6** for the specific limitations when using tagout only.

21.3.1.5. Retraining. Authorized employees and affected employees will be retrained for the following reasons:

21.3.1.5.1. A change in their job assignments, a change in machinery, equipment or processes that present a new hazard, or when there is a change in the energy control procedures or other conditions as specified in 29 CFR § 1910.147(c)(7)(iii). **(T-0)**

21.3.1.5.2. When a periodic inspection shows, or when a commander or supervisor has reason to believe that there are deviations from or inadequacies in an employee's knowledge or use of hazardous energy control procedures. **(T-0)**

21.3.1.5.3. To reestablish employee proficiency and introduce new or revised methods or procedures. **(T-0)**

21.3.1.5.4. Refer to 29 CFR § 1910.147(c)(7)(iii) for additional guidance.

21.3.1.6. Documentation. Supervisors will certify that employees have completed training and are current on requirements by documenting, as a minimum, the employee's name and dates of training. **(T-0)** Additional training documentation requirements can be found in DAFI 91-202.

21.4. Program Self-Inspections.

21.4.1. The shop hazardous energy control program will receive periodic inspections by the shop supervisor to ensure compliance with all program elements at least annually. **(T-0)** The periodic inspection will be performed by an authorized employee other than the one(s) utilizing the energy control procedure being inspected. **(T-0)** Periodic inspections will be designed to identify and correct any deviations or inadequacies observed. **(T-0)** The periodic inspection will be documented to certify the following, as a minimum, was reviewed:

21.4.1.1. Identification of equipment and machinery for which the hazardous energy control program applies. **(T-0)**

21.4.1.2. Verification that training has been conducted, is current and properly documented. **(T-0)**

21.4.1.3. A review of hazardous energy control procedures with authorized employees, to include demonstration by the employee of the required practices to ensure the procedures have no deviations or inadequacies. **(T-0)**

21.4.1.4. Where lockout is used, the inspection will have the inspector and each authorized employee review the employee's responsibilities under the energy control procedure being inspected. **(T-0) Note:** The review of employer responsibilities does not require one-on-one interviews to complete the requirement but can be done in a group setting with all authorized persons who utilize the inspected procedures.

21.4.1.5. Where tagout is used, the inspection will have the inspector and each authorized employee review the employee's responsibilities under the program and the employee's understanding of the limitations of tags. **(T-0)** This includes:

21.4.1.5.1. Tags are essentially warning devices affixed to energy isolating devices and do not provide the physical restraint on those devices that are provided by a lock.

21.4.1.5.2. When a tag is attached to an energy isolating device, it will not be removed without the authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated. **(T-0)**

21.4.1.5.3. Tags must be legible and understandable by all authorized employees, affected employees and all other employees whose work operations are or may be in the area, in order to be effective. **(T-0)**

21.4.1.5.4. Tags and their means of attachment must be made of materials which will withstand the environmental conditions encountered in the workplace. **(T-0)**

21.4.1.5.5. Tags may evoke a false sense of security, and their meaning must be understood as part of the overall energy control program. **(T-0)**

21.4.1.5.6. Tags must be securely attached to energy isolating devices so that they cannot be inadvertently or accidentally detached during use. **(T-0)**

21.4.1.6. An out-brief to the supervisor will be conducted, as appropriate, and findings documented in the written report. **(T-1)**

21.4.2. A qualified occupational safety inspector will review the annual self-inspection hazardous energy control report(s) during the organization's safety assessment to ensure compliance IAW DAFI 91-202. **(T-1)**

21.5. Authorized Lockout and Tagout Devices. Authorized lockout and tagout devices will be used IAW 29 CFR § 1910.147(c)(5) and in the paragraphs below. **(T-0) Note**: When using tags, a tag is required to be supplemented with at least one additional safety measure that provides a level of safety equivalent to that obtained using a lockout device.

21.5.1. Lockout and tagout devices will be singularly identified for use in controlling energy under this program and identify the employee applying the devices. **(T-0)** Additionally, tagout devices will warn against hazardous conditions if the machine or equipment is energized. **(T-0)**

21.5.2. Be durable to withstand the environment that they are exposed to for the maximum time the exposure is expected. **(T-0)** Tagout devices must be constructed and printed so that exposure to weather, wet and damp locations, or corrosive environments will not deteriorate the tag and make it unreadable. **(T-0)**

21.5.3. Be singularly keyed with only authorized employees retaining the key(s) to the lock(s) when in use. **(T-0)** Lockout and tagout devices will be standardized by at least one of the following criteria: color, shape, or size. **(T-0)** For tagout devices, the print and format will be standardized. **(T-0)**

21.5.4. AF Form 983 or DoD tag or commercial equivalent tags will be used in conjunction with energy-isolating devices. **(T-1)** The functional manager or supervisor will ensure an adequate supply of energy-isolating devices are available. **(T-1)**

21.5.5. Lockout devices will be strong enough to require excessive force or unusual techniques to remove them, e.g., bolt cutters. **(T-0)** Tagout devices must be strong enough to prevent inadvertent or accidental removal, the attachment device will be non-reusable, attached by hand, self-locking, with an unlocking strength of no less than 50 pounds. **(T-0)**

21.6. Hazardous Energy Control Procedures. Develop and document specific procedures for each piece of equipment identified in the hazardous energy control program unless exempted in 29 CFR § 1910.147(c)(4)(i). **(T-0)** Procedures will include all steps from **Figure 21.1** and **Figure 21.2** **(T-0)** Additional information for procedure development can be found in 29 CFR § 1910.147(c)(4). **Exception**: The employer need not document the required procedure for a particular machine or equipment when all elements identified in 29 CFR § 1910.147(c)(4)(i) exist.

Figure 21.1. Eight-Step Hazardous Energy Control Procedure Checklist.

The authorized employee will:	
1. Notification	Notify all affected employees of the impending shutdown and that they will not touch hazardous energy control devices or attempt to restart the machinery/equipment until informed it is safe to resume normal operations. **(T-0)**
2. Preparation	Determine if documented hazardous energy control procedures for the machinery/equipment are applicable to the task. **(T-0)** Procedures do not need to be documented if the work meets the eight preconditions found in

	the Note of 29 CFR § 1910.147(c)(4)(i). If so, the authorized employee will review hazardous energy control procedures and ensure they are followed correctly. **(T-0)**
	Prior to shutting down machinery/equipment, the authorized employee must have knowledge of and assess the type (e.g., electrical, mechanical, hydraulic), magnitude (e.g., 120 volts, 60 psi) and hazards of the energy to be controlled, including hidden energy sources such as springs, capacitors, elevated parts, etc. **(T-0) Warning**: Machinery/equipment may contain more than one type of energy.
	Determine IAW written procedures, appropriate methods for controlling the hazardous energy. **(T-0)** Methods for energy-isolation may include, but are not limited to, circuit breakers, disconnect switches or valves.
3. **Shutdown**	Verify it is safe to shut down the machinery/equipment. **(T-0)**
	The machinery/equipment will be turned off or shut down using normal stopping and shutdown procedures (depress stop button, open toggle switch, close shut off valve, etc.). **(T-0)**
4. **Isolation**	Isolate all energy sources by operating (switch off, valve off, etc.) energy-isolating device(s). **(T-0)**
	All energy isolating devices that are needed to control the energy to the machine or equipment will be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s). **(T-0)**
5. **Authorized LOTO Device Application**	Affix lockout device to hold energy-isolating devices in an "off" or "safe" position that physically prohibits normal operation of the device. **(T-0)** If possible, both locks and tags will be installed. **(T-1)**
	Tags will indicate date, time, reason, and name of the authorized employee installing device. **(T-0)**
	To prevent inadvertent or accidental detachment, tags will be securely attached with a self-locking and non-releasable attachment (e.g., a nylon or plastic cable tie-off strap) with a minimum unlocking strength of 50 pounds. **(T-0)**
	For group hazardous energy control procedures, conduct IAW **paragraph 21.6.1.**
6. **Release Stored Energy**	Once the system is locked/tagged out, all potentially hazardous stored or residual energy will be relieved, disconnected, restrained, or otherwise rendered safe. **(T-0)** 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. **(T-0)** Machinery/equipment will be in a zero-energy state. **(T-0)**
	When the equipment to be worked on does not have normal controls, e.g., energy-isolating device, on/off switch, use the following procedure for isolation confirmation. Test potential energy sources using appropriately rated and calibrated instruments or testers. **(T-0)** Instruments used to test voltage, pressure or temperature will be checked for proper operation both before and after use. **(T-0)** If the authorized employee is not qualified to test the energy being isolated, he or she will ensure the energy is tested by a qualified person. **(T-0)**
7. **Verification**	Physically attempt to operate energy-isolating devices and attempt to restart the equipment or machinery using normal controls**. (T-0) Caution:** Return energy-isolating devices to "safe" or "off" position after the test.
8.	The LOTO device will remain in place until work on the machinery/equipment is complete. **(T-0)**

Locked Out – Keep Hazardous Energy Control Devices in Place	
Additional Procedures	
1. Testing, adjustment, or repositioning requiring temporarily removing LOTO devices	When circumstances require testing, adjustment or repositioning of machinery/equipment, it may be necessary to temporarily remove LOTO devices before work is complete to verify functionality. The following sequence of actions will be used when LOTO devices must be temporarily removed from the energy-isolating device: 1. Notify all affected employees and supervisors. **(T-0)** 2. Clear machinery/equipment of tools and materials. **(T-0)** 3. Remove all employees from the machinery/equipment area and ensure the required tools are safely and properly positioned. **(T-0)** 4. Remove all repositioning and blocking devices and return all vents and valves to normal operating positions. **(T-0)** 5. Remove all grounding/shorting conductors, hooks, or wands. **(T-0)** 6. Don any required PPE. **(T-0)** 7. Energize and proceed with testing or positioning. **(T-0)** 8. De-energize all systems; reapply hazardous energy control measures; notify all affected employees and supervisors; and continue servicing, maintenance or modification of equipment or machinery. **(T-0)**
2. Transferring LOTO devices to another authorized employee	Where transfer of LOTO devices occurs due to shift change or other reasons, specific procedural steps will be developed to ensure an orderly transfer. **(T-0)**
3. Restoring machinery or equipment to service when the authorized employee is not available	When the authorized employee is unavailable to remove LOTO devices they applied, the following must be completed by shop supervisor: 1. Verify that the authorized employee who applied the device is not at the facility. **(T-0)** 2. Make all reasonable efforts to contact the employee to inform them that the LOTO device has been removed, and **(T-0)** 3. Ensure the authorized employee is informed of the removal prior to resuming work at the facility. **(T-0)**

Figure 21.2. Three-Step Release from Hazardous Energy Control Procedure Checklist.

1. Preparation and Notification	Before removing LOTO devices and reenergizing machinery/equipment, the authorized employee will:
	1. Notify all affected employees the system is ready for return to service. **(T-0)** Ensure all personnel are clear of the equipment point of operation and other hazard zones. **(T-0)**
	2. Inspect the work area and ensure all tools, debris and non-essential personnel are removed or are a safe distance from the machinery/equipment. **(T-0)**
	3. Replace safety guards, inspect machinery/equipment, and ensure guards are operational. **(T-0)**
2. Verify Condition of Machinery/Equipment	Verify the controls are in neutral. **(T-0)**
3.	Each LOTO device will be removed only by the authorized employee who applied it. **(T-0)** When the authorized employee who applied the device is not available

Removal of all LOTO Devices	to remove it, their supervisor may remove the device IAW **paragraph 21.6.3. (T-0)** This is considered an emergency procedure, undertaken only in extreme circumstances, e.g., use of machinery/equipment is required immediately.
	Authorized employees will remove all LOTO devices and restore the energy-isolating device to the "ON" position. **(T-0)**
	Notify all employees the hazardous energy control condition has been cleared (LOTO devices removed) and machinery/equipment is ready for service. **(T-0)**
	Energize the machinery/equipment and restore to normal operating condition. **(T-0)**

21.6.1. Group LOTO is used when the machinery or equipment under servicing or maintenance is conducted by a crew, craft, department, or other group and must be protected to the level equivalent of a personal lockout or tagout device. **(T-0)** Group procedures will be IAW 29 CFR § 1910.147(f)(3) and:

21.6.1.1. Have an authorized employee who has primary responsibility over a set number of employees working under a group lockout or tagout device. **(T-0)**

21.6.1.2. Provision for the authorized employee to determine the exposure status of the individual group members regarding the lockout or tagout of the machine or equipment. **(T-0)**

21.6.1.3. Coordinate affected work forces and ensure continuity of protection when more than one crew, craft, department, etc. is working on the same assignment. **(T-0)**

21.6.1.4. Each authorized employee in the group lockout or tagout will have their own device that can be attached to the group lockout device and will be removed when they stop working on the machine or equipment under servicing or maintenance. **(T-0) Note:** All group LOTO authorized employees must be informed of their right to verify the effectiveness of the hazardous energy control procedure and verify that hazardous energy sources have been effectively isolated. **(T-0)**

21.6.2. Authorized Employee Requirements. No employee may attach or remove another person's LOTO device, including signing on or signing off for another person, unless the provisions of the exception to 29 CFR § 1910.147(e)(3) are met. **(T-0)** Individual employee device removal indicates that employees are no longer exposed to the hazards from the servicing or maintenance operation.

21.6.3. Shift Changes. Specific, written procedures will be developed and used during shift or personnel changes to ensure continuity of hazardous energy control protection. **(T-0)** This includes provision for orderly transfer of authorized LOTO devices between off-going and on-coming supervisors and authorized employees to minimize exposure to hazards from unexpected energization, start up, or release of stored energy from machinery/equipment. Refer to 29 CFR § 1910.147(f)(4) for more information.

21.7. Hazardous Energy Control Procedures When Establishing an Electrically Safe Work Condition. When establishing an electrically safe work condition IAW NFPA 70E, *Electrical Safety in the Workplace,* Article 120, hazardous energy control program will meet the requirements of this chapter and procedures listed below.

21.7.1. Simple Lockout/Tagout Procedure. All LOTO procedures that involve only an authorized person(s) de-energizing one set of conductors or circuit part source for the sole

purpose of safeguarding employees from exposure to electrical hazards will be considered a simple LOTO. **(T-0)** Written, simple LOTO procedures will not be required for each application. Each authorized employee will be responsible for their own LOTO. **(T-0)**

21.7.2. Complex Lockout/Tagout.

21.7.2.1. A complex LOTO procedure will be required where one or more of the following exists:

21.7.2.1.1. Multiple energy sources, e.g., electrical, and other sources. **(T-0)**

21.7.2.1.2. Multiple crews. **(T-0)**

21.7.2.1.3. Multiple crafts. **(T-0)**

21.7.2.1.4. Multiple locations. **(T-0)**

21.7.2.1.5. Multiple employers. **(T-0)**

21.7.2.1.6. Multiple disconnecting means. **(T-0)**

21.7.2.1.7. Particular sequences. **(T-0)**

21.7.2.1.8. Job or task that continues for more than one work period. **(T-0)**

21.7.2.2. The complex LOTO procedures will require a written plan of execution IAW 29 CFR § 1910.147 and identifies the person(s) in charge. **(T-0)**

21.7.2.3. The complex LOTO procedure will vest primary responsibility in an authorized employee for employees working under the protection of a group lockout or tagout device, such as an operation lock or lockbox. **(T-0)** The person(s) in charge will be held accountable for safe execution of the complex LOTO. **(T-0)**

21.7.2.4. Each authorized employee will affix a personal lockout or tagout device to the group lockout device, group lockbox or comparable mechanism when he or she begins work and will remove those devices when he or she stops working on the machine or equipment being serviced or maintained. **(T-0)**

21.7.2.5. All complex LOTO plans will identify the method to account for all persons who might be exposed to electrical hazards during the use of the LOTO procedure. **(T-0)**

21.8. Contractors. Interaction with contractors will be IAW DoDI 6055.01, DAFI 91-202 and 29 CFR § 1910.147(f)(2). **(T-0)** These details will be specified in the contract. **(T-0)**

Chapter 22

FLAMMABLES AND COMBUSTIBLES

22.1. Scope. This chapter provides the criteria for storage, use and handling of flammable and combustible liquids and gases, and 29 CFR § 1910.106, *Flammable Liquids,* and NFPA 30. 29 CFR § 1910.101, *Compressed Gases (General Requirements),* and NFPA 55 must be followed. **(T-0)** Use of these gases will also comply with requirements in this chapter and other parts of this publication, along with requirements in NFPA 70, *National Electric Code*, and other National Fire Codes related to use and storage of flammable materials. **(T-1) Note**: There are a few chemicals with a flashpoint outside these limits, such as anhydrous ammonia, that are still considered flammable liquids. Refer to **Table 22.1** for additional information.

22.2. Hazards. Flammable and combustible liquids always require careful handling. Many of these liquids are used by the DAF daily, and mishandling is a significant cause of injury, occupational illness, or catastrophic failure. 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 exposure to temperatures higher than the flashpoint. The best means of employee protection is to engineer hazards out of the job so the employee is not exposed. If this is not possible, PPE may be required. A documented job hazard analysis (JHA) will be conducted to determine if hazards are present and take actions necessary to protect employees from injury, illness, or death. **(T-1)** Refer to **paragraph 1.5** and DAFI 91-202 for additional guidance on JHA.

22.2.1. Solvents with flammable characteristics must be handled with care. **(T-0)** Solvents can burn or explode if handled or used improperly.

22.2.2. Flammable and combustible liquids can be highly reactive with other substances, subject to explosive decomposition, or have other properties that dictate extra safeguards. Review the SDSs and/or contact the Occupational Safety office, F&ES Flight or installation BE when in doubt or for additional guidance. **Note**: Water-reactive materials will not be stored where fire protection sprinklers are in place. **(T-1)** These materials will not be stored with flammable or combustible liquids. **(T-1)** Refer to 29 CFR § 1910.106 and the latest edition of the Emergency Response Guidebook. Ensure emergency response personnel are advised that water-reactive materials are present. **(T-0)**

22.2.3. 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.

22.2.4. Operations where fuels, solvents or other flammable liquids are used must be constantly observed to avoid unsafe practices. **(T-0)** 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 will be avoided, when possible. **(T-0)** Open flames, heaters, equipment not properly grounded and non-explosion proof electrical equipment will not be used in the presence of flammable or combustible liquids. **(T-0)** Refer to NFPA 30 for additional guidance.

22.3. Training.

22.3.1. Functional Managers and/or Supervisors will ensure:

22.3.1.1. All employees and handlers of flammable or combustibles have accomplished appropriate training associated with tasks and hazards related to the work environment. **(T-0)**

22.3.1.2. Personnel handling, storing, or using hazardous materials are trained IAW AFI 90-821. **(T-1)**

22.3.1.3. Individuals involved in dispensing of flammable or combustible liquids are instructed on hazards of static electricity. **(T-0)**

22.3.1.4. Employees handling and storing flammable or combustible liquids are trained in fire prevention and protection as it relates to their duties. **(T-0)**

22.3.2. Job safety training will include, as a minimum, information on the need for and use of approved PPE, maintenance and care of PPE, review of SDSs, safe chemical handling procedures, Emergency Response Guidebook, and emergency treatment practices in case of exposure, ingestion, or inhalation of liquids or vapors. **(T-0)** Refer to **paragraph 22.4.**, **Chapter 14** and AFI 90-821 for additional guidance.

22.4. Personal Protective Equipment (PPE).

22.4.1. PPE will be used whenever there are hazards that can do bodily harm through absorption, inhalation, or physical contact. **(T-0)** This equipment includes respiratory protective devices, special clothing, and protective devices for the eyes, face, head, torso, and extremities. All PPE will be approved for the work performed and will be maintained in satisfactory condition. **(T-0)** Refer to **Chapter 14** for additional requirements.

22.4.2. Functional Managers and/or Supervisors will ensure PPE is available and appropriately worn when handling flammable or combustible liquids. **(T-0)**

22.4.3. DAF personnel will comply with all PPE requirements when handling flammable or combustible liquids. **(T-0)**

22.5. Housekeeping. Where flammable and combustible liquids are used or handled, except in closed containers, means will be provided to dispose promptly and safely of leakage or spills. **(T-0)** Refer to the appropriate SDSs for spill clean-up procedures and PPE required.

22.5.1. Leaking containers will be removed to a safe location outside the building, and the contents transferred to an undamaged container IAW guidance from the F&ES Flight and installation CE. **(T-1)**

22.5.2. Functional Managers and/or Supervisors will ensure:

22.5.2.1. Appropriate spill and containment control materials are readily available at storage or dispensing areas. **(T-1)**

22.5.2.2. Leakage and spills are cleaned up in a timely manner. **(T-0)**

22.5.2.3. All containers are clearly labeled to identify contents and indicate hazards. **(T-0)**

22.6. Fire Protection.

22.6.1. Facility Pre-Fire Plans. Facility pre-fire plans will be developed for flammable and combustible liquid warehouses, laboratory, and storage buildings. **(T-0)** These plans will be maintained in the F&ES Flight and on vehicles designated by the fire chief. **(T-1)** Refer to AFI 32-2001, *Fire and Emergency Services (F&ES) Program,* for additional information. The plans include the hazardous materials contained in installation facilities, their locations, and emergency procedures to be followed.

22.6.2. Inside Storage Room Requirements. For inside room storage capacity and required fire resistive ratings refer to 29 CFR § 1910.106, Table H-13. Storage rooms will not have an opening into any portion of a building used by the public. **(T-0)** At least one clear 3-foot-wide aisle will be maintained in all inside storage areas. **(T-0)** Containers more than 30-gallons in capacity will not be stacked. **(T-0)** Dispensing will be IAW **paragraph 22.7.1.3** for Class I flammable liquids. **(T-1)** All other dispensing will be by approved pump or self-closing faucet only. **(T-0)** Refer to NFPA 30 for additional information.

22.6.2.1. At least one portable fire extinguisher having a rating of at least 40-B will be located outside of, and within 10 feet of, the door opening into an inside liquid storage area. **(T-0)**

22.6.2.2. At least one portable fire extinguisher rated at least 40-BC will be located within 30 feet of any Class I or Class II liquid storage area outside of a storage room but inside a building. **(T-0)**

22.6.2.3. Installed fire suppression systems will be approved IAW UFC 3-600-01. **(T-1)** Additionally, consult the F&ES Flight for further guidance.

22.6.3. Storage Inside Buildings.

22.6.3.1. Storage will 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. **(T-0)**

22.6.3.2. If a flammable and combustible liquids storage building is used, it will be one-story and devoted principally to handling and storing of flammable or combustible liquids. **(T-0)** The building will have a 2-hour fire-rated exterior wall with no openings within 10 feet of stored material. **(T-0)**

22.6.3.3. At least one portable fire extinguisher will 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. **(T-0)** Coordinate with the F&ES Flight on the proper type, quantity, and placement of extinguishers for size and layout of the facility.

22.6.4. Storage Outside.

22.6.4.1. At least one portable fire extinguisher rated at least 20-B will be located 50 feet travel distance from any Class I or Class II liquid storage area outside of a storage room. **(T-0)** Coordinate with the F&ES Flight on the proper type, quantity, and placement of extinguishers for size and layout of the facility.

22.6.4.2. Installed fire suppression systems will be approved IAW UFC 3-600-01. **(T-0)** Contact the F&ES Flight for further guidance.

22.6.4.3. Welding, cutting, or brazing will be accomplished IAW **Chapter 20**. **(T-1)** Refer to 29 CFR § 1910.252, *Welding, Cutting, and Brazing*, for additional guidance.

22.6.5. All laboratories will have fire protection appropriate for their fire hazard classification. **(T-0)** Fire protection will include, as a minimum, portable fire extinguishers, an alarm system, and an emergency evacuation plan. **(T-0)** For additional details regarding required fire protection requirements, refer to NFPA 45, *Standard for Fire Protection for Laboratories Using Chemicals*.

22.7. Building and Equipment Requirements.

22.7.1. Electrical.

22.7.1.1. Electrical wiring and equipment located in inside storage rooms used to store Class I liquids will meet requirements for Class I, Division 2 hazardous classified locations. **(T-0)** Refer to 29 CFR § 1910.106 and NFPA 70 for additional guidance.

22.7.1.2. Electrical equipment and wiring in inside storage rooms used to store only Class II and Class III liquids will be suitable for general purpose use. **(T-0)**

22.7.1.3. Containers and portable tanks used for Class I liquids will be electrically grounded and bonded during liquid transfer. **(T-0)** Positive measures will 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. **(T-0)**

22.7.2. Ventilation. Liquid storage areas where dispensing is conducted will be provided with either a gravity or continuous mechanical exhaust ventilation system. **(T-0)** Areas in which flammable or combustible liquids are transferred from one container to another tank or container in quantities greater than 5 gallons will be separated from other similar operations by 25-feet or by construction with a fire resistance of at least one hour. **(T-0)** Drainage or other means will be provided to control spills. **(T-0)** Adequate natural or mechanical ventilation will be provided to maintain the concentration of flammable vapors at or below 10 percent lower explosive limit (LEL). **(T-0)** Mechanical ventilation will be used if Class I liquids are dispensed within the room. **(T-0)** Refer to 29 CFR § 1910.106 for additional information.

22.7.2.1. Exhaust air will be taken from a point near a wall on one side of the room and within one foot of the floor with one or more make-up inlets located on the opposite side of the room within one foot of the floor. **(T-0)** The location of both the exhaust and inlet air openings will be arranged to provide air movement across all portions of the floor to prevent accumulation of flammable vapors. **(T-0)** Exhaust from the room will be directly to the exterior of the building without re-circulation. **(T-0)** Refer to NFPA 30 for additional guidance.

22.7.2.2. Mechanical ventilation systems will be sized to supply and exhaust the equivalent of six volumes per hour. **(T-0)** If a mechanical exhausting system is used, it will be controlled by a switch located outside the door. **(T-0)** The ventilating equipment and any lighting fixtures will be operated by the same switch. **(T-0)** The switch will be illuminated, or an electric warning pilot light will be adjacent to the switch if flammable liquids are dispensed within the room. **(T-0)** The mechanical ventilation system for dispensing areas will be equipped with an airflow switch or equally reliable method interlocked to sound an audible alarm upon failure of the ventilation system. **(T-0) Note**:

Coordinate with installation CE and installation BE to assist in the proper selection of a ventilation system.

22.7.2.3. Ventilation ducts and airflow requirements will comply with UFC 3-410-04, *Industrial Ventilation,* and NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* and 29 CFR § 1910.106, Table H-11, for vent line diameters. **(T-0)**

22.7.3. Storage Cabinets. All flammable/combustible storage cabinets will be listed/approved for the specific class of storage. **(T-0)** Refer to 29 CFR § 1910.106 and NFPA 30 for additional information. **Note**: Metal storage cabinets and wooden cabinets will be constructed IAW 29 CFR § 1910.106(d)(3)(ii). **(T-0)**

22.7.3.1. HAZMAT Storage Warehouses and Other Areas that may Exceed Maximum Allowable Quantities Limit. In HAZMAT Pharmacies, buildings and/or portions of buildings where liquids are stored that may exceed maximum allowable quantities per control area will be classified as High-Hazard Level 2 or High-Hazard Level 3, as established by NFPA 30. **(T-0)**

22.7.3.1.1. 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.

22.7.3.1.2. 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.

22.7.3.2. Cabinets will be labeled with conspicuous lettering, “Flammable — Keep Fire Away.” **(T-0)** Additional guidance for marking storage containers is contained in **Chapter 17**. Refer to NFPA 30 for additional guidance.

22.7.3.3. The cabinet is not required to be vented for fire protection purposes. However, the following will apply:

22.7.3.3.1. If the cabinet is vented, for whatever reasons, the cabinet inlet will be vented outdoors in a manner that will not compromise performance of the cabinet. **(T-0)**

22.7.3.3.2. If the cabinet is not required to be vented, the vent opening, as applicable, will be sealed with bungs supplied with the cabinet or specified by the manufacturer of the cabinet. **(T-0)**

22.7.3.4. Storage cabinets that meet at least one of the following sets of requirements will be acceptable for the storage of liquids. Storage cabinets, certified by the manufacturer, 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 325º F (162.8º C), when subjected to a 10-minute fire test that simulates the fire exposure of the standard time-temperature curve specified in ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, will be acceptable. **(T-0)** All joints and seams will remain tight, and the door will remain securely closed during the test. **(T-0)**

22.7.3.5. 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.

22.7.4. Inside Storage Rooms. Refer to NFPA 30 for additional guidance.

22.7.4.1. Inside storage rooms will meet specifications of 29 CFR § 1910.106(d)(4), *Design and Construction of Inside Storage Rooms,* and NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials,* and the required fire-resistive rating for their use. **(T-0)** Openings to other rooms or buildings will have noncombustible liquid-tight raised sills or ramps at least four inches in height or, as an alternative, the floor in the storage area will be at least four inches lower than the surrounding floor. **(T-0)** Rooms will be liquid-tight where walls join the floor. **(T-0)** 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, *Fire Doors and Other Opening Protectives*, will be used. **(T-0)** Where other portions of the building or other properties are exposed, windows will be protected as required by NFPA 80. **(T-0)** Wood of at least 1-inch nominal thickness may be used for shelving, racks, dunnage, scuff boards, and floor overlay.

22.7.4.2. Class I liquids will not be stored or handled within a building having a basement or pit where heavier-than-air flammable vapors can accumulate, unless such an area is ventilated to prevent the accumulation of flammable vapors. **(T-0)**

22.7.5. 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 will comply with NFPA 30. **(T-1)** Refer to 29 CFR § 1910.106 for additional information. **(T-0)**

22.7.5.1. Storage will 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. **(T-0)**

22.7.5.2. Water reactive materials will not be stored in the same room with flammable or combustible liquids. **(T-0) Exception**: Small quantities may be stored in laboratories. Refer to **paragraph 22.6.1** and NFPA 30 for additional guidance.

22.7.5.3. Base supply warehouses, Army and Air Force Exchange Service (AAFES) storage rooms and commissary storage areas will be IAW 29 CFR § 1910.106, Table H-14. **(T-0)** Buildings or portions of such buildings utilized for flammable and/or combustible storage will be isolated by standard fire walls approved for the type and quantity of liquids being stored. **(T-0)** Materials which create no fire hazard may be stored in the same area.

22.7.5.4. 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 will be a blank wall having a fire-resistance rating of at least 2 hours. **(T-0)**

22.7.5.5. The total quantity of liquids within a building is not restricted, but arrangement of storage will comply with 29 CFR § 1910.106, Table H-14 and Table H-15. **(T-0)**

22.7.5.6. Stacked containers of flammable liquids will be separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls. **(T-0)** Refer to **paragraph 22.6.2** for guidance on stacking containers.

22.7.5.7. Portable tanks stored over one tier high will be designed to nest securely, without dunnage. **(T-0)** Adequate materials handling equipment will be available to handle tanks safely at the upper tier level. **(T-0)**

22.7.5.8. No stack will be closer than three feet to the nearest beam, chord, girder, or other construction member and will be at least three feet below sprinkler deflector or discharge orifice of water spray or other installed fire protection systems. **(T-0)**

22.7.5.9. Aisles at least three feet wide will be provided for clear access to all doors, windows, or fire department standpipe connections. **(T-0)**

22.7.6. Outside Storage. 29 CFR § 1910.106, Table H-16 and Table H-17 provide maximum quantities and separation criteria for outside storage of flammable and combustible liquids. Refer to 29 CFR § 1910.106 for additional information.

22.7.6.1. Maximum storage of 1,100 total gallons may be located adjacent to other buildings provided: (Reference NFPA 30)

22.7.6.1.1. A minimum distance of 10 feet is maintained between buildings and nearest container. **(T-0)**

22.7.6.1.2. The storage area is graded IAW **paragraph 22.7.6.3**. **(T-0)**

22.7.6.1.3. 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. **(T-0)**

22.7.6.2. Where the quantity stored exceeds 1,100 gallons, refer to 29 CFR § 1910.106, Table H-17 for quantities and separation distances.

22.7.6.3. The storage area will be graded to divert possible spills away from buildings or other facilities or will be surrounded by a curb at least six inches high. **(T-0)** When curbs are used, provisions will be made for draining accumulations of ground or rainwater or spills of flammable or combustible liquids. **(T-0)** Drains will terminate at a safe location and will be accessible and operate under fire conditions. **(T-0)**

22.7.7. Incidental Storage of Flammable Liquids in Industrial Areas. Incidental storage will be authorized only after the following requirements are met: (Reference NFPA 30)

22.7.7.1. Incidental storage will be in industrial areas only. **(T-0)**

22.7.7.2. Storage will be in metal cabinets stenciled, "FLAMMABLE—KEEP FIRE AWAY" (metal wall lockers meet this requirement). **(T-0)**

22.7.7.3. Storage will 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. **(T-0)** Storage will be limited to a five-day supply of flammables in a metal cabinet, and in closed containers not to exceed limits specified in paragraphs **22.6.2** and **22.7.6** **(T-0)** Each work center will be limited to one cabinet. **(T-1)**

22.7.7.4. The F&ES Flight will be consulted prior to establishing incidental storage areas in industrial shops. **(T-1)**

22.7.8. Laboratories. Many laboratory operations require special controls for 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.

22.7.8.1. A list of working supplies and operating instructions on handling flammable and combustible liquids will be published. **(T-0)** The aggregate total outside of storage cabinets in any laboratory will not exceed 10 gallons. **(T-0)** All quantities of flammable and combustible liquids in one laboratory more than 10 gallons will be stored in an approved storage cabinet or in an approved storage room. **(T-0)** Flammable or combustible liquids will not be stored or transferred from one vessel to another in any exit way, corridor, or passageway leading to an exit. **(T-0)** A minimum of one approved storage room will be available within any building housing a laboratory which regularly maintains a reserve storage capacity exceeding 300 gallons. **(T-0)** Refer to NFPA 45 for additional guidance.

22.7.8.2. Flammable or combustible liquids will 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. **(T-0)** Container types and maximum capacities will comply with NFPA 45. **(T-1)** 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. **(T-0)** Containers used to draw from an original container must be marked to identify their contents. **(T-0)** Refrigerators or cooling equipment used to store or cool flammable liquids will be approved for the material being stored or cooled and labeled or stenciled, "Approved for Flammable Liquid Storage." **(T-0)**

22.7.9. Military Exchanges, Commissaries, and Associate Retail Stores. In rooms or areas accessible to the public, storage of flammable and combustible liquids will be limited to quantities needed for display and normal merchandising purposes, not to exceed two gallons per square foot of gross floor area. **(T-0)** The gross floor area used for computing the maximum quantity permitted is that portion of the store actually used for merchandising flammable and combustible liquids. Refer to NFPA 30 for additional guidance.

22.7.9.1. Storage of Class IA liquids will be prohibited in basement display areas and limited to one gallon per square foot on any other floor. **(T-0)** In areas not protected, storage of Class IB, IC and II liquids on other than the ground floor will be limited to one gallon per square foot of gross floor area. **(T-0)** Protected will mean protected with automatic sprinklers installed IAW NFPA 13, *Standard for the Installation of Sprinkler Systems.* **(T-0)**

22.7.9.2. On floors above ground level, storage or display of Class I and Class II liquids will be limited to 60 gallons in unprotected occupancies and 120 gallons in protected occupancies. **(T-0)**

22.7.9.3. Containers in a display area will not be stacked more than three feet or two containers high, whichever is greater. **(T-0)**

22.7.9.4. Shelving will 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. **(T-0)**

22.7.9.5. Storage will be IAW 29 CFR § 1910.106, Table H-14. **(T-0)** Buildings or portions of such buildings utilized for flammable and/or combustible storage will be isolated by standard fire walls approved for the type and quantity of liquids stored. **(T-0)** Materials which create no fire hazard to the liquids may be stored in the same area.

22.7.9.6. 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 will be a blank wall having a two-hour fire-resistance. **(T-0)** Refer to 29 CFR § 1910.106 for additional information.

22.7.9.7. The total quantity of liquids within the building is not restricted, but the arrangement of storage will comply with 29 CFR § 1910.106, Table H-14. **(T-0)**

22.7.9.8. Stacked containers of flammable liquids will be separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls. **(T-0)**

22.7.10. 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 NFPA 30 for additional guidance.

22.7.10.1. Equipment will be serviced after use and prior to extended off-season storage. **(T-0)**

22.7.10.1.1. Equipment will be stored IAW manufacturer's instructions. **(T-0)**

22.7.10.1.2. Storage facilities will be protected against tampering or unauthorized entry and area around the facility will be kept free of weeds, debris, and other combustibles. **(T-0)**

22.7.10.1.3. Workplace storage facilities will be inspected monthly by supervisor and/or building custodian. **(T-1)** The supervisor and/or building custodian will document each inspection. **(T-1)**

22.7.10.2. Gasoline powered equipment will 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. **(T-1)** All storage areas must be inspected (one-time inspection) and approved by the F&ES Flight. **(T-1)** Subsequent inspections will be accomplished IAW manufacturer's inspection and on an as required basis as determined by the F&ES Flight. **(T-1)**

22.7.10.3. Custodians of dormitories, multiple living quarters, assembly, institutional, military exchange, commissary, and warehouse facilities will store small gasoline powered equipment in an enclosed one-hour fire-rated storage room. **(T-1)** Boiler rooms and other utility rooms will not be utilized as storage areas for flammable or combustible liquids. **(T-0)**

22.7.10.4. 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 are 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 29 CFR § 1910.106, Table H-13 for additional guidance on storage in inside rooms.

22.7.10.5. 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 dwelling units with attached or detached garages.

22.8. Handling and Dispensing.

22.8.1. Containers. Containers and portable tanks will meet handling, storage, and dispensing requirements specified in this publication for the product concerned. **(T-1)** Refer to NFPA 30 for additional guidance. Tanks and vats will be installed so rupture or overflow is contained or controlled through dikes, sumps, etc., per 29 CFR § 1910.106. **(T-0)**

22.8.1.1. The capacity of flammable and combustible liquid containers will be IAW 29 CFR § 1910.106, Table H-12. **(T-0)**

22.8.1.2. Flammable liquids will be kept in covered containers when not in use. **(T-0)** Refer to NFPA 30 for additional information.

22.8.1.3. Storage of flammable and combustible liquids will be prohibited in office occupancies, except when required for maintenance and operation of buildings and equipment. **(T-0)** Such storage will 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. **(T-0)** Maximum quantities will meet the requirements of the storage cabinet, container or room IAW **paragraph 22.7.3** and NFPA 30, Table 9.6.1. **(T-1)**

22.8.2. Storage Inside Building.

22.8.2.1. Containers will remain tightly sealed except when transferred, poured, or applied. **(T-0)** Employees will remove from the storage container only that portion required to accomplish a particular job. **(T-0)**

22.8.2.2. 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.

22.8.3. Outside Storage. All containers having flammable or combustible materials will be protected from heat sources to prevent the content expanding and pressurizing the container, which could rupture the container. **(T-0)** Open flame or smoking will not be permitted within 50 feet of flammable or combustible liquid storage areas. **(T-0)**

22.8.4. Laboratories.

22.8.4.1. Flammable and combustible liquids will not be positioned near Bunsen burners, hot surfaces, steam pipes, valves, or other sources of heat. **(T-0)**

22.8.4.2. Refer to AFI 90-821 for additional information regarding flammable, combustible, and hazardous materials handling in laboratories.

22.8.5. Small Gasoline Engine Powered Equipment.

22.8.5.1. Fueling operations will be conducted in outside areas free from ignition sources. **(T-0)** Fuel tanks will not be filled or drained inside buildings or other facilities where fuel vapors or other explosive gases can accumulate. **(T-0)**

22.8.5.2. Operators will not refuel a running engine or one that is hot from recent use. They will allow a minimum of five minutes cooling off time before starting refueling operations. **(T-1)**

22.8.5.3. Fueling and/or refueling operations will be accomplished using a safety can with pouring spout or an appropriately sized funnel. **(T-1)** Care will be taken not to spill fuel onto hot surfaces. **(T-0)** Spilled fuel will be cleaned up before attempts are made to start equipment. **(T-0)**

22.8.5.4. Equipment will be serviced after use and prior to extended off-season storage to ensure equipment is:

22.8.5.4.1. Thoroughly cleaned. **(T-0)**

22.8.5.4.2. Functioning properly. **(T-0)**

22.8.5.4.3. The fuel tank is drained. **(T-0)**

22.8.5.5. Cleaned and drained small gasoline powered equipment may be stored during the off-season in inspection and testing facilities, fire stations, shops, and maintenance facilities. However, this equipment will not be stored in hangars, nose docks, corrosion control, fuel cell repair, munitions maintenance facilities, or missile assembly and repair facilities. **(T-1)** When stored, the equipment will be isolated from potential ignition sources. **(T-0)**

22.8.6. Handling Flammable and Combustible Liquids at Final Point of Use. Flammable and combustible liquids will 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. **(T-0)** Transferring by means of air pressure on the container or portable tanks is prohibited. Refer to 29 CFR § 1910.106 for additional information.

22.8.6.1. Only approved safety containers will be used for transporting and dispensing flammable liquids in quantities of five gallons or less. **(T-0)**

22.8.6.2. Flammable liquids will be kept in covered containers when not actually in use. **(T-0)**

22.8.6.3. Means will be provided to clean up and remove spills. **(T-0)** Refer to the appropriate SDS for spill clean-up procedures and PPE required.

22.8.6.4. Class I liquids will be used only where there are no open flames or other sources of ignition within the area or possible path of vapor travel. **(T-0)**

22.8.6.5. Safety cans or other portable containers of flammable liquids having a flashpoint at or below 80^{o} F will 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. **(T-0)** 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.

22.8.6.6. Disposal. Consult installation CE for proper guidance regarding disposal of any excess or unneeded hazardous materials. Also refer to DAFMAN 32-7002 for additional information.

Table 22.1. Classifications of Flammable and Combustible Liquids.

Designation	Class	Subclass Definition

Flammable	Class I	Any liquid with flashpoint below 100° F; 37.8° C.
	Class IA	Includes liquids having flashpoints below 73° F; 22.8° C and having a boiling point below 100° F; 37.8° C.
	Class IB	Includes liquids having flashpoints below 73°F; 22.8° C and having a boiling point above 100° F; 37.8° C.
	Class IC	Includes flashpoints at or above 73°F (22.8°C), but below 100°F (37.8°C).
Combustible	Class II	Includes those liquids with flashpoints at or above 100°F (37.8° 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).
Note: Refer to 29 CFR § 1910.106 for additional guidance.		

Chapter 23

CONFINED SPACES

23.1. Scope. This chapter establishes DAF-specific confined space program requirements based on OSHA required program elements found in 29 CFR § 1910.146, *Permit-Required Confined Spaces,* and 29 CFR § 1926, Subpart AA, *Confined Spaces in Construction,* as required. Use of the standards will depend on the industry the work falls under. Units with personnel entering permit-required confined spaces will comply with 29 CFR § 1910.146, 29 CFR § 1926, Subpart AA, this chapter, and other applicable standards. **(T-0)** Industries excepted under 29 CFR § 1910.146(a) and 29 CFR § 1926.1201(b) will use the cited standard as it applies. **(T-0)** Using the Construction standard versus 29 CFR § 1910.146 ensures consistent compliance where construction and general industry activities happen concurrently or intermittently during confined space entries. OSHA has recognized this as an acceptable practice and considers compliance with 29 CFR § 1926, Subpart AA as compliance with 29 CFR § 1910.146 during these situations.

23.2. Definitions.

23.2.1. Confined space is defined as a space that:

23.2.1.1. Is large enough and so configured that a worker can bodily enter and perform assigned work.

23.2.1.2. Has limited or restricted means for entry or exit.

23.2.1.3. Is not designed for continuous occupancy. **Note 1**: Examples of confined spaces include, but are not limited to, aircraft fuel cells, utility holes, silos, tanks, pits, manholes, vaults, storage bins, etc. **Note 2:** All three conditions in paragraphs **23.2.1.1 – 23.2.1.3** must be present to constitute a confined space. **(T-0)**

23.2.2. There are two classifications of confined spaces:

23.2.2.1. Permit-required confined space is defined as a space that has one or more of the following characteristics:

23.2.2.1.1. Contains or has the potential to contain a hazardous atmosphere.

23.2.2.1.2. Contains a material that has the potential for engulfing an entrant.

23.2.2.1.3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.

23.2.2.1.4. Contains any other recognized serious safety or health hazard.

23.2.2.2. Non-permit confined spaces are defined as spaces that do not contain, or with respect to atmospheric hazards, do not have the potential to contain any hazard capable of causing death or serious physical harm.

23.2.3. Serious physical harm is defined as an impairment or illness in which a body part is made functionally useless or is substantially reduced in efficiency. Such impairment or illness may be permanent or temporary and includes, but is not limited to, loss of consciousness, disorientation, or other immediate and substantial reduction in mental efficiency. Injuries involving such impairment would usually require treatment by a physician or other licensed

healthcare professional. Such physical harm would impair an entrant's ability to conduct self-rescue.

23.3. Hazards. Personnel entering or working in confined spaces may encounter any number of serious hazards that can affect their ability to safely work in or evacuate from a confined space. Refer to **Table 23.1** for common atmospheric and serious physical hazards found in permit-required confined spaces.

Table 23.1. Common Hazards Involving Confined Spaces (Not all-inclusive).

Category	Confined Space Hazard

Atmospheric	• Oxygen Deficiency (<19.5%)
	  • Displacement of air by another gas
	  • Various biological processes or chemical reactions, such as rotting of organic matter, rusting of metals, burning, etc.
	• Oxygen Enrichment (>23.5%)
	  • An excess of oxygen, in the presence of combustible materials, results in an increased risk of fire and explosion
	  • Some materials, which do not burn in air, may burn vigorously or even spontaneously in an enriched oxygen atmosphere
	• Flammable or Explosive Atmospheres
	  • A flammable atmosphere presents a risk of fire or explosion
	  • Such an atmosphere can arise from the presence in the confined space of flammable liquids or gases or of a suspension of combustible dust in the air
	  • If a flammable atmosphere inside a confined space ignites, an explosion may occur, resulting in the expulsion of hot gases and the disintegration of the structure
	• Toxicity – An atmospheric concentration of any chemical substance (e.g., hydrogen sulfide (H2S), carbon monoxide (CO), welding fumes) which is capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to its health effects

Serious Physical	• Limited or restricted means for entry or exit • Cramped working conditions • Temperature extremes • Rotating or moving equipment • Reactive or corrosive residues • Entrapment hazards • Electrical hazards • Wildlife • Poor light levels • Engulfment

23.4. Responsibilities.

23.4.1. Major Commands (MAJCOMs), Field Commands (FLDCOMs), Direct Reporting Units (DRUs) and Field Operating Agencies (FOAs) with safety staff will:

23.4.1.1. Ensure program oversight through various means that includes evaluations, Staff Assistance Visits, and assistance with resolution of identified deficiencies. **(T-1)**

23.4.1.2. Formally review Confined Space Programs as part of Safety Program Evaluations. **(T-1)** The review will include the number and type of confined spaces found

on the Master Installation Confined Space Listing, the installation's best practices and/or major challenges, cancelled entry permits and approved Master Entry Plans. **(T-1)**

23.4.1.3. Standardize Master Entry Plan documentation to fit command needs. **(T-1)**

23.4.1.4. Approve subordinate occupational safety office developed train-the-trainer materials. **(T-1)**

23.4.1.5. The MAJCOM/FLDCOM Identified Aircraft Confined Spaces list will be reviewed annually and updated by MAJCOM/FLDCOM offices when changes occur. **(T-1)**

23.4.2. The occupational safety office will:

23.4.2.1. Manage the installation confined space program and lead the Confined Space Program Team (CSPT). **(T-1)**

23.4.2.2. Identify a safety representative to the CSPT as assigned by the occupational safety manager (OSM). **(T-1)**

23.4.2.2.1. Be competent in confined space program requirements and be trained according to **paragraph 23.10**. **(T-1)** Training and appointment will be in writing, to show the OSM certifies the representative(s) is/are competent in the confined space program requirements. **(T-1)**

23.4.2.2.2. Maintain consolidated confined space inventories provided by each organization for all confined spaces, whether located on or off the installation, e.g., geographically separated units. **(T-1)** The inventory, at a minimum, will include organization, classification, data supporting the classification, location of all identified confined spaces and updates provided to them by each organization. **(T-1)** A map of the confined space may be included to support the inventory list but is not mandatory.

23.4.3. Tenant units with assigned safety staff will appoint a representative to CSPT to serve as an agent for confined spaces program responsibilities within their organization and codified in the applicable host-tenant support agreement. **(T-1)** The tenant safety representative will provide documentation to the OSM, when appointed to represent the tenant unit on the CSPT, to show competency in the confined space program. **(T-1)**

23.4.4. The Fire Chief will identify, in writing, to the OSM the appointed F&ES Flight representative(s) to the CSPT and certify the representative(s) is/are competent in confined space program requirements. **(T-1)**

23.4.5. Installation BE will identify, in writing, to the OSM the appointed BE representative(s) to the CSPT and certify the representative(s) is/are competent in confined space program requirements. **(T-1)**

23.4.6. Commanders and/or Functional Managers will:

23.4.6.1. Identify, in writing, to the OSM their designated representative(s) to the CSPT and certify the representative(s) is/are competent in confined space program requirements and are trained according to **paragraph 23.10**. **(T-1)**

23.4.6.2. Ensure workplaces under their control are evaluated to identify confined spaces that employees work near or around. **(T-0)** Identified spaces will be placed in an inventory

that includes: the number of spaces (quantity), type/number of access points (with every entry point uniquely identified and listed), type of space (i.e., utility hole, underground vault, tank), and exact location (e.g., grid coordinates, Global Positioning Satellite coordinates, if available, highlighted maps, if necessary). **(T-1)** Provide the inventory to the CSPT Safety representative to coordinate evaluation for classification of spaces as non-permit or permit-required confined spaces. **(T-1)** Newly identified confined spaces or changes to any spaces on the inventory will be immediately reported to the CSPT to ensure proper testing, evaluation, and classification of each confined space within the organization. **(T-1)**

23.4.6.3. Ensure required equipment needed to conduct safe entry into a permit-required confined space is purchased and properly maintained. **(T-0)**

23.4.6.4. Require that all workplaces that contains permit spaces, the supervisor will inform exposed employees, by posting danger signs or by any other equally effective means, of the existence and location of and the danger posed by the permit spaces. **(T-0)**

23.4.6.5. Ensure a written confined space program is developed and approved by the CSPT to ensure the program meets requirements found in 29 CFR § 1910.146 and this chapter. **(T-0)** Master Entry Plan(s) will be annually reviewed by the CSPT for approval. **(T-1)** **Note**: The requesting unit, not the CSPT, will lead the development of the unit's Confined Space Program and Master Entry Plan(s). **(T-1)**

23.4.6.6. Ensure all personnel assigned duties and responsibilities that support confined space program tasks are properly trained according to **paragraph 23.10** **(T-0)** All equipment and training will be approved by the CSPT prior to purchase or implementation. **(T-1)**

23.4.7. Commander's designated representative(s) will:

23.4.7.1. Coordinate between each shop supervisor, who has employees who work in permit-required confined spaces, and the commander on elements of the program needed to maintain compliance. **(T-1)**

23.4.7.1.1. Obtain CSPT approval when selecting and purchasing equipment for confined space entries. **(T-1)**

23.4.7.1.2. Identify confined spaces program shortfalls, e.g., equipment, manning, funding, and ensure they are up channeled to the commander and the CSPT. **(T-1)**

23.4.7.2. Develop the inventory of organizationally controlled permit-required and non-permit confined spaces with all information required in **paragraph 23.4.6.2** **(T-1)** Submit the completed confined space inventory to the commander for review prior to submission to the occupational safety office. **(T-1)** Initially, annually, and as changes occur, review the confined spaces inventory, and immediately incorporate any newly identified confined spaces. **(T-1)** Where changes to the classification of existing permit and non-permit confined spaces on the inventory are discovered during (re)evaluation and (re)classification by the CSPT, update the inventory with the status change and submit to the commander for review and to the occupational safety office. **(T-1)**

23.4.7.3. Be knowledgeable of the general hazards, conditions, and layouts of each confined space under their program. **(T-1)** The representative(s) will have experience with the confined spaces (or similar spaces) they manage. **(T-1)**

23.4.7.4. Designate the appropriate number of entry supervisors needed to cover all permit-required confined space entries. **(T-1)**

23.4.7.5. Ensure personnel entering non-permit confined spaces receive the same initial confined space training as personnel entering permit-required confined spaces found in **paragraph 23.10.1.1** to confirm employees working in non-permit confined spaces are aware that tasks conducted in the space can change the nature of the space from non-permit confined space to a permit-required confined space entry and ensure the protections found in permit-required confined space entries are followed. **(T-1)**

23.4.7.6. Assist each shop supervisor with the development of a written permit-required confined space program, that includes a structured and effective training program that establishes safe work practices and techniques specific to the confined spaces they enter. **(T-0)** Ensure all developed training meets the requirements found in **paragraph 23.10** **(T-1)** Training will be approved by the CSPT prior to implementation. **(T-1)**

23.4.7.7. Notify the occupational safety member of the CSPT when the organization plans to contract work in confined spaces. **(T-1)** It is the organization's responsibility to provide required information known about permit-required confined spaces under their organizational control to contractors working in permit-required confined spaces. **(T-1)** Notification to the occupational safety office ensures the CSPT members can be made aware of all permit-required confined space entries and notify affected organizations of any cross-tell necessary to ensure all employees are aware of any generated hazards due to activities by other organizations. **(T-0)**

23.4.7.8. Be a CSPT member. **(T-1)**

23.4.7.9. Be trained according to **paragraph 23.10**. **(T-1)**

23.4.8. Entry supervisor will:

23.4.8.1. Be knowledgeable of all their confined space duties as identified in 29 CFR § 1910.146(j). **(T-0)**

23.4.8.2. Issue entry permits consistent with the organizational written confined space program or the Master Entry Plan, when applicable. **(T-0)** Entry permits (DAF Form 1024) will be issued for each permit-required confined space entered and not combined, to include similar permit-required confined spaces. **(T-0)**

23.4.8.3. Entry permits will not be issued using a Master Entry Plan when unexpected conditions exist in the permit space that were not previously anticipated or allowed for in the entry plan. **(T-1)** If hazardous conditions develop after entry, the entry will be terminated, the permit revoked and retained for one year. The Occupational Safety office will contact the CSPT members to meet and re-evaluate the space and assist in the issuance of a new entry permit (DAF Form 1024, *Confined Space Entry Permit*). **(T-0)**

23.4.8.4. Cancel the entry permit after becoming aware of a prohibited or unexpected condition. **(T-0)** Use of suspending an entry permit under 29 CFR § 1926.1205(e)(2) will not be allowed in DAF confined space entry operation. **(T-0)**

23.4.8.5. Ensure employees are aware that work on energized electrical equipment is prohibited unless approved by the Installation CE IAW AFMAN 32-1065. **(T-1)**

23.4.8.6. With assistance from Occupational Safety, installation BE, or the F&ES Flight, as appropriate, determine and evaluate newly identified hazardous condition source(s) found at the time of entry, e.g., residue from the confined space, leaking valve or pipe in the confined space, etc. **(T-0)**

23.4.8.7. Ensure all members of the rescue team are trained and current in CPR for permit-required confined space entry operations. **(T-1)**

23.4.8.8. Ensure DAF employees enter a permit-required confined space only after a DAF Form 1024 or other entry permit, approved by the CSPT that meets the minimum documentation requirements, has been completed and signed. **(T-0)**

23.4.8.9. Maintain the entry permit and a copy of the written confined space program and Master Entry Plan, when applicable, at the permit space entry to provide personnel fulfilling confined space entry duties with a reference to required procedures applicable to the confined space entered. **(T-0)**

23.4.8.10. Request assistance from CSPT, as needed, to ensure all program requirements are met. **(T-1)**

23.4.8.11. Be trained according to **paragraph 23.10**. **(T-1)**

23.4.8.12. The entry supervisor may use 29 CFR § 1910.146(c)(7) to reclassify a permit-required confined space as a non-permit confined space. The written program and/or master entry plan (MEP) will specifically identify the permit-required confined spaces that will be reclassified and the procedures to be used to make reclassification for CSPT review and approval. **(T-1)** All identified hazards in the space must be eliminated to use this temporary reclassification. **(T-0)** Control of a hazardous atmosphere, e.g., through forced ventilation, is not the same as elimination. For example, a chemical tank that contains 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 if the hazardous atmosphere remains eliminated without continuous ventilation and no other hazards are present. Entry into confined spaces, where the only hazard is an actual or potential hazardous atmosphere that can be maintained through continuous forced ventilation may follow the alternate procedures identified in 29 CFR § 1910.146(c)(5). Reclassifying a permit-required confined space also applies to those spaces containing physical hazards, e.g., hazardous energy sources or engulfment hazards. Such reclassification would allow entry without a permit provided.

23.4.8.12.1. Testing is accomplished prior to entry with the results showing the space is free of all hazards. **(T-0) 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 OSHA and this standard. **(T-0)** Once the hazards have been eliminated, the space may be reclassified as non-permit confined space as long as the hazards remain eliminated. **(T-0)** Elimination is achieved by completely removing all hazards from the space.

23.4.8.12.2. The actual or potential atmospheric hazards are eliminated, and continuous monitoring is used to ensure the atmosphere remains free of hazards. **(T-0)** That all hazards within the space are eliminated without entering the space at the time of testing, and any non-atmospheric hazards remain eliminated. **(T-0)**

23.4.8.12.3. During routine work, the entrant does not take tools, introduce materials, or perform work in the space that would create a new hazard. **(T-0)**

23.4.8.12.4. The entry permit is revoked whenever any test, monitoring instrument or observation shows conditions are developing in the permit-required confined space not allowed under the permit. **(T-0)** When this occurs, the entry supervisor will remove entrants, secure the area, and prevent entry until a revised and approved entry permit is issued. **(T-0)**

23.4.8.12.5. The entry supervisor documents the basis for the reclassification on a separate sheet of paper, attaches it to the entry permit and signs or initials next to the statement. **(T-0) Note:** Routine or repetitive entries for daily inspections of lateral fuel pits are examples of work tasks that may qualify for reclassification.

23.4.9. Confined space attendants will perform the following duties and be trained according to **paragraph 23.10.:**

23.4.9.1. Be familiar with and understand the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure. **(T-0)**

23.4.9.2. Be aware of possible behavioral effects of hazard exposure in authorized entrants. **(T-0)**

23.4.9.3. Continuously maintain an accurate count of authorized entrants in the permit space and ensure a positive means is used to accurately identify authorized entrants who are in the permit confined space. **(T-0)**

23.4.9.4. Remain outside the permit space during entry operations until relieved by another attendant. **(T-0) Note**: Once an attendant has been relieved by another attendant, the relieved attendant may enter a permit space to attempt a rescue when the employer's permit space program allows attendant entry for rescue and the attendant has been trained and equipped for rescue operations.

23.4.9.5. Communicate with authorized entrants as necessary to assess entrant status and to alert entrants of the need to evacuate the space. **(T-0)**

23.4.9.6. Assess activities and conditions inside and outside the space to determine if it is safe for entrants to remain in the space and order the authorized entrants to evacuate the permit space immediately under any of the following conditions:

23.4.9.6.1. If there is a prohibited condition. **(T-0)**

23.4.9.6.2. If the behavioral effects of hazard exposure are apparent in an authorized entrant. **(T-0)**

23.4.9.6.3. If there is a situation outside the space that could endanger the authorized entrants. **(T-0)**

23.4.9.6.4. If the attendant cannot effectively and safely perform all the duties required under this section. **(T-0)**

23.4.9.6.5. Summons rescue and other emergency services as soon as the attendant determines that authorized entrants may need assistance to escape from permit space hazards. **(T-0)**

23.4.9.6.6. Take the following actions when unauthorized persons approach or enter a permit space while entry is underway:

23.4.9.6.6.1. Warn the unauthorized persons that they must stay away from the permit space. **(T-0)**

23.4.9.6.6.2. Advise the unauthorized persons that they must exit immediately if they have entered the permit space. **(T-0)**

23.4.9.6.6.3. Inform the authorized entrants and the entry supervisor if unauthorized persons have entered the permit space. **(T-0)**

23.4.9.6.7. Perform non-entry rescues as specified by the organizational rescue procedure. **(T-0)**

23.4.9.6.8. Perform no duties that might interfere with the attendant's primary duty to assess and protect the authorized entrants. **(T-0)**

23.4.10. Confined space entrants will perform the following duties and be trained according to **paragraph 23.10.:**

23.4.10.1. Be familiar with and understand the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure. **(T-0)**

23.4.10.2. Properly use equipment provided to safely work in the permit required confined space. **(T-0)**

23.4.10.3. Communicate with the attendant as necessary to enable the attendant to assess entrant status and to enable the attendant to alert entrants of the need to evacuate the space. **(T-0)**

23.4.10.4. Alert the attendant whenever:

23.4.10.4.1. There is any warning sign or symptom of exposure to a dangerous situation. **(T-0)**

23.4.10.4.2. The entrant detects a prohibited condition. **(T-0)**

23.4.10.4.3. An exit from the permit space as quickly as possible is warranted via an order to evacuate is given by the attendant or the entry supervisor, there is any warning sign or symptom of exposure to a dangerous situation, the entrant detects a prohibited condition, or an evacuation alarm is activated. **(T-0)**

23.4.11. Rescue teams will perform duties that can accomplish the following:

23.4.11.1. Reach the victim(s) within a time frame that is appropriate for the permit space hazard(s) identified. **(T-0)**

23.4.11.2. Be equipped for, trained and proficient in performing the needed rescue services. **(T-0)**

23.4.11.3. Be informed of the hazards they may confront when called on to perform rescue at the site. **(T-0)**

23.4.11.4. Have appropriate access to all permit spaces from which rescue may be necessary so that the rescue service can develop appropriate rescue plans and practice rescue operations. **(T-0)**

23.4.11.5. Practice making permit space rescues at least once every 12 months, by means of simulated rescue operations in which they remove dummies, manikins, or actual persons from the actual permit spaces or from representative permit spaces. **(T-0)** Representative permit spaces will, with respect to opening size, configuration, and accessibility, simulate the types of permit spaces from which rescue is to be performed. **(T-0)**

23.4.12. The Confined Space Program Team (CSPT) will:

23.4.12.1. Assist commanders and/or functional managers in the development and administration of their organizational confined space program. **(T-1)** With the participation of the functional managers, commanders, or their designated representative, assist in the identification, evaluation, and classification of all confined spaces.

23.4.12.2. When requested, assist the functional manager in identifying ways of obtaining training for entrants, entry supervisors, attendants, and rescue teams to include basic first aid and CPR. **(T-1)** When notified of new confined spaces or changes to existing confined spaces, the CSPT will test and evaluate identified confined spaces to classify them. **(T-0)** **Note**: Prior to any confined space entries, further testing will be accomplished to identify all hazards and develop effective controls prior to the start of permit-required confined space entry operations. **(T-0)**

23.4.12.3. Validate that organizations who maintain confined spaces have ensured all exposed personnel are informed of the permit-required confined space hazards. **(T-0)**

23.4.12.4. Assist the organization in the development of the written confined space program to ensure the program meets OSHA requirements found in 29 CFR § 1910. 146, 29 CFR § 1926 subpart AA and this chapter. **(T-0)**

23.4.12.5. Evaluate all equipment for use by entrants to ensure effectiveness against identified hazards. **(T-0)**

23.4.12.6. Assist in identification and selection of required equipment, to include PPE and full-face piece demand self-contained breathing apparatus-certified by National Institute for Occupational Safety and Health (NIOSH) for a minimum service life of 30 minutes or a combination full-face piece pressure supplied-air respirator with auxiliary self-contained air supply, for rescue teams. **(T-1)**

23.4.12.7. Ensure unit trainers, with assistance from installation BE, certify organizational personnel, as required, to conduct atmospheric testing on permit-required confined spaces. **(T-1)**

23.4.12.8. Ensure installation BE representative assist entry supervisor in the interpretation of air monitoring results when requested. **(T-1)**

23.4.12.9. Ensure installation BE representative serves as the OPR for the respiratory program IAW AFI 48-137 and is the sole authority for selecting appropriate respiratory equipment and enrolling all personnel required to wear any type of respirator, to include rescue teams, who may enter confined spaces into the respiratory protection program. **(T-1)** This includes PPE and full-face piece demand self-contained breathing apparatus-certified by NIOSH for a minimum service life of 30 minutes or a combination full-face piece pressure supplied-air respirator with auxiliary self-contained air supply, for rescue teams.

23.4.12.10. Ensure installation BE provide appropriate atmospheric testing and monitoring in isolated cases where trained unit personnel and/or equipment are not available. **(T-1)**

23.4.12.11. Ensure installation BE provide appropriate atmospheric testing and monitoring for IDLH conditions during permit-required confined space operations. **(T-1)**

23.4.12.12. Ensure installation BE evaluate potential employee exposure related to confined spaces IAW DAFI 48-145, *Occupational and Environmental Health.* **(T-1)**

23.4.12.13. When requested by the unit, assist in the development of the MEP. **(T-1)**

23.4.12.14. Evaluate and approve MEPs that meet requirements in **paragraph 23.7**. **(T-1)**

23.4.12.15. Review and approve all entry permits not issued from a Master Entry Plan. **(T-1)**

23.4.12.16. Establish procedures with the appropriate agencies, e.g., contracting office, United States Army Corp of Engineers, to review all construction projects to identify, evaluate, and classify new confined spaces, or changes to current confined spaces. **(T-1)**

23.4.12.17. Allow the occupational safety office to directly coordinate with the contractor to fulfill requirements in 29 CFR § 1926.1203(h), *Permit Space Entry Communication and Coordination,* for government-owned, contractor-operated confined spaces, where no DAF personnel enter. **(T-0)**

23.4.12.18. Commanders, through the CSPT, will evaluate prospective rescue teams to ensure they meet the requirements found in 29 CFR § 1910.146, Appendix F can be used to help evaluate rescue teams under consideration. **(T-0)**

23.4.12.19. Review and assess unit and rescue team training program at least annually. **(T-1)** The review/assessment will include lesson plans, hands-on training methodology, exercises, and documentation of training completion. **(T-1)** The completed annual assessment will be provided to the assessed unit. **(T-1)** Incorporate findings from annual reviews into other reports, such as annual safety reports. **(T-1)**

23.4.12.20. Where the F&ES Flight has a primary and secondary rescue team, the F&ES Flight representative will verify the currency of the rescue team members. **(T-1)**

23.4.12.21. Convene after a confined space mishap investigation to review actions taken during the entry, evaluate documentation, and re-examine training to determine program shortfalls, implement improvements, and to collect any quantifiable data for the mishap investigation, as requested. **(T-1)**

23.4.12.22. Meet annually to conduct a review of the Confined Space Program. **(T-1)** Include all approved written confined space programs, Master Entry Plans, training plans,

rescue team evaluations and training, changes to OSHA standards, DAF or MAJCOM/FLDCOM confined spaces guidance, issues discovered during surveillance, cancelled permits, and any fire, safety, or health inspection findings over the past year. **(T-1)**

23.4.12.23. Develop a status report from the results of the annual review to include, as a minimum, the number and type of confined spaces, the installation's major issues/challenges during the past 12-month period, the number of personnel trained on confined space operations, the number of entry permits issued, and Master Entry Plans approved. **(T-1)** Ensure status report also identifies unit confined space program shortfalls, e.g., equipment, manning, funding, etc., and is then provided to the commander and appropriate MAJCOM-FLDCOM/SEG for review and/or action. **(T-1)**

23.5. Written Confined Space Program.

23.5.1. This program will include All required elements outlined in 29 CFR § 1910.146 and 29 CFR § 1926, Subpart AA, as required. **(T-0)**

23.5.1.1. Testing and classification of confined spaces will be done by the CSPT. **(T-1)**

23.5.1.2. Only explosion-proof or intrinsically safe equipment may be used where flammable or explosive atmospheres are present. **(T-0)** Additionally, NFPA 70, Article 504, *Intrinsically Safe Systems,* and Article 501, Class I Locations, provide additional guidance. **(T-1)**

23.5.1.3. Atmospheric monitoring will be continuously conducted for atmospheric hazards in permit spaces unless the organization can demonstrate that continuous monitoring for the identified atmospheric hazard is not commercially available. **(T-0)** Final determination will be documented in the written permit confined space program. **(T-0)** Where continuous monitoring is proven to be unavailable, procedures for periodic evaluation will be developed by the supervisor and approved by the CSPT. **(T-0)** 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. **(T-0) Note**: For aircraft fuel cell/tank confined space monitoring, follow requirements in TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells.*

23.5.1.4. Monitoring equipment used to evaluate confined spaces will be calibrated by the Testing, Measurement, Diagnostic and Evaluation (TMDE) laboratory at an interval established by manufacturer's instructions or applicable technical orders. **(T-1)**

23.5.1.4.1. Some monitoring equipment, e.g., colorimetric tubes, do not require calibration. Equipment that comes with manufacturer-approved calibration devices and does not require TMDE calibration may use manufacturer approved methods by qualified personnel.

23.5.1.4.2. Monitoring equipment that requires calibration, but cannot be calibrated by TMDE, will be sent to the manufacturer for calibration. **(T-1)**

23.5.1.5. The user will be required to field check and span gas test equipment IAW the manufacturer's instructions immediately before testing the confined space. **(T-0)** Employees 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. **(T-0)**

23.5.2. When employees perform hot riveting, welding, cutting, or burning, or heating operations within a confined space, they will obtain a DAF Form 592 from the F&ES Flight. **(T-0)** Refer to **Chapter 20** for additional information. If chemicals are introduced into the confined space by the hot work, installation BE will be contacted to evaluate the potential health hazards and recommend ventilation procedures if not previously assessed during the unit's OH Assessment. **(T-1)** Employees will inspect, test, operate and maintain welding and cutting equipment such as hoses, connections, torches, etc., IAW provisions of **Chapter 20**, applicable TOs and manufacturer' instructions. **(T-0)**

23.5.3. Entry into telecommunications only controlled spaces is governed by 29 CFR § 1910.268, *Telecommunications,* and **Chapter 28. Note**: The requirements of this chapter can also apply to telecommunications confined spaces. Contact the CSPT for assistance.

23.5.4. Aircraft fuel systems personnel will follow this publication and applicable technical data for responsibilities, qualifications, training, and rescue procedure requirements for working in permit-required confined spaces. **(T-0) Note**: Any conflict between this instruction and applicable technical data will be addressed to AFSEC/SEG for resolution.

23.6. Entry into Immediately Dangerous to Life and Health (IDLH) Conditions. Entry supervisors will not permit entry into and work in known IDLH conditions under normal operations. **(T-0)** Entry into known IDLH conditions is only authorized in cases of extreme emergencies such as rescue efforts or emergency repairs. **(T-0)** The entry supervisor will continuously work to reduce the hazard(s) within the confined space. **(T-0)** The CSPT will authorize entry only when the following conditions are met:

23.6.1. Continuous monitoring is conducted. **(T-0)**

23.6.2. An installation BE and occupational safety representative will always be present to serve as consultants to the entry supervisor. **(T-1)**

23.6.3. An experienced on-site supervisor will be present. **(T-0)**

23.6.4. Personnel will be equipped with respirators IAW 29 CFR § 1910.134, *Respiratory Protection.* **(T-0) Note**: Additional guidance can be found in AFI 48-137.

23.6.5. Trained and equipped emergency rescue will be on-site during IDLH entry operations. **(T-1)**

23.7. Master Entry Plan. This part of the written confined space program serves as approval for recurring entries into permit-required confined spaces to conduct work under routine conditions. The Master Entry Plan is developed by the organization and approved by the CSPT to allow the commander's designated representative(s) to identify entry supervisor(s) that will issue entry permits without the need for the CSPT to come out.

23.7.1. Recurring basis is defined, for the purpose of this manual, as occurring at least once a quarter or more frequently. Conflict between this standard and a Technical Order (TO) will comply with requirements in the TO. **(T-1)** Refer to conflict resolution on precedence described in TO 00-5-1, *AF Technical Order System,* paragraph 1.3, *TO Precedence,* for additional information.

23.7.2. The Master Entry Plan will:

23.7.2.1. Require the commander's designated representative(s) or shop supervisor to brief entry supervisor(s) on their duties prior to performing the entry. **(T-1)**

23.7.2.2. Describe the acceptable entry conditions, including atmospheric conditions, under which permits may be issued. **(T-0)**

23.7.2.3. Designate as many entry supervisors as needed. **(T-1)**

23.7.2.4. Identify the specific type and location of permit spaces to be entered and specific types of tasks or operations to be performed. **(T-0)** Only permit-required confined spaces that are entered on a recurring routine manner IAW **paragraph 23.7.1,** but are similar to those on the MEP, are not included as part of the MEP.

23.7.2.5. Describe the purpose of the entry and list either by reference or direct statement, the procedures to be used for entry, e.g., shop Operating Instruction (OI) that cover specific tasks. **(T-0)**

23.7.2.6. Account for around-the-clock operations, when appropriate. **(T-1)**

23.7.2.7. List PPE, atmospheric monitoring and rescue equipment, and conditions under which they will be used. **(T-0)**

23.7.2.8. Require continuous atmospheric monitoring. **(T-0)** When continuous monitoring is not possible, or determined by the CSPT to not be necessary, based on test data verifying that acceptable entry conditions are being maintained IAW 29 CFR § 1910.146(d)(5)(ii), documentation must be maintained. Documentation will include why continuous monitoring is not possible or needed, what procedures will be used to periodically evaluate for atmospheric hazards, and the evaluation frequency to be used that will ensure exposed entrants will have adequate time to escape the permit space will be described. **(T-0)**

23.7.2.9. List other controls required that will eliminate or control identified atmospheric or other significant hazards for safe entry, e.g., lockout and ventilation. **(T-0)**

23.7.2.10. List chemicals and quantities authorized for use. **(T-1)** List expected exposure levels based on air sampling results. **(T-1)** Based on exposure levels, perform reassessments of the confined spaces. **(T-1)** The installation BE is the subject matter expert for determining appropriate PPE. Refer to installation BE to identify concerns and necessary PPE in case of exposure.

23.7.2.11. List conditions under which the space may or will be reclassified IAW 29 CFR § 1910.146(c)(7). **(T-0)**

23.7.2.12. Establish communication procedures and identify communication equipment to be used during entries between the attendant and entrants. **(T-1)**

23.7.2.13. Document emergency rescue procedures for each permit-required confined space covered under the MEP. **(T-0)** Procedures will include:

23.7.2.13.1. Self-rescue training and equipment. **(T-0)**

23.7.2.13.2. Retrieval lines must be used to conduct non-entry rescue. **(T-0)** However, when a formal risk assessment determines retrieval lines themselves may constitute an increased risk to the entrant and not contribute to the rescue of the individual, another

means will be identified and approved by the CSPT. **(T-0)** Results will be documented and maintained with the written confined space program. **(T-0)**

23.7.2.13.3. Rescue Teams. Determine and evaluate the source of rescue services (unit organized, contracted, F&ES Flight) to be used for permit-required confined space entries. **(T-0)**

23.7.2.13.3.1. Identify the method used for reliable summoning of the rescue team, e.g., telephone, radio, and ensure it is operable, on-hand and easily accessible to ensure prompt response. **(T-0)**

23.7.2.13.3.2. Entry will not be made until the rescue team has been notified and their availability is verified. **(T-0)**

23.7.2.13.3.3. When the identified rescue service is not available, the operation will be halted, unless a secondary trained team is available. **(T-0) Note**: Within aircraft maintenance, the fuel systems shop/work center may maintain a rescue team capability IAW TO 1-1-3. **(T-1)**

23.7.2.14. Ensure the inspection, testing, maintenance and documentation of safety and rescue equipment is accomplished IAW **Chapter 14,** *Personal Protective Equipment (PPE),* TO 00-25-245, and manufacturer's instructions. **(T-0)** If a conflict exists between these guidance documents, use the most restrictive guidance. **(T-1)** Contact the CSPT for additional assistance.

23.7.2.15. Describe the procedure to retain the canceled permit for one year to facilitate the review of the permit-required confined space program, as required by 29 CFR § 1910.146(e)(6). **(T-0)**

23.7.2.16. Include procedures to amend the Master Entry Plan, as needed. **(T-1)**

23.8. Non-permit Confined Space Entry. These spaces are defined as confined spaces because they meet the definition of a confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm. **(T-0**) Permit-required confined spaces can be reclassified as non-permit confined spaces where the hazards in the confined space can be effectively eliminated from the space following requirements found in 29 CFR § 1910.146(c)(7). **(T-0)**

23.8.1. Entries into a permit-required confined space for the purpose of reclassifying the space will follow permit-required confined space entry requirements while conducting those activities until the permit-required confined space hazards are eliminated. **(T-0)**

23.8.2. Confined spaces classified as non-permit confined spaces will have a formal risk assessment conducted by the shop supervisor to determine if work to be conducted could or will introduce hazard(s) that will change its classification to a permit-required confined space, e.g., welding, sanding, use of chemicals. **(T-0)**

23.8.2.1. Results will be provided to the CSPT for review and concurrence. **(T-1)**

23.8.2.2. Work differing from that identified in the formal risk assessment will be identified to the occupational safety representative for evaluation by the CSPT. **(T-1)**

23.8.3. Prior to entry into a non-permit confined space, visually inspect in and around the space to determine if any previously unidentified potential hazards are present or if conditions have changed. **(T-0)**

23.8.3.1. Non-permit confined spaces will have atmospheres tested prior to entry and when conditions or operations introduce new hazards to validate no atmospheric hazards are present. **(T-1)**

23.8.3.2. When atmospheric monitoring reveals hazardous condition or results are uncertain, contact the CSPT for assistance prior to entry. **(T-1)**

23.8.3.3. Personnel working in non-permit required confined spaces will complete one of the identified trainings found in **paragraph 23.10.1** or a MAJCOM/FLDCOM approved alternate to be able to identify when a space may need to be reclassified as permit-required due to the work or changes occurring in the space. **(T-0)**

23.9. MAJCOM/FLDCOM Identified Aircraft Confined Spaces. Refer to AFSEC SharePoint® (**https://usaf.dps.mil/teams/AFSEC-SEG/Lists/ACFT_ConfinedSpaces/Aircraft%20Spaces.aspx?siteid=%7B7514EA6A%2D8569%2D4015%2D99C5%2DFE30F71D446D%7D&webid=%7BD5E42E4E%2D3E1E%2D4C97%2DBE47%2D028C8534C821%7D&uniqueid=%7B169EDC5A%2D32FE%2D4D99%2D8FD2%2D6F81EBFDDB86%7D**) for the most current listing.

23.10. Training.

23.10.1. General Information. Each organization will develop a structured training program, to include a hands-on portion that establishes safe work practices and techniques specific to the type of permit-required confined space entries made. **(T-1)** Initial training can be completed using AFCEC's CBT, 367 TRSS's "The Griffin" Confined Space CBT (Course code: A1AKU00TVT0002), or OSHA Course 2264, Permit-Required Confined Space Entry. Train-the-Trainer training is provided by the safety office.

23.10.1.1. Commanders and functional managers will take the CBT on myLearning for general awareness understanding. **(T-1)**

23.10.1.2. The occupational safety office, installation BE, and F&ES Flight representatives will receive additional on-the-job training through each career field's applicable training program. **(T-1)**

23.10.1.2.1. On-the-job training should be with an experienced member (Civilian GS-09 or Military 7-Level) and include time observing confined space entries to mentor new members and answer questions.

23.10.1.2.2. Any additional training required by the MAJCOM/FLDCOM/DRU/FOA safety office, occupational safety office, F&ES Flight and installation BE.

23.10.2. Commander's designated representative(s) and/or supervisor will ensure initial, train-the-trainer and unit specific training is provided to employees working under the permit-required confined space program. **(T-1)** Training will be comprised of the following:

23.10.2.1. Initial training will be given to all personnel working under the permit-required confined space program as identified in **paragraph 23.10.1**. **(T-1)**

23.10.2.2. Train-the-trainer will be provided to all supervisors who have employees that work in permit-required confined spaces IAW **paragraph 23.10.4**. **(T-1)**

23.10.2.3. Organization specific training will ensure that personnel receive classroom and hands-on training to develop proficiency in their expected duties, which will include entry into simulated or actual confined spaces that represent common hazards and procedures found in their workplaces. **(T-0)**

23.10.2.3.1. A formal risk assessment will be conducted as part of lesson planning to ensure student safety. **(T-1) Note:** Simulated means using a trainer that can best simulate the configuration of the represented confined space.

23.10.2.3.2. Students in this training will be required to experience entry into simulated or actual confined spaces that represent common hazards and procedures found on the base. **(T-1)**

23.10.2.4. Personnel required to test the atmospheric conditions in a confined space will be trained using manufacturer's instructions or other information to develop effective training. **(T-0)** Supervisors will contact installation BE for assistance in developing training. **(T-1)** If unable to support this requirement, installation BE will assist in identifying a training resource. **(T-1)**

23.10.2.5. Training will ensure that the individual, with atmospheric testing duties, are proficient in the use, calibration (user level and manufacturer requirements), and care of atmospheric testing and monitoring equipment. **(T-0)** This includes testing and calibration of direct reading portable gas monitors. In addition, if entry is required to conduct tests, the tester will also meet the training requirements of an entrant. **(T-0)**

23.10.2.5.1. Annual training on the use, calibration, and care of atmosphere testing and monitoring equipment will be conducted to maintain proficiency. **(T-1)**

23.10.2.5.2. Supervisors will maintain a list of personnel trained and knowledgeable to conduct atmospheric testing and monitoring of confined spaces for their shop by name, name of trainer, and date completed training; and provide a copy to the commander's designated representative. **(T-1)**

23.10.3. Rescue Training. Supervisors will develop rescue training that covers rescue methods that the organization will use, e.g., self-rescue, non-entry rescue, entry rescue. **(T-0)** Contact the F&ES Flight for assistance in developing the training. **(T-1)** The F&ES Flight will validate that all organizationally developed rescue training, equipment and procedures meet requirements. **(T-1)**

23.10.4. Train-the-Trainer. The CSPT will develop a train-the-trainer program to provide entry supervisors with the initial program knowledge needed to effectively manage their program. **(T-1)**

23.10.4.1. This training will not replace the organization specific training required to be developed specifically to address the procedures required to enter organizational permit-required confined spaces but will supplement initial training. Training objectives must focus on providing a clear understanding of how a confined space program will be developed and implemented. **(T-1)** Training will include:

23.10.4.1.1. General confined space, hazard identification and evaluation. **(T-1)**

23.10.4.1.2. Discussion on fulfilling training requirements for employees working in permit-required confined spaces. **(T-1)**

23.10.4.1.3. Discussion on written program requirements. **(T-1)**

23.10.4.1.4. Discussion on proper completion of entry permits with exercise. **(T-1)**

23.10.4.1.5. Discussion of MEP requirements. **(T-1)**

23.10.4.1.6. Discussion of MAJCOM/FLDCOM requirements, as applicable. **(T-1)**

23.10.4.2. The MAJCOM-FLDCOM/SEG or FOA/DRU SEG (when the organization has their own safety staff) will approve the train-the-trainer course materials and provide MAJCOM/FLDCOM or FOA/DRU specific requirements, as appropriate. **(T-1)**

23.10.5. Refresher training will be provided as prescribed by the CSPT, at least annually, or when an employee shows lack of knowledge or demonstrates unsafe behavior while working in a permit-required confined space. **(T-1)**

23.10.6. Documentation of training will have name of student, name of trainer and dates of training. **(T-0)**

23.11. Instructions for Completing the DAF Form 1024, *Confined Space Entry Permit.* The following guidance will be used to complete the DAF Form 1024, or equivalent DoD or commercial form:

23.11.1. Section 1 – Master Entry Plan. Mark the appropriate block indicating whether or not the entry permit was issued under a Confined Space Program Team-approved Master Entry Plan. **(T-1)** If not, occupational safety office, installation BE and F&ES Flight will be coordinated with using Section 9 prior to entering a confined space.

23.11.2. Section 2 – General Information. Enter the location (Global Positioning Satellite coordinates, if known) of the confined space and indicate if the space is located on or off the installation. **(T-0)** Include a description of the space to be entered, and the purpose for entry. **(T-0)** Identify any TO or OI that covers the entry. **(T-1)** Enter the date and duration (time used and time expires) of the permit. **(T-0)**

23.11.3. Section 3 – Hazards. Specify all probable hazards associated with the entry, e.g., oxygen enrichment, engulfment, mechanical. **(T-0)**

23.11.4. Section 4 – Hazard Controls. Specify exact items required, to include manufacturer and part number, and add any equipment not listed in the form. **(T-0)**

23.11.5. Section 5 – Preparation for Entry. Identify required preparations prior to entering the space. **(T-0)** Refer to Master Entry Plan, governing TO or OI, as appropriate.

23.11.6. Section 6 – Atmospheric Testing and Monitoring Record. Enter the make, model, and serial number for all testing equipment along with its calibration and bump test date. **(T-0)** Indicate if continuous monitoring is required; if yes, document the frequency. **(T-0)** Consider the potential for stratified atmospheres that would facilitate additional testing/monitoring. Indicate if there is additional testing/monitoring or entrant paperwork; if yes, ensure it is attached. **(T-0)**

23.11.7. Section 7 – Authorized Personnel. List the names of all entry supervisors, atmospheric monitors, attendants, and entrants for entry. **(T-0)** If the entry supervisor(s) will

enter the permit-required confined space, list them as entrants. **(T-0)** Attach an additional separate sheet to list additional entrants, if needed. **Note**: Attendants and entrants are not required to sign or initial next to their names.

23.11.8. Section 8 – F&ES Flight or equivalent. Identify and notify emergency response personnel. **(T-0)** Include POC name, contact information (e.g., phone number, radio call sign, etc.) and indicate the date/time when availability of emergency response personnel was confirmed. **(T-0)**

23.11.9. Section 9 – Coordination. Occupational safety office, installation BE, and F&ES Flight will be coordinated with prior to entry. **(T-1) Note**: Coordination is not required if entry is covered by a Confined Space Program Team-approved Master Entry Plan.

23.11.10. Section 10 – Entry Time Log. Enter the name of each entrant and their time of entry and exit. **(T-0)**

23.11.11. Section 11 – Close-out/Cancellation. The entry supervisor will sign each entry permit to validate the form. **(T-0)** (For Construction Only—Personnel responsible for the confined space will brief the owner that all occupants for the space have exited and the permit has been closed). **(T-0)**

23.12. Contractor Requirements.

23.12.1. Contractors performing confined space work for the DAF will comply with OSHA, DoDI 6055.01 and DAFI 91-202 per contract requirements. **(T-0)** Required communication of known hazards in permit-required confined spaces will be conducted IAW 29 CFR § 1926.1203(h). **(T-0)**

23.12.1.1. The contractor is required to conduct its own exposure monitoring during permit-required confined space operations. **(T-1)** Installation BE will not test or monitor a confined space for a contracted confined space operation. **(T-1)**

23.12.1.2. Rescue services for contractors will not be provided by the F&ES Flight without specific written approval from the fire chief. **(T-1)** Rescue support must also be a part of the agreed upon contract requirements by the unit, the installation contract office, the fire chief and the contractor. **(T-1)**

23.12.2. The contracting office will notify the safety office of contracts where permit-required confined space entries are written in the contract. **(T-1)** The contracting office will set up a meeting between the safety office and the contractor to fulfill the requirements of 29 CFR § 1926.1203(h). **(T-1)**

Chapter 24

AIRCRAFT FLIGHTLINE – GROUND OPERATIONS AND ACTIVITIES

24.1. Scope. This chapter addresses hazards and safe operating procedures on the flightline, to include activities in maintenance hangars and ground operations conducted on the flightline ramp. Refer to DAFI 91-202 for additional guidance on job hazard analysis (JHA). **Note**: A JHA is not required when existing guidance adequately covers all safety requirements of an operation or process.

24.2. Specific Requirements.

24.2.1. Guidance. Supervisors and managers will follow requirements applicable to their areas of responsibility. **(T-1)**

24.2.2. Fire Prevention. Refer to **Chapter 6** for guidance on fire prevention guidance and **paragraph 24.17** for additional guidance on contractor operations regarding fire prevention and protection.

24.2.3. CPR/TCCC. Aircraft maintenance, support shop employees, and personnel acting as safety observers exposed to electrical hazards from energized aircraft electrical systems, aircraft components or aircraft equipment will be provided CPR and TCCC training. **(T-1)** Maintenance commanders and supervisors may identify other job tasks that require CPR/TCCC training based on hazards associated with those tasks. Unit CPR instructors will meet training requirements described in **paragraph 1.9**. All personnel requiring CPR/TCCC training will remain current. **(T-0)**

24.2.4. Lifting Devices. Refer to **Chapter 12** for guidance on material handling guidance for hoists and below-the-hook equipment.

24.2.5. Compressed Air.

24.2.5.1. Compressed air will not be used for cleaning purposes, except where reduced to 30 psi and only when used with effective chip guarding and PPE. **(T-0)** OSHA prohibits the use of compressed air for cleaning when cadmium, lead, chromium dusts or any other regulated air contaminant may be present. **(T-0)** Refer to **paragraph 25.3.1** for additional guidance.

24.2.5.2. Before servicing or checking pressure for any aircraft system or component, e.g., aircraft tires, air bottles or landing gear struts, mechanics will:

24.2.5.2.1. Inspect all chucks and valve stems for serviceability to ensure safe servicing. **(T-1)**

24.2.5.2.2. Not over-inflate these components. **(T-1)**

24.2.5.2.3. Install pressure regulators to prevent over-pressurization of components. **(T-1)**

24.2.5.2.4. Wear proper PPE and eye protection IAW TO and local directives. **(T-0)**

24.2.5.2.5. Ensure appropriate equipment has been calibrated, as required. **(T-1)**

24.2.5.3. Air Lines and Fittings. Employees will:

24.2.5.3.1. Avoid bending or kinking air hose lines. **(T-1)**

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. **(T-0)**

24.2.5.3.3. Inspect airlines and fittings for defects before each use. **(T-1)**

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. **(T-1)**

24.2.5.4. A drainpipe and valve will be installed at the lowest point of the air receiver to remove accumulated oil and water. **(T-1)** The air receiver drain valve, if not automatic, will be opened and receiver completely drained daily to prevent accumulation of excess fluids. **(T-1)** Refer to manufacturer instructions for additional guidance.

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_2) are extremely cold, can cause serious burns and can freeze skin upon contact. Nitrogen also depletes oxygen in unventilated, confined areas. Refer to **Chapter 26**, *Cryogenic Liquids,* for additional guidance.

24.2.6.1. Personnel Training and Safety. Only fully trained and qualified personnel will operate oxygen and nitrogen equipment or service aircraft systems. **(T-0)** A trainee may service only if directly supervised by a qualified supervisor or operator. **(T-1)**

24.2.6.2. Mobile Servicing Units or Bottles. Mobile servicing units or bottles used to service aircraft or components will be positioned and not left unattended after hook-up or during servicing operations. **(T-1)**

24.2.6.3. Aircraft oxygen systems (both gaseous and liquid) will be emptied/drained prior to entering a major maintenance cycle. **(T-1)** Safeguards will be taken while performing aircraft servicing or maintenance operations to prevent inherently or accidentally introducing ignition or combustible sources. **(T-1)** Refer to TO 00-25-172 for additional guidance.

24.2.7. Aircraft arresting systems may pose hazards to aircraft and vehicle operations.

24.2.8. Confined Spaces. Supervisors will comply with requirements in **Chapter 23**. **(T-0)**

24.2.9. Red Ball Maintenance Events. Maintenance personnel will not deviate from authorized maintenance procedures or violate any flightline requirements, e.g., flightline speed limits or safety requirements, during Red Ball maintenance events. **(T-1)**

24.2.9.1. Emphasis will be placed on foreign object damage (FOD) awareness/prevention during this critical maintenance operation. **(T-1)** TOs, tools, rags, parts, unused supplies and checklists will be accounted for before aircraft engine startup. **(T-1)**

24.2.9.2. If aircraft engines are operating, a safety observer (maintenance or aircrew member) will 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. **(T-1)**

24.2.9.3. Weapons loaded aircraft will be made safe IAW applicable Mission Design Series (MDS) and/or weapons specific TOs. **(T-1)**

24.2.10. Aircraft Lavatory Servicing. Aircraft lavatory servicing will be conducted IAW AFI 24-605V2, *Air Transportation Operations.* **(T-1)**

24.3. Flightline Potentially Hazardous Areas and Operations.

24.3.1. Flammable Fuel Vapor Areas. Supervisors will ensure all personnel are aware of potentially flammable fuel vapor areas and the restriction against ignition sources in these areas. **(T-0)**

24.3.1.1. 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.

24.3.1.2. Spark arresters are not required on general or special purpose vehicles driving on the flightline and around aircraft. However, these vehicles are not designed, certified, or authorized to operate in flammable fuel vapor areas. Employees in flammable fuel vapor areas will receive specialized training emphasizing hazards associated with these operations. **(T-0)** Refer to DESR 6055.09_DAFMAN 91-201 for requirements for spark arresters on general or special purpose vehicles within or near structures containing exposed explosives.

24.3.1.3. Not rated and/or approved equipment will be turned off or removed from the area during refueling operations and fuel cell/tank work, unless permitted by TO 1-1-3. **(T-1)** 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, FLDCOM, HQ AFMC, AFCEC) will be used in and around flammable fuel vapor areas. **(T-0)** Refer to NFPA 70, Article 501, Class I Locations, for additional information.

24.3.2. Electrical Receptacles. Exterior electrical receptacles on the flightline are protected from weather conditions but are not authorized for use in hazardous areas as defined in NFPA 70, *National Electrical Code*. If separation is not possible, receptacles in the immediate area of the fueling or defueling operations will be de-energized using administrative devices IAW **Chapter 17**. **(T-1)**

24.3.3. Aircraft Maintenance Operations. Aircraft maintenance operations in hangars, shelters, or docks (closed or semi-enclosed) on the flightline or outside maintenance areas, such as wash racks, will be accomplished IAW Air Force guidance or recognized national consensus standards. **(T-1)** MAJCOMs, FLDCOMs and units operating in overseas or remote areas may supplement this publication to meet international or host country safety requirements or unique working conditions.

24.3.3.1. Electrical Devices and Power Equipment. Portable electrical equipment in Class I, Division 1 and Class I, Division 2 locations will be explosion-proof or intrinsically safe and will comply with NFPA 70 or will be approved by competent authority, e.g., HQ AFMC, AFCEC/COS, to show that the equipment is incapable of having sufficient energy

to be an ignition source. **(T-0)** Items listed in TO 00-25-172 can be used in Class 1, Division 2 locations.

24.3.3.1.1. Equipment not meeting this requirement may be temporarily approved by the F&ES Flight prior to the use of the equipment. Approval will be documented in writing, stating the area, nature, duration, and the reason for the exception. **(T-1)**

24.3.3.1.2. If the working environment has been tested and contains flammable fuel vapors, all maintenance activities will be stopped until the hazardous condition is eliminated, and a safe work environment restored. **(T-0)**

24.3.3.1.3. Equipment in an area with a high potential for flammable fuel vapor release and that can be automatically energized when unattended will be considered for explosion- proof or intrinsically safe design. **(T-0)**

24.3.3.2. Tobacco. IAW AFI 48-104, *Tobacco Free Living,* tobacco use is prohibited in aircraft maintenance facilities, flightline areas, and weapons storage and maintenance areas, unless designated by the F&ES Flight, in coordination with the Maintenance Group Commander (MXG/CC) or equivalent, Airfield Manager and/or the functional manager. **(T-1)**

24.3.3.3. Aircraft Fuels Management and Servicing. Fuel system maintenance and servicing operations will be IAW **Chapter 18**, *Hydrocarbon Fuels,* TO 00-25-172 and other applicable TOs. **(T-1).** Aircraft fuel cell and integral tank inspections and repairs will be IAW TO 1-1-3. **(T-1)**

24.3.3.4. Welding on Aircraft. Welding on aircraft will be done outside of hangars, whenever possible. **(T-1)** A DAF Form 592 will be issued prior to aircraft welding operations. **(T-1)** Welding will only be performed on aircraft system components IAW applicable aircraft technical data and **Chapter 20**, *Welding, Cutting and Brazing.* **(T-1)** Welding operations in hangars will meet the requirements of NFPA 410, *Standard on Aircraft Hangars.* . **(T-1)** Contact installation BE for ventilation concerns regarding welding on aircraft.

24.3.3.5. Fire Extinguishers. Suitable fire extinguishers will be placed throughout flightline and maintenance areas, within easy reach of the operator and close to ground power equipment. **(T-1)** Refer to TO 00-25-172, Table 3-1, for flightline operations fire extinguisher requirements and **Chapter 6,** *Fire Protection and Prevention,* for additional information. **Note:** 150-pound flightline fire extinguisher programs are maintained under the Aircraft Maintenance Squadrons or Generation Squadrons as required per HAFMD 1-38, *Deputy Chief of Staff, Logistics, Engineering and Force Protection*.

24.3.3.6. Nondestructive Inspection (NDI). NDI operations involving ionizing radiation (normally X-ray operations) will be conducted IAW TO 33B-1-1. **(T-1)** The IRSO will approve flightline X-ray procedures and locations. **(T-1)**

24.3.4. Hazardous Noise. Personnel assigned to the flightline may be exposed to hazardous noise levels. Supervisors will ensure assigned personnel adhere to engineering controls, administrative controls and properly wear PPE. **(T-0)** Refer to AFI 48-127 for additional guidance.

24.4. Additional PPE Requirements. The information below is specific to flightline operations and activities and is in addition to the PPE requirements of **Chapter 14**. Maintenance employees will wear heat-resistant gloves and long-sleeved shirts to cover exposed skin to prevent burns when working around hot exhaust or tail pipes. **(T-1)**

24.4.1. Head Apparel. Hard hats or bump caps without chinstraps will not be worn in an engine intake danger zone, as defined by the specific aircraft TO, while engines are operating. **(T-1)** Refer to DAFI 21-101, *Aircraft and Equipment Maintenance Management,* for additional guidance.

24.4.1.1. Bump Caps. If bump caps are the chosen PPE for use after conducting a hazard assessment IAW paragraphs **14.3.1 and 14.3.2,** follow the guidance in **paragraph 14.3.5**.

24.4.1.2. Metal, plastic or leather hair fasteners and wigs will not be worn during aircraft maintenance. Hair ties (with no metal parts) that secure the hair at the back of the head may be worn. Refer to **paragraph 14.3.5.1** for additional guidance. Umbrellas are not permitted on the operational flightline except when assisting passengers on or off aircraft during inclement weather. Criteria in **Chapter 14,** *Personal Protective Equipment (PPE)* will be used when aircraft or equipment TOs do not provide specific PPE guidance. **(T-1).** When in doubt, consult the occupational safety office and installation BE. **Note**: Helmets to protect employees from impact and flying objects must meet requirements in **Chapter 14**. **(T-1)**

24.4.2. Footwear. Protective footwear will be provided and worn when there is a reasonable possibility of foot injuries. **(T-0)** Removable shoe cleats may be worn on the flightline in areas where severe snow/ice conditions are common. Organizations may permit use of removable shoe cleats to improve traction on ice/snow covered surfaces and prevent employee slips and falls. Organizations will obtain coordinated approval from their installation management, to include the F&ES Flight and occupational safety office. **(T-1)** Organizations should consider using non-metallic cleats to reduce the potential for spark- initiated fire. Organizations will 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. **(T-1)** Cleats will not be worn while working on or inside aircraft. **(T-1)** Metal cleats will not be worn within 50 feet of fueling, defueling or fuel cell repair operations, or operations that involve flammable solvents, paints, etc. **(T-1)**

24.4.3. Jet Intakes. Mechanics entering jet intake sections will wear appropriate PPE that consists of a pocket-less, zipper-less, button-less bunny-suit labeled, “Intakes Only,” and cloth over-booties or stocking feet. **(T-0)**

24.4.3.1. Boots, if worn, must be inspected and FOD removed from boots prior to installing cloth over-booties. **(T-2) Note:** Boots may be worn if not restricted for use by TO or MAJCOM/FLDCOM and are authorized by MXG/CC.

24.4.3.2. To minimize heat stress during high heat/humidity conditions, e.g., air temperatures above 85° F, employees 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 will have procedures in place to control use. **(T-1)**

24.4.4. LOX/LN_2 Transfers. When transferring LOX/LN_2, personnel will wear PPE (all items will be clean and free of grease, oil and fuel) as identified in the task specific JHA, OI and/or JSTO. **(T-1)** Protective footwear, which fit closely around the top, with rubber soles and heels. **(T-0) Note:** A leather boot approximately eight 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 of footwear, when equipped with a hard protective toe area, is generally classified as a safety shoe or boot.

24.4.5. Face Shield. Face shields are secondary eye protection and must be worn in conjunction with primary eye protection, e.g., safety glasses, goggles. **(T-0)**

24.5. Aircraft Parking Requirements.

24.5.1. Specific parking locations will be designated for each aircraft IAW DAFMAN 32-1084, *Standard Facility Requirements*. **(T-1)** Generally, distances between parked aircraft, wingtip to wingtip, will allow immediate access of emergency vehicles and permit free movement of equipment and materials. **(T-1)** Refer to DAFMAN 32-1084 for specific aircraft wingtip distances. Refer to DESR 6055.09_DAFMAN 91-201 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 will be used to warn of oncoming traffic when temporarily parked aircraft extend into an active taxiway. **(T-1)** A suitable flag will suffice in daytime; however, when dark, a high-visibility reflective equipment/gear and red warning light will be used. **(T-1)** A ground observer will remain with the aircraft until moved to a safe location. **(T-1).**

24.5.3. Wheel Chocking. Aircraft wheel chocks will be placed fore and aft of the main landing gear or as specified in applicable aircraft TOs. **(T-1)**

24.5.4. Clean Parking Areas. Maintenance equipment, work stands, loose aircraft parts, and materials not actually required for work in progress or planned, will be moved from the aircraft parking area to designated storage locations. **(T-1)** Equipment stored outside buildings will be tied down and/or chocked or brakes applied to prevent movement by wind or engine blast. **(T-1)** Mobile work platforms and stands will be moored/tied down when in designated storage locations to prevent collision with aircraft, vehicles, or other equipment. **(T-1)** Designated flightline support equipment storage areas will be determined by the Aerospace Ground Equipment (AGE) flight commander and airfield manager and approved by the MXG/CC or equivalent in coordination with the occupational safety office. **(T-1)**

24.5.5. Taxi/Tow Lines. Refer to AFMAN 11-218, *Aircraft Operations and Movement on the Ground,* for guidance.

24.5.6. Mooring or Tie-Down of Aircraft. Follow applicable aircraft TOs and use designated fittings on aircraft. **(T-1)** Square or bowline knots will be used to provide secure rope fastenings. **(T-1)** 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. **(T-1)** Aircraft mooring points will be placed directly over ground mooring points, or as close as possible. **(T-1)**

24.5.7. Aircraft Emergency Removal. Emergency procedures will be developed to remove endangered aircraft in the event of fire, adverse weather, or other emergency situations on the flightline, or in hangars. **(T-1)** Refer to **paragraph 24.14.10** or additional guidance.

24.5.8. Propeller Driven Aircraft and Helicopters. Do not walk through the propeller or tail rotor arc(s). **(T-1)** Walk around the outside of the propeller or tail rotor arc(s). **(T-1)**

24.6. Adverse Weather Conditions.

24.6.1. Specific weather thresholds and notification procedures will be documented in the installation weather support document. **(T-1)** Aircraft will be moved/evacuated to safe weather areas when tornadoes, hurricanes, or winds of 50 knots or greater are forecast. **(T-1)** Local damaging wind and severe weather safety plans will be developed to include an evacuation plan and hangaring of installation and transient aircraft. **(T-1)** The option to evacuate is the commander's decision in coordination with the appropriate MAJCOM/FLDCOM. Refer to **Chapter 3,** *Weather Safety,* for additional guidance.

24.6.2. Safeguarding Aircraft.

24.6.2.1. Taxiing Aircraft. Avoid taxiing aircraft during strong or damaging wind conditions defined by local weather support document. Taxi only at the discretion of the wing/delta commander when the action will lessen the possibility of aircraft damage.

24.6.2.2. Outside Parking. If possible, park aircraft inside hangars during periods of strong or damaging winds. Light aircraft will be given priority over heavy aircraft for parking inside hangars. **(T-1)** Aircraft parked outside will be faced into the wind and tied down. **(T-1)** Wing spoilers will be used when necessary to reduce airfoil lift. **(T-1)** Transient aircraft will be parked inside hangars, if space permits, or tied down as directed by the MXG/CC or equivalent. **(T-1)**

24.6.2.3. When to Tow Aircraft. Light aircraft in docks or extending outside hangars will be towed clear and parked IAW applicable aircraft TOs when winds exceed 30 knots (sustained or gusts). **(T-1)** Medium or heavy aircraft in docks or extending outside hangars will be towed clear and parked IAW applicable aircraft TOs when winds meet or exceed 50 knots (sustained or gusts). **(T-1)** Refer to **Table 24.1** for additional information.

24.6.2.4. Working Materials. All maintenance equipment, work stands, loose aircraft parts, flightline fire extinguishers and materials not in use will be removed from aircraft parking areas and stored in a safe area. **(T-1)** Equipment remaining outside will be secured against wind movement. **(T-1)**

24.6.2.5. Personnel. Activities other than those required to safeguard aircraft will be suspended and avoided when winds reach velocities of 40 knots or greater. **(T-1)**

24.6.3. High Profile Vehicles (e.g., C-5 Wide-body Staircases, Raised K-Loader, etc.). Caution is required when using high profile vehicles during high wind conditions. Refer to the vehicle technical order and lesson plan for specifics regarding specific vehicle types.

Table 24.1. Adverse Weather High Wind Safeguards.

	Winds 20-30 Knots	Winds 31-50 Knots	Winds Over 50 Knots
Required Actions:	Ensure all aircraft precautionary actions	In addition to high wind precautions	In addition to high wind precautions, have all

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. **(T-1)** Criteria for advisories varies from state to state; local procedures will consider these factors. **(T-2)**	are taken IAW applicable TOs, Directives and Publications.	secure all materials and maintenance equipment.	nonessential personnel move to shelter or remain in their duty section. **WARNING**: 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 flightline and secured (except fire extinguishers)	Hangar all aircraft with less than 15,000 pounds gross weight (e.g., engines removed, no fuel)	ALL AGE must be removed from flightline. Maximum number of aircraft will be hangared.
	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 will seek shelter or remain inside their duty sections. **(T-1)**
	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 will be used as a guide in tying down, hangaring, or evacuating aircraft. **Note 2:** Base Commander (or equivalent) is the government authority on the evacuation of aircraft.			

24.7. Towing and Taxiing Aircraft.

24.7.1. Tow Operations and Procedures. In addition to this manual, DAFI 21-101, AFMAN 11-218 and aircraft specific TOs outline additional requirements for aircraft towing. **Note**: Technical data takes precedence over this publication when differences exist in towing procedures.

24.7.1.1. Avoid backing aircraft, when possible.

24.7.1.2. Tow Operations with Engines Running. MAJCOMs/FLDCOMs may authorize movement of aircraft into hardened aircraft shelters while the aircraft engines are operating, provided a System Safety Engineering Analysis (SSEA) has been conducted. A SSEA will be conducted for each type of generation shelter and type of aircraft to be moved into the shelter. **(T-1)**

24.7.1.3. Commercial aircraft may be towed or pushed short distances, e.g., pushing away from hangar or terminal gate, with engines operating IAW Federal Aviation Administration-approved procedures in operations and maintenance handbooks. Copies of these procedures will be carried on the aircraft. **(T-1)** DAF 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 TOs.

24.7.1.4. Place propellers in an "X" position or position suitable for the aircraft and dock combination. **(T-1)**

24.7.1.5. Station two team members to observe the top clearance of propeller blades. **(T-1)**

24.7.1.6. Towing Speed. Towing speed must not exceed the walking speed of team members, with a maximum of five miles per hour. **(T-1)**

24.7.1.7. Brakes. Aircraft brake systems will be charged before each towing operation. **(T-1)** Towing will be stopped immediately if brake pressure drops below safe operating limits. **(T-1)** Aircraft with inoperative brakes will follow MDS-specific procedures. **(T-1)** Procedures for towing aircraft without MDS-specific guidance for inoperative brakes as follows:

24.7.1.7.1. Obtain squadron commander or designated representative approval prior to each tow. **(T-2)**

24.7.1.7.2. Maintain radio communication throughout the entire towing operation. **(T-1)**

24.7.1.7.3. Additional personnel will chock walk the aircraft, positioned outboard of each landing gear strut requiring chocks. **(T-1)**

24.7.1.7.4. Local procedures for aircraft without MDS-specific guidance will be developed and published in a supplement. **(T-2)** Procedures will include main landing gear chock walk requirements. **(T-2)**

24.7.1.8. Steerable Gear. Steerable landing gear, including outriggers, will be set in tow position before the aircraft is moved and returned to original position after tow bar removal. **(T-1)** The tow team supervisor will 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. **(T-1)**

24.7.1.9. Starts and Stops. Tow vehicle operators will not stop and start suddenly when moving aircraft. **(T-1)** Aircraft brakes will only be applied upon direction from tow supervisor. **(T-1)** Chocks will be properly placed, and the aircraft's brakes set before the towing vehicle is unhooked from the aircraft. **(T-1)**

24.7.1.10. Equipment, Stands and Similar Materials. The tow team supervisor will ensure all equipment, work stands, loose aircraft parts, fire extinguishers and all other materials are removed from the vicinity of an aircraft and properly stored. **(T-1)** Equipment or materials left outside will be secured to prevent accidental movement by wind or jet or propeller blast. **(T-1)**

24.7.1.11. Chocks. Chocks will be maintained near the tow vehicle or aircraft for emergency use throughout the tow operation. **(T-1)** Chocks will be properly placed before the tow vehicle is unhooked. **(T-1)** Chocks or other support equipment will not be placed on or hung from any part of the aircraft exterior during tow operations. **(T-1) Exception**: Lights attached to tow during reduced visibility are excluded.

24.7.1.12. Tow Equipment. Only authorized equipment in good condition will be used in tow operations. **(T-1)** Tow vehicles, tow bars, and any other equipment required to facilitate the tow operation will be inspected for defects by the tow team supervisor. **(T-1)** The tow team supervisor is responsible for the entire tow operation and will 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. **(T-1)** Tow vehicles with safety defects will be removed from service until repaired. **(T-1)**

24.7.1.12.1. Tow Bars. Tow bars may be designed with load limiting devices to prevent secondary damage to the aircraft when a mechanical overload occurs due to sudden braking, deceleration, acceleration, excessive steering force, exceeding turn limits, etc.

24.7.1.12.1.1. Only authorized equipment in good condition will be used in towing operations. **(T-1)** Before moving any aircraft, the tow vehicle, tow bar and connections, and other associated equipment will be inspected for defects by the tow team supervisor. **(T-1)**

24.7.1.12.1.2. Tow Bar Failure. In the event of a tow bar failure, separation between the towing vehicle and aircraft must be maintained. **(T-1)** Many tow bars incorporate a load limiting device (e.g., shear joints, axial load limiters, etc.) by design with the purpose of preventing secondary damage to the aircraft in the event of a mechanical overload that could occur with sudden braking or deceleration, acceleration, excessive steering force, exceeding turn limits, etc. The tow team supervisor will brief tow bar failure contingencies to the entire tow team prior to commencing towing operations. **(T-1)**

24.7.1.12.2. Tow Vehicles. Tow vehicle operators will inspect the tow vehicle to ensure it is serviceable prior to performing any tow operation. **(T-1)** The inspection will be documented on the AF Form 1800, *Operator's Inspection Guide and Trouble Report.* **(T-1)** Towing connections will be inspected before each use. **(T-1)** Pintle assemblies and towing connections will be secured with a pintle hook safety or cotter pin that will positively lock towing connections. **(T-1)** Tow vehicles will stop at least 50 feet from the aircraft to be moved and will only proceed when directed by the tow team supervisor. **(T-1)** The tow team supervisor is responsible for the entire towing operation and will 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. **(T-1)** Tow vehicles with safety defects will be removed from service until repaired. **(T-1)**

24.7.1.12.2.1. During inclement weather conditions, when towing or parking aircraft with snow, ice, or frost present, 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, as needed, to ensure safe towing operations in ice or snow conditions.

24.7.1.12.2.2. Conduct a risk assessment of proposed tow operation based on current runway and taxiway condition readings from local Airfield Management. **(T-1)** The decision to proceed will be approved by appropriate squadron command levels. **(T-1)**

24.7.2. Qualified Personnel. Newly assigned aircraft maintenance personnel will pass a proficiency test on the types of aircraft towed after completing supervised on-the-job training (OJT). **(T-1)** All tow team members will be familiar with all published towing procedures for the aircraft being towed. Tow vehicle operators, brake-riders, wing and tail walkers, and tow supervisors require annual proficiency training. **(T-1)** Tow team supervisors will clearly define duties and responsibilities of each tow team member at the time of the pre-tow briefing. **(T-1)**

24.7.2.1. Tow Team Supervisor. The tow team supervisors will be in complete command of the movement. **(T-1)** Tow team supervisors will take a position to effectively supervise the tow operation and performance of the tow team. **(T-1)** The tow team supervisors will use applicable technical data and instructions/manuals to ensure personnel safety and safe movement of the aircraft. **(T-1)** The tow team supervisor is the only position authorized to give the "all clear to move" order. **(T-2)** The tow team supervisors will determine the safe distance, based on aircraft type and amount of allowable space to maneuver the aircraft. **(T-1)** Prior to towing an aircraft, the tow team supervisor will conduct a pre-tow briefing to ensure all members of the tow team are qualified and understand the duties and responsibilities to be performed. **(T-1)**

24.7.2.2. Brake Operator. A qualified person, authorized by the tow team supervisor, will be in the pilot's seat to operate aircraft brakes, and follow the tow team supervisor's instructions. **(T-1)** If the brake operator is unable to maintain hydraulic pressure, another qualified person will be stationed to watch and maintain the pressure. **(T-1)** Tow operations will be terminated if brake pressure drops below safe operating limits. **(T-1)**

24.7.2.3. Tow Vehicle Operator. A qualified and authorized tow vehicle operator will operate the vehicle in a safe manner, follow the tow team supervisor's instructions, and always maintain control of the tow vehicle. **(T-1)** The tow vehicle operator will stop the tow vehicle if line of sight or communication with the tow team supervisor is lost. **(T-1)** The tow vehicle operator will face the direction of travel while seated and not look over the shoulder to face the direction of travel except while making minor changes during final positioning. **(T-1)**

24.7.2.4. Wing Walker. A wing walker will be positioned at each wing tip to ensure adequate clearance of any obstruction. **(T-1)** Wing walkers will signal the supervisor whenever the aircraft is in danger of colliding with an obstruction. **(T-1)** In such cases, towing will be stopped until clearance is personally checked by the tow team supervisor. **(T-1)** Wing walkers will be used when towing through obstructed areas and during final positioning in hangars/docks. **(T-1)**

24.7.2.5. Tail Walker. A tail walker will be used when the aircraft is turned sharply or backed into position. **(T-1)** A tail walker will signal the supervisor whenever the aircraft is in danger of colliding with an obstruction. **(T-1)** In such cases, towing will be stopped until clearance is personally checked by the tow team supervisor. **(T-1)**

24.7.2.6. Nose Walker. The tow team supervisor serves as the nose walker and will maintain a position in front of the nose of the aircraft with a clear view of wing walkers, the vehicle operator, and the brake operator in the cockpit. **(T-1)** When tail and wing walkers are not required, the tow team supervisor may ride in the tow vehicle if the traversed path can be observed.

24.7.3. Taxiing Operations. Refer to AFMAN 11-218 for additional guidance. A marshaller will be used. **(T-1)** Personnel will remain clear of taxiing aircraft until the aircraft has come to a complete stop. **(T-1)** Aircraft will not be taxied without clearance. **(T-1)** Radio contact will be maintained with the control tower throughout taxi operations. **(T-1)** Taxi speeds in uncongested areas will be reasonable, with aircraft and personnel safety the determining factors. **(T-1)** Follow guidance in appropriate TOs for taxi operations under varying wind conditions. Personnel, vehicles, and towed aircraft will remain clear of taxiing traffic and will not pass within 200 feet behind aircraft with engines running. **(T-1) Note**: Exercise care not to blind ground crewmembers when taxiing with landing lights on. **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 impeding it.

24.7.4. Employees Riding or Walking. Personnel will not cross a tow bar when connected to 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. **(T-1)** No one will try to board or leave a moving aircraft or tow vehicle. **(T-1)** The tow supervisor will brief this information prior to towing. **(T-1)**

24.7.5. Night Crew Signals. Refer to AFMAN 11-218 for night crew signaling practices. Many units have established local policy on night crew signaling procedures. Local policy will be written IAW the tenets of AFMAN 11-218. **(T-1)**

24.7.6. Control Tower Clearance. The tow team supervisor will 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. **(T-1)** The primary means of communication will be the aircraft radio, but, if not feasible, a radio-equipped escort vehicle, in direct radio contact with the control tower, will accompany the aircraft throughout the towing operation. **(T-1)**

24.7.7. Engine Operation. As a rule, aircraft will not be towed with engines operating. **(T-1)** However, civilian contract air carrier jet engine transport aircraft may be towed or pushed short distances, e.g., pushing away from hangar or terminal gate, with engines operating IAW Federal Aviation Administration-approved procedures in operations and maintenance handbooks. Copies of these procedures will be carried on the aircraft. **(T-0)** DAF 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 TO.

24.8. Aircraft Jacking Operations.

24.8.1. Jacks will be:

24.8.1.1. Operated, maintained, inspected, and tested IAW applicable TOs, handbooks or manufacturer's instructions. **(T-1)**

24.8.1.2. Inspected before use to verify lifting capacity, proper functioning of safety locks, conditions of pins, and general serviceability. **(T-1)**

24.8.1.3. Inspected with documentation maintained by work section supervisor. **(T-1)**

24.8.1.4. Removed from service if integrity of the jack is questionable, and the supervisor will be notified. **(T-1)**

24.8.2. Employees will follow specific aircraft TO jacking procedures. **(T-1)** Non-essential work stands and equipment will be removed from under the aircraft before jacking. **(T-1)** If the aircraft weight-and-balance condition has been affected by removing heavy items, weight will be added to reestablish the proper center of gravity before jacking. **(T-1)** Employees will not remain in aircraft being raised or lowered, unless directed by TO, such as to observe leveling instruments. TO-prescribed jack pads, jack pad fittings and correct jack screw adapters and extensions will be installed prior to jacking. **(T-1)** Chocks will be removed, and brakes released before the aircraft is raised or lowered. **(T-1)**

24.8.3. Safety jack stands of suitable capacity or as specified by the manufacturer will be installed under aircraft wings and tail after the aircraft is jacked and leveled if equipment failure or an unbalanced condition could occur. **(T-1)**

24.8.4. Personnel will 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 will be secured and warning signs posted. **(T-1)** Personnel not directly involved in jacking operations or performing maintenance on jacked aircraft will remain outside the posted area. **(T-1)** Depot maintenance facilities may post signs at work area, hangar and flightline entrances in lieu of securing and signing individual aircraft.

24.8.5. Engines and other major components, such as wing panels and stabilizers, that affect aircraft center of gravity or are identified as stress areas, will not be changed or removed on jacked aircraft with landing gear clear of the ramp or floor except IAW aircraft TOs. **(T-1)**

24.8.6. 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) will be used as a safe maximum velocity for outside jacking. **(T-1)** Jacking will be done on a level surface. **(T-1)** High tail surfaces of some aircraft require special consideration when exposed to even moderate wind. Maintenance employees will be familiar with appropriate aircraft TOs before jacking. **(T-1)**

24.8.7. Hangar-dock Jacking. Hydraulic pumping units for aircraft jacks will not be operated in aircraft hangars unless authorized by the MXG/CC or equivalent, occupational safety representative and the F&ES Flight or equivalent. **(T-1)** When authorized, hydraulic pumping unit design will ensure all electrical equipment, sparking contacts, hot surfaces and other possible ignition sources ae at least 18 inches above floor level. **(T-1)** Refer to NFPA 410 and NFPA 70 for additional guidance. Hydraulic pumping units will be placed at least 25 feet from the aircraft in an area free of combustible material and the pumping unit engine properly grounded. **(T-1)**

24.8.8. Releasing Jacks. Maintenance employees will 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. **(T-1)** Employees will ensure the landing gear is completely down and locked in position with all ground locking devices installed. **(T-1)** Only employees required to operate jacks and free the struts will remain near the aircraft while lowering. **(T-1)** The aircraft will be lowered slowly and evenly to the surface. **(T-1)** Employees should exercise care when removing jacks to prevent skin or structure damage. Jacks will be removed by first turning down the jack screw extension, then depressing the ram into the

cylinder. **(T-1)** Personnel will not place any part of their hands on top of the ram to avoid injury while depressing the ram. **(T-1)**

24.8.9. Landing Gear Retraction Tests. Landing gear retraction tests will be directed orally, using an interphone system for communication between a ground observer outside the aircraft and the landing gear operator. **(T-1)** Use of hand signals is acceptable if the interphone system is inoperable, and the ground observer always maintains direct visual contact with both the wheel well/gear swing areas and the landing gear operator. The ground observer will ensure the wheel well and gear swing areas are clear of personnel and equipment prior to and during all testing. **(T-1)**

24.8.10. Fire Fighting Equipment. Maintenance personnel will ensure suitable portable firefighting equipment is readily available and properly positioned. **(T-1)** After aircraft departure, fire extinguishers used to support that aircraft will be removed from the ramp. **(T-1)** Refer to **Chapter 6** for additional guidance or contact the F&ES Flight.

24.9. Aircraft Engine Operations.

24.9.1. Follow aircraft TOs and procedures. Refer to AFMAN 11-218 for engine start, run-up and testing.

24.9.1.1. Personnel near an engine start or run-up will wear, at a minimum, hearing protection as prescribed by installation BE. **(T-1)** Eye protection will be required if conditions exist where flying debris is present, e.g., unimproved/austere runways or aircraft backing maneuvers. **(T-1)**

24.9.1.2. 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. **(T-1)** The ignition switch for reciprocating or electric start engines will be in the OFF position when engines are not operating, and the master battery switch will be turned off when no longer required. **(T-1) Warning:** 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.

24.9.1.3. Personnel will not stand in line with the stripe that designates the plane of propeller operation. **(T-1)** Radio contact with the control tower will be maintained during engine operation or taxiing or with job control during engine runs when the control tower is not operating. **(T-1)** Maintenance Operations Center will be prepared to request F&ES Flight or medical services assistance, as needed. **(T-1)**

24.9.1.4. MXG/CCs or equivalent will develop and implement aircraft maintenance engine pre-run safety checklist that include, at a minimum, review of aircraft and subsystem serviceability (i.e., inoperable systems with warning tags), maintenance crew qualifications, FOD check, tool accountability, and actions to be taken by supporting maintenance personnel in the event of an emergency.

24.9.2. Aircraft Chocks. When aircraft engines are in operation, chocks will be removed with the utmost caution after the proper signal has been given. **(T-1)** Employees will approach the

aircraft from the safest direction, considering location of propellers, jet intakes and exhausts. **(T-1)**

24.9.3. Fire Guard. A qualified fire guard (need not be a certified firefighter) will be positioned by the fire bottle(s) as required by the aircraft TO prior to starting aircraft engines. **(T-1)** This individual must remain in standby readiness until all engines are operating, and no fire danger exists, e.g., crew chief or team leader can release fire guard once engines are started and no fire danger exists. **(T-1)** If no fire guard is required by aircraft TO:

24.9.3.1. Aircraft with internal firefighting capability will have a ground observer in position on interphone to monitor and report any problems, e.g., fire, fuel leaks, aircraft movement, and will remain in position until released by the individual operating the engine. **(T-1)**

24.9.3.2. Aircraft without interphone capability will have a fire guard stationed to observe the engine start process. **(T-1)** After starting, the fire guard will remain in clear view of cockpit personnel and observe aircraft and area during engine operation. **(T-1) Warning**: Use extreme caution to ensure all personnel remain clear of propeller arc and/or jet intakes or exhaust during ground operation. **Exception**: Aero Club or similar aircraft used by 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.

24.9.4. Qualified Personnel. Only personnel trained and certified IAW AFMAN 11-218 will be authorized to start and run-up aircraft engines. **(T-1)** 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 will be repositioned or secured. **(T-1)** Refer to DAFI 21-101 for additional information.

24.9.5. Jet Engine Start Observers. A ground crewmember will maintain constant contact by interphone with the person operating the engine control and will be stationed in front and to one side of the engine being started. **(T-1)** On aircraft without interphone capability, a ground crewmember will be stationed to observe the start and give necessary signals to the person in the cockpit. **(T-1)**

24.9.6. Cockpit Checklist. Employees starting, operating, and testing aircraft engines will use the appropriate cockpit checklist before, during, and after the operation. **(T-1)**

24.9.7. Jet Engine FOD. Damage caused to jet engines by FOD 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 DAFI 21-101 for additional information on FOD prevention and FOD prevention programs.

24.9.8. Hearing Protection Devices. Crew and maintenance personnel will wear approved hearing protection in noise hazard areas to prevent permanent hearing loss. **(T-1)** Installation BE will determine noise hazard areas, protection requirements, and adequacy of hearing protection. **(T-1)**

24.9.9. Rotary Wing Aircraft.

24.9.9.1. The collective pitch stick will be locked in the full low position during engine run-up by ground employees. **(T-1)** Personnel and equipment will 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. **(T-1)**

24.9.9.2. Main rotor blades will be tracked only with an experienced pilot at the controls. **(T-1)** Engine run-up will not be attempted by fewer employees than specified in specific aircraft TOs. **(T-1)** Personnel will exercise caution when approaching the plane of rotation of main rotor blades because they droop at decreased speeds. **(T-1)**

24.9.9.3. All personnel will remain in full view of the pilot or helicopter operator and keep a crouched position approaching or leaving a helicopter with rotating blades. **(T-1)** Personnel will avoid the area from cockpit or cabin rearward unless authorized by helicopter operator to work in this location. **(T-1)** Keep unauthorized personnel at least 50 feet from helicopters with turning rotor blades.

24.9.9.4. Personnel will use caution to stay clear of main and stabilizing rotors when visibility is reduced by dust or other conditions. **(T-1)** Protective goggles will be worn by all personnel and other precautions taken as needed to minimize problems from reduced visibility. **(T-0)**

24.9.9.5. Adequate precautions will be taken to protect personnel from flying objects caused by rotor downwash. **(T-1)** All loose gear within 100 feet of the area susceptible to rotor downwash will be secured or removed. **(T-1)**

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. Suction Effect. Jet engine suction can ingest personnel, causing loss of life. Additionally, ingestion of tools, personal articles, or any form of FOD causes extensive engine damage. Unless required by TO, crewmembers, maintainers, and other personnel will not approach closer than 5 feet from the side or rear or 25 feet from the front of engine intakes of running engines. Personnel may approach multi-engine aircraft, e.g., F-15, from the opposite direction of the running engine, but will use extreme caution to prevent ingestion. **(T-1)** All objects will be removed from in front of or within intakes prior to starting engines. **(T-1)** Visiting personnel or observers will be briefed on removing hats and carrying objects near jet engines. **(T-1)** Employees will not place hands or fingers on auxiliary air inlet doors as they operate automatically and may close. **(T-1)** If open, access doors will be secured or removed as they may be forced closed by engine suction. **(T-1)**

24.10.3. Exhaust Blast. Jet engine exhaust blast is hazardous to personnel and property. Local procedures will 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. **(T-1)** A ground or flight crewmember will 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. **(T-1)** A blast fence will be installed where needed to protect personnel and

equipment from exhaust blast. **(T-1)** Tools, spare parts, and other objects will be removed from blast areas before any jet engine is started. **(T-1)**

24.10.4. Ejection Seats and Canopies. Accidental discharge of ejection seats, cockpit canopies, and jettisonable hatches (e.g., A-10, B-2, and F-16) is hazardous to employees. 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 will have aircraft cockpit and flight deck familiarization training prior to entry IAW DAFI 21-101. **(T-1) Exception**: C-17 Aircraft, Flotation Equipment Deployment Systems – Electro-Environmental employees with task qualification training and annual explosive safety training for time change compliance related to Flotation Equipment Deployment Systems meets the intent of this paragraph, and paragraphs **24.10.4.1** and **24.10.4.2**.

24.10.4.1. Personnel will avoid accidental arming and firing when working near ejection seat catapults and ejection seat or canopy remover controls. **(T-1)** Exercised caution to avoid snagging arming, and firing mechanisms when removing crewmembers from crashed aircraft. **(T-1)** Cook-off, inadvertent actuation, or residual pressure stored in lines and tubes of explosive egress components may pose hazards during rescue attempts.

24.10.4.2. Salvage Operations. Explosive Ordnance Disposal personnel will ensure explosive devices are removed before any aircraft salvage operations begin. **(T-1)** Only qualified and certified egress personnel will remove escape and/or egress system explosive components. **(T-1)**

24.10.4.3. Transient Alert Checklists. Transient alert organizations will develop local checklists to ask pilots about explosive egress systems for aircraft not normally processed through their installations and will follow specific TO procedures for aircraft being serviced. **(T-1)**

24.10.5. Sharp Edges. Some jet aircraft control surfaces have sharp edges, personnel will use caution when working near these edges. **(T-1)** Suitable protective covers will be installed during prolonged maintenance periods to protect personnel from these hazards and include their location. **(T-1)**

24.10.6. Entering Tail Pipe. Employee entry to evaluate condition of tailpipe, e.g., to inspect engine turbine wheel assembly, will be coordinated with CSPT IAW **Chapter 23. (T-1)** The CSPT will evaluate the tailpipe to include atmospheric testing and determine classification of the confined space prior to employee entry. **(T-0)** CSPT determination of confined space classification will direct employee entry procedures IAW **Chapter 23. (T-0)**

24.10.7. Handling Hydrazine. Firefighting and transient maintenance personnel may be exposed to hydrazine. Employees will be trained IAW **Chapter 14** of this manual, and AFI 90-821, *Hazard Communication (HAZCOM) Program,* and TO 00-25-172. **(T-0)** Training will be documented IAW DAFI 91-202. **(T-1)**

24.11. Aircraft Cleaning.

24.11.1. General Requirements. Aircraft will be cleaned IAW MDS-specific TOs. **(T-1)** To prevent falls, employees will not climb or walk on wet aircraft surfaces. **(T-1)** Separate

elevated work platforms and long-handle brushes will be used to the maximum extent possible. **(T-1)** Exercise caution when walking on aircraft TO-designated areas during washing. Locally designed fall protection systems, such as skylines (horizontal lifelines) will be used. **(T-1)** Refer to **paragraph 24.16** for additional guidance. Employees will wear PPE identified by the installation BE OH Assessment. **(T-1)** Only authorized cleaning agents will be used. **(T-0)** Appropriate footwear will be worn to prevent falls from wet surfaces. **(T-0)** Refer to **Chapter 14** for additional PPE guidance and AFI 90-821 for hazard communication requirements.

24.11.2. Aircraft Cleaning Operations.

24.11.2.1. Cleaning Parts. Parts will be cleaned with approved high flashpoint or nonflammable solvents or compounds whenever possible. **(T-1)** Do not clean aircraft parts, hangar floors, equipment, or clothing with gasoline or unauthorized solvents. Operations requiring low flashpoint solvents will be considered hazardous and performed in a facility or area compatible with the solvents. **(T-1)**

24.11.2.2. Flammable liquids will be kept in approved containers, marked to identify contents, and stored in buildings/areas specifically approved by the F&ES Flight. **(T-1)** Refer to **Chapter 22** for additional guidance.

24.11.2.3. Wiping cloths, oily waste, and other combustible materials will be disposed of IAW **paragraph 24.11.2.2**. **(T-1)**

24.11.2.4. Maintain proper ventilation and use protective clothing when working with solvents per installation BE recommendations. **(T-1)** Refer to AFI 90-821 when handling and using hazardous materials.

24.11.3. Fire Control. Use Class B extinguishers for flammable solvents. In no case will water be used. Employees using flammable solvents will be trained and proficient in extinguisher use. **(T-0)** Extinguishers will be sized for possible fires; for example, a gallon of spilled solvent can cover 25 to 50 square feet, but a small extinguisher may only extinguish 2 square feet. **(T-1)** The F&ES Flight will be consulted to ensure extinguishers with proper capacity are obtained. **(T-1)** Employees will remain vigilant after a fire is extinguished because flammable solvent may still be present beneath the extinguishing material. **(T-1)** If an ignition source is present, the vapors can re-ignite. Safety cans and solvent storage cabinets will have flash arresters to prevent flame from entering the container. **(T-1)**

24.12. Aircraft Tire Mounting and Servicing Operations. Refer to TO 4T-1-3, *Inspection, Maintenance Instructions, Storage, and Disposition of Aircraft Tires and Inner Tubes,* and 29 CFR § 1910.177, *Servicing Multi-piece and Single Piece Rim Wheels*, for additional guidance on tire mounting and servicing operations.

24.12.1. Maintenance employees will use tire dollies or mechanical devices when mounting, servicing, or removing heavy aircraft tires. **(T-0)** Sufficient personnel are also necessary, in addition to mechanical aids, to safely handle heavy tires and wheels. Employees will use tire cage guards or tire inflation equipment to prevent the risk of personal injury and equipment damage, i.e. over-inflate a tire, use uncalibrated equipment, etc. **(T-1)** Tire cages will be used when inflating tires in the shop. **(T-0)** Caution will be used to avoid over-inflating tires. **(T-1)** Only qualified PMEL personnel will adjust and/or calibrate tire inflation equipment. **(T-1)**

24.12.2. The supervisor will ensure each employee demonstrates and maintains the ability to service aircraft wheels safely. **(T-0)** An employee is considered qualified after completing the installation or unit's training program. The supervisor will evaluate each employee's ability to perform tasks safely and provide additional training as necessary to ensure each employee maintains proficiency. **(T-0)**

24.13. Flightline Vehicle Operations.

24.13.1. General Requirements. Refer to DAFI 24-301, DAFI 13-213, *Airfield Driving,* and AFI 31-218*, Motor Vehicle Traffic Supervision,* for additional guidance and information on vehicles operated on the flightline, including motorcycles, mopeds, bicycles and tricycles.

24.13.2. Vehicle and Equipment Marking. Vehicles, ground servicing and ground powered equipment will be marked with reflective materials authorized by appropriate TOs, such as TO 36-1-191 and TO 35-1-3. **(T-1)** Fire extinguishers and all hazardous obstacles on or adjacent to the flightline will be marked with reflective materials. **(T-1)**

24.13.3. Speed Limits. No vehicle, including motorcycles, mopeds, bicycle, or tricycles will be operated at a speed deemed reasonable and prudent for existing traffic, road, weather conditions, and posted flightline speed limits. **(T-2)** Emergency vehicles will not automatically assume the right of way. **(T-2)** Commanders and aircraft maintenance commanders are responsible for ensuring personnel authorized to drive on the flightline are informed of flightline speed limits. **Note**: Vehicles responding to Red Balls (emergency flightline scenarios), exercises and precautionary landings are not authorized to exceed posted flightline speed limits.

24.13.4. Entering or Leaving Flightline Driving Areas. Entering or Leaving Flightline Driving Areas. All vehicles, except emergency and alert vehicles responding to an alert or emergency, shall stop prior to entering the flightline and accomplish a FOD check. **(T-2)** Refer to DAFI 13-213, Chapter 4, for additional information. FOD check signs shall be positioned at every entrance to ramp areas and flightline. **(T-3)** Traffic lanes on aircraft parking ramps are normally to the right of the aircraft. Unless it is prevented by local procedures, traffic flow on aircraft parking ramps will be parallel to the noses of parked aircraft with the driver side toward the aircraft. **(T-1)** Vehicles will not be driven diagonally across the parking ramp, but at 90-degree angles to the driving lanes. **(T-1)**

24.13.5. Vehicle Parking. Vehicles will not be backed or parked within 25 feet of any aircraft, unless authorized for operations such as loading or unloading, servicing, or towing. **(T-1)** A spotter will be posted when backing a vehicle towards an aircraft. **(T-1)** Prepositioned wheel chocks will be used to prevent vehicles backing into aircraft. **(T-1)** Refer to **paragraph 30.3.3.2** for additional backing/spotter guidance.

24.13.5.1. Unattended vehicles will be parked with the driver's side facing the aircraft and so it will not interfere with aircraft being towed or taxied. **(T-1)** Ignition will 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. **(T-1)** 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. **(T-1)**

24.13.5.1.1. Only alert and emergency vehicles responding to an alert or emergency are exempt from these requirements. IAW AFI 24-302, the installation/delta

commander may authorize operators to leave vehicles idling subject to weather conditions. With approval from the MAJCOM/FLDCOM, the commander may permit leaving the vehicle running while unattended. **Note**: AGE towing vehicles may be placed in "park" (neutral for manual transmissions) with parking brake set and engine left running during equipment hitching and unhitching operations, and during FOD checks.

24.13.5.1.2. To conduct a rolling FOD check, the vehicle operator must enter the vehicle and "close ALL doors" prior to placing the vehicle in drive to rotate tires the minimum distance necessary to finish the FOD check. **(T-1)** AGE towing vehicles must be turned off when the driver seat is vacated for any other purpose. **(T-1)**

24.13.5.2. Vehicles will 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 will be clear of wingtips and clearly visible to personnel in cockpit. **(T-1)**

24.13.6. Passengers in Vehicle. Passengers will be limited to the designed seating capacity of the vehicle during routine operations. **(T-1)** This includes pickup trucks and cargo vans with passenger seats as well as sedans, station-wagons, and buses. Passengers will use available seat belts when the vehicle is in motion. **(T-1)** 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. **(T-1)** 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. **(T-1)** Passengers will not ride in doorways or sit on engine covers in metro vans/step vans. **Note**: Personnel jumping or descending from the bed of pickup and stake bed trucks have caused many injuries and the practice of riding in the bed of these type vehicles is highly discouraged.

24.13.7. Restricted Visibility or Night Operations.

24.13.7.1. Flashing or parking lights will be used at night when vehicles are temporarily parked on any part of the aircraft ramp. **(T-1)** This does not apply to vehicles parked in a designated parking area. **Note**: Due to possible battery and alternator concerns, MAJCOMs and FLDCOMs may substitute this requirement by adding portable flashing lights.

24.13.7.2. Refueling and explosive loaded (laden) vehicles will not be operated when visibility is less than 300 feet unless directed by the base commander.

24.13.7.3. PMVs and GMVs, except emergency and alert vehicles, will not be operated on the flightline with visibility less than 100 feet. A walking guide with a flashing or luminescent wand will be used during emergency movement of alert vehicles when visibility is under 50 feet. **(T-1)** Vehicle operators will ensure headlights do not point toward taxiing aircraft or towing operations to prevent blinding aircraft or tow vehicle operators. **(T-1)**

24.13.8. Control Tower Signs. Refer to DAFI 13-213 for information.

24.13.9. *Follow Me* Vehicles. *Follow Me* vehicles for guiding aircraft will be equipped with signs, easily visible at night, reading *"Stop"* and *"Follow Me"*. **(T-1)** They will have two-way

radio communication on control tower frequencies. **(T-1)** 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. **(T-1)** *Follow Me* vehicles may exceed the 15 MPH flightline speed limit when necessary to accommodate the safe taxiing speed of aircraft. Tugs will not be used as *Follow Me* vehicles. **(T-1)**

24.13.10. Forklift and Hi-Lift Truck Operations 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 drives will operate forklifts and hi-lift trucks. **(T-1)** Training and licensing will be IAW DAFI 24-301. **(T-1)** Forklift or hi-lift truck operators will not exceed 10 MPH on ramps or 5 MPH within 50 feet of any aircraft. The responsibility to provide hi-lift truck operators special training falls on the owning organization. **(T-1)** Refer to **Chapter 12,** *Material Handling Equipment,* and DESR 6055.09_DAFMAN 91-201 for additional guidance.

24.13.10.1. A spotter will assist operators in determining safe clearances when maneuvering close to aircraft. **(T-1)** Bumper blocks or vehicle chocks placed on ramps will be used to prevent backing into aircraft. **(T-1)** Spotters will assist operators when necessary to back the vehicle. **(T-1)** The driver and spotter will be able to always communicate. **(T-1)** The spotter will use luminous wands or flashlights to relay signals to the hi-lift operator during the night unless supplemental lighting (light carts) is used. **(T-1)**

24.13.10.2. Spotters will be used any time the cargo bed is raised or lowered. **(T-1)** Forklift carriage operation (e.g., raise/lower, tilt, side shift) is prohibited while forklift is in motion. Forklifts will never be driven under an aircraft except when required by the aircraft involved. **(T-1)**

24.13.10.3. When travelling long distances and/or when carrying bulky loads, the forklift will be driven in reverse as the operator's field of vision is less obstructed. **(T-1)** Forks of parked forklifts will be lowered flat on the ground to prevent injury to personnel working or walking in the area. **(T-1)** Parked and unattended forklifts will have operating levers placed in neutral, ignition switched off and handbrake set. **(T-1)**

24.13.11. 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 persons will operate this piece of equipment. **(T-1)** 1-inch by 12- inch shoring or equivalent protection will be used to prevent floor damage when moving extremely heavy loads inside aircraft. **(T-1)** Care should be taken to avoid damaging aircraft ceilings and sidewalls.

24.13.12. Tractor Operations. All tractor-trailer combinations will be equipped with lights when operating at night or during low visibility. **(T-1)** Signs reading "*Slow Moving Vehicle*" or the triangular slow moving vehicle emblem will be displayed on these vehicles. **(T-1)** Passengers will not be allowed to ride on tractors unless adequate seats are installed. **(T-1)** No more than four trailers, loaded or empty, will be pulled by any tractor. **(T-1)** To avoid jackknifing, trailer trains will be arranged with the most heavily loaded trailer next to the towing vehicle, the next heaviest second in line, etc. **(T-1) Exception: S**ix A/M- 3H-6 palletized cargo trailers may be moved behind one prime mover.

24.13.13. Deicing Operations. Conduct deicing operations IAW TO 42C-1-2, *Anti-icing, Deicing and Defrosting of Parked Aircraft,* and aircraft-specific deicing TO guidance. Only licensed drivers will operate deicing trucks. **(T-1)**

24.14. Aircraft Hangar Operations.

24.14.1. Hangaring Aircraft. The MXG/CC or equivalent will ensure detailed local operating procedures for hangaring aircraft, including safety precautions, are prepared, and coordinated with the Occupational Safety office and F&ES Flight. **(T-1)** Include Weapons Safety Office coordination if hangaring weapons-loaded aircraft.

24.14.2. Aircraft Hangar, Shelter, and Dock Facility Guidance. The Occupational Safety office, F&ES Flight, and installation BE will evaluate facilities, equipment, processes, etc., and provide recommendations to ensure safety, fire, and health hazards are properly mitigated and/or controlled, and complied with required standards, codes, etc. **(T-1)** Refer to NFPA 70, Article 513, *Standard on Aircraft Hangars,* NFPA 409, *Standard on Aircraft Hangars,* NFPA 410, UFC 3-600-01, and associated engineering technical letters (ETLs) for detailed design guidance. **Note 1:** ETLs supplement UFC 3-600-01 and compliance with ETLs is required per AFI 32-1023, *Designing and Constructing Military Construction Projects.* **Note 2:** ETLs take precedence in conflicts with national fire codes, building codes or UFC 3-600-01.

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 will be de-energized or disabled and locked out until special operations are complete and hazardous conditions permanently eliminated. **(T-1)** 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.

24.14.2.3. Install barriers such as chains and fencing to restrict personnel from hazardous areas. Ensure mechanical safeguards for hangar, nose dock, and shelter doors are in place such as installing limit switches and doorstops where necessary to limit unnecessary door travel. **(T-1)** Doors not in compliance will be assigned a RAC by the occupational safety office. **(T-1)** A JHA will be performed, and appropriate controls put in place until doors are compliant. **(T-1)** Establish a clear zone, e.g., five feet if space allows, around all hazardous areas. **(T-1)**

24.14.2.3.1. Hazardous areas include crush and pinch points between structural beams and hangar doors.

24.14.2.3.2. Highlight hazardous areas such as crush and pinch points that cannot be eliminated by engineering controls or mechanical safeguards with colored paint and signs. Clear zones will be marked with solid yellow or yellow and black stripes. **(T-2)**

24.14.2.4. Safety signs will be printed in English and the predominant language of non-English reading employees. **(T-0)** Established symbols should also be considered. Employees unable to read posted signs will be informed of hazardous areas and instructions printed on the signs. **(T-0) Note**: For overseas locations with host-nation employees, the maintenance group or squadron commander should consider a training class on safety signs

and symbols for host-nation employees. All signage will meet the design requirements found in **Chapter 17,** *Mishap Prevention Safety Signs, Tags and Labeling.* **(T-1)**

24.14.3. Training. Employees who routinely work in hangars or require access through hangar doors will receive hangar door awareness Training, both an initial training and refresher training for when personnel who fail to demonstrate appropriate level of knowledge. **(T-1)** Training courses will include, at a minimum, door hazards, emergency procedures, including manual door operation, and safe operation. **(T-1)**

24.14.4. Operating Condition. Hangar doors will be maintained in safe working condition. **(T-1)** Door paths will be free of obstructions with door tracks and trackways in good condition and free of debris. **(T-1)** A visual inspection will be made prior to operation and discrepancies corrected before operation. **(T-1)** Hangar doors will be on a preventive maintenance schedule and only qualified employees will perform hangar door maintenance. **(T-1)**

24.14.4.1. Hangar doors will be fully opened, doors not completely closed must have an opening of at least 10 feet to prevent injury to personnel. **(T-1)**

24.14.4.2. Personnel will not cross the hangar door threshold while hangar doors are in operation. **(T-1)**

24.14.5. Door Pockets. Hangar door pockets and recessed areas will not be used for storage and will be adequately illuminated so the door operator can see any obstructions or personnel in the door path. **(T-1)** Door pockets will be checked prior to movement of hangar doors to ensure the pockets are free of personnel or equipment. **(T-1)**

24.14.6. Alarm/Warning Lights. To prevent confusion, powered hangar doors will have an alarm device with a sound distinguishable from the facility fire alarm and audible above normal noise levels. **(T-1)** The warning device will automatically signal at least five seconds before any door section movement, continuously while the door is operated and will reset immediately after movement stops. **(T-1)** Additionally, warning lights are required in high noise areas if the audible alarm is difficult to hear but use caution to avoid stroboscopic effects. **(T-1)**

24.14.7. Operational Checkout of Doors and Safety Features. Facility managers will conduct monthly inspections of hangar door operational and safety features. **(T-1)** Installation CE and Airfield Management will be notified immediately of any discrepancies. **(T-1)**

24.14.8. Roll-up Doors. Refer to **paragraph 2.7** for roll up door requirements.

24.14.9. 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 guidance.

24.14.10. Heaters. Combustion heaters installed in aircraft will not be operated in a hangar. Portable engines and cabin heaters will be removed and stored immediately after each use or when no longer required. **(T-1)** Engine and shelter heaters will be placed as far from the aircraft as ducting permits. **(T-1)** No portable heater will be left operating unattended. **(T-1)** Only heaters approved for operation inside hangars and that do not give off unacceptable levels of hazardous gases will be used. **(T-1)** Heaters and the processes for which they are used will be evaluated by installation 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. **(T-1)**

24.14.11. Aircraft Emergency Removal. The aircraft maintenance officer, designated by the MXG/CC or equivalent, will establish emergency procedures to remove aircraft from hangars in case of fire, severe weather, or other hazards. **(T-1)** Employees will be trained on emergency procedures to eliminate confusion and ensure timely evacuation of aircraft. **(T-1)** If normal towing method (nose gear) is not available, snatch blocks and/or harnesses laid out on hangar floors will be attached to the aircraft when in-progress work permits. **(T-1)**

24.14.12. Aircraft will only be fueled or defueled in facilities approved through a SSEA to the current weapons system and facility configuration IAW instructions in TO 00-25-172. **(T-1)** Documentation of SSEA, other than Tactical Air Base Hardened Aircraft shelters, modified Tactical Air Base Hardened Aircraft, 2nd and 3rd generation aircraft shelters, flow-through revetments and facilities listed in TO 00-25-172 will be maintained by the appropriate maintenance unit. **(T-1)** Aircraft fueling and fueling operations in aircraft fuel system maintenance (fuel cell repair) facilities will not be allowed unless the facility is in full compliance with requirements of TO 1-1-3 and/or UFC 4-211-01, *Aircraft Maintenance Hangars.* **(T-1)**

24.15. Aircraft Shop and Flightline Maintenance Operations.

24.15.1. General Requirements. **Note:** Refer to **Chapter 7**, *Walking-Working Surfaces,* and **Chapter 11,** *Hand Tools, Portable Power Tools, and Machinery,* for additional guidance on machine safeguarding and shop layout.

24.15.1.1. Tool Safety. Use of personally owned hand and power tools is prohibited. **(T-1)** Refer to TO 32-1-101 and TO 32-1-2, *Use of Hand Tools (International Business Machines),* and paragraphs **14.15.1.2.1** and **24.15.1.2.2** for battery-powered tool use.

24.15.1.2. 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:

24.15.1.2.1. 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).

24.15.1.2.2. Tool battery exchanges and recharging will not be conducted in Class 1, Division 1 or 2 hazard areas.

24.15.1.3. Compressed Gases. Refer to TO 42B-5-1-2, *Gas Cylinders (Storage Type) – Use, Handling, and Maintenance,* for additional guidance on compressed gases.

24.15.1.4. Occupational Health. Aircraft maintenance operations on the flightline, in shops, aircraft shelters, hangars and maintenance facilities pose chemical and physical hazards. These hazards will be evaluated, the level of risk established, and controls incorporated where necessary. **(T-1)** Installation BE performs a unit OH Assessment routinely at least every three years and HRAs upon request when process or chemical/physical hazard changes occur.

24.15.2. Aircraft Electrical System Maintenance. Electrical systems will be de-energized whenever possible and approved procedures strictly followed. **(T-1)** If the approved procedure requires work on an energized circuit, approved technical data or manufacturer's instructions

and 29 CFR § 1910.333, *Selection and Use of Work Practices,* will be followed and other maintenance personnel informed of the actions. **(T-0)** If work is done on energized circuits of 50 volts or more, arc flash protection must be worn. **(T-1)** Refer to **paragraph 8.17.2.2** for additional guidance.

24.15.2.1. For on-equipment aircraft maintenance, the AFTO Form 492, *MX Warning Tag*, will be used to flag a condition that could cause damage or injury if ignored. **(T-1)** Warning tags will be used during maintenance actions as required by applicable technical data and/or local procedures. **(T-1)** Refer to DAFI 21-101 for additional guidance. Do not use the AF Form 979, for on-equipment aircraft maintenance. The AF Form 979 or commercial equivalent will 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. **(T-1)** Tags will 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, will be secured to prevent scraping and chafing. **(T-1)** Electrical components will be bench-tested in a properly designed shop. **(T-1)** Testing of electrical systems or equipment while installed on the aircraft will be held to a minimum.

24.15.2.2. If a circuit breaker opens (pops) during maintenance on an aircraft, the popped circuit breaker will not be reset without following specific guidance in the applicable aircraft system TO and the cause is determined. **(T-1)** An unexpected, popped circuit breaker may result from an overload or ground fault.

24.15.2.3. Electrical components and systems will be de-energized and isolated from other energized circuits or power sources during cleaning operations. **(T-1)**

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 27,** NFPA 410 and NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, for additional information.

24.15.4. Aerospace Ground Equipment (AGE). Operators will be familiar with OIs for equipment they use, including emergency shutdown, other precautionary measures, and use of fire extinguishers. **(T-1)** Operators will review maintenance records and inspect equipment for leaks, damage, or malfunction before operation. **(T-1)** AGE equipment will not be left unattended while running, unless specifically designed for unattended operation. **(T-1)** Contact the AGE Maintenance Shop for further guidance. **Warning**: Personnel will not climb inside combustion powered AGE (e.g., light carts) as the enclosure may contain fatal levels of hazardous gases. **(T-1)**

24.15.5. Communication and Navigation Equipment Repair. Repair communication and electronic equipment on an approved shop bench IAW TO or manufacturer's instructions. Do not operate, test, or check radar or high frequency 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 AFI 48-109 for additional information.

24.15.6. Flight Control Systems. Unexpected movement of flight controls may cause severe injuries. Maintenance personnel will be trained and aware of dangers with flight control system operation. **(T-1)** Flight control operation will be directed orally by interphone or after visual assurance from a person outside the aircraft that flight control surfaces and movement areas are clear. **(T-1)** All maintenance activities will be coordinated, and TO procedures applied to the flight controls to prevent movement when employees are exposed to potential injury. **(T-1)** Local procedures will be developed to address work shift changes. **(T-1)**

24.15.7. Aircraft Hydraulic Systems. Employees will ensure pressures are relieved prior to disassembling any hydraulic lines or system components. **(T-1)** Control(s) that could injure personnel or damage equipment will be tagged out IAW TO procedures and/or local procedures while maintenance activities are in progress. **(T-1)** Proper PPE, such as goggles, will be worn. **(T-0)** Hydraulic spills will be cleaned up immediately to prevent slips and falls. **(T-1)**

24.15.8. Explosives. Storing, handling, and using explosives will be IAW specific TOs and DESR 6055.09_DAFMAN 91-201. **(T-1)**

24.16. Fall Protection Requirements. MXG/CCs or designated representative must ensure safe DAF maintenance operations IAW this chapter and **Chapter 13**. **(T-0)** Flightline and hangar operations must include an appropriate level of fall protection commensurate with DAF mission requirements. **(T-0)** To ensure consistency across DAF operations, AFMC and the lead MAJCOM/FLDCOM for the MDS will work together to ensure development of standardized fall protection requirements and procedures are published in the applicable weapon system TOs. Operations are termed as military unique and nonmilitary unique, these terms are discussed below.

24.16.1. Military-Unique. Military-unique operations are specifically defined in DAFI 91-202, paragraph 1.8.1. The determination of military-unique does not allow for safety requirements to be ignored, but to allow for deviations that protect employees while accomplishing the mission. For example, during deployed operations where compliance with all fall protection requirements is not possible, a Fall Hazard Survey (refer to **Chapter 13** for additional information) will be used to evaluate the hazards and plan the appropriate procedures to best protect employees while addressing the limitations due to location and mission requirements to best mitigate the risks for employees falling while working at height.

24.16.2. Nonmilitary-Unique. Nonmilitary-unique operations refer to most day-to-day operations as defined in DAFI 91-202, paragraph 1.8.2.

24.16.3. Given the diversity and complexity of DAF operations, it is impossible to address every situation in this manual. However, the intent is reasonably clear that commanders must employ a balance between safety and mission objectives that ensure mission success when regarding military uniqueness. Decisions that are based upon sound RM principles, and the DoD guidance provided, are very likely to be defendable and correct. Working with the local safety staff is the best way to receive recommendations that will assist commanders to balance safety and mission accomplishment objectives. **(T-1)** Organizations should discuss fall hazard surveys with the applicable TO writer or Aircraft Item Manager for their airframe, then involve organizational/appropriate safety office. **Note:** For Air Logistics Center (ALC) Depots, a standardized Process Order integrated into the task may be used in lieu of a fall hazard survey.

24.16.4. Types of Fall Protection. Fall hazards from aircraft walking and working surfaces are controlled through application of RM at command and local levels to determine which fall protection method offers optimal employee safety for the tasks performed. The maximum use of maintenance stands and work platforms, whenever possible, will reduce exposure and risk. Whenever it becomes necessary to perform required tasks where an employee can fall four feet or more, fall protection will be used. **(T-0)**

24.16.4.1. Passive. Passive fall protection is the most preferred means of protecting employees from falls. Passive systems need not be directly connected to the employee to prevent an employee from falling. These systems include guardrails, work stands and platforms (including aircraft maintenance stands, e.g., B-1, B-4, B-5), nets and other devices. If passive fall protection is not feasible, active fall protection will be the next option considered. **(T-0)**

24.16.4.2. Active. Active fall protection, such as positioning devices, fall restraint systems, ladder climbing devices and PFAS, require the employee to wear a full body harness and components to attach to an anchorage or lifeline. Fall restraint systems prevent an employee from falling off unprotected sides and edges by restricting the employee's range of movement while a PFAS stops an employee's fall off unprotected sides and edges, before striking the next level. Positioning systems allow employees to work from vertical surfaces with both hands free.

24.16.4.2.1. PFAS allow an employee to fall, but limits arresting loads to generally safe levels and prevents the employee from hitting the next level. Refer to Chapter **13** and **29** CFR § 1910.140, *Personal Fall Arrest Systems,* for additional guidance on PFAS. (**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 can be fatal.) Supervisors will ensure employees using a personal fall arrest system can be promptly rescued or be able to self-rescue should a fall occur. **(T-0)** Rescue procedures will be developed prior to using a fall arrest system. **(T-0)**

24.16.4.2.2. Positioning and Restraint Systems. Fall restraint systems restrict an employee's range of movement so the individual cannot get into a position that would allow a fall. Positioning systems allow an employee 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 employee will have minimal support strength of 5,000 pounds (22.2 kN). **(T-0)** Secure the employee to an anchor using a lanyard short enough to prevent the employee's center of gravity from reaching the fall hazard.

24.16.5. Mobile Work Platforms. Refer to **Chapter 16** for additional guidance.

24.17. Safety in Flightline Contractor Operations.

24.17.1. Contractor operations may create hazardous working conditions for DAF personnel. To ensure contracts and activities of contractors performing a task or service for the DAF does not subject DAF personnel or resources to hazards, the Occupational Safety office, F&ES

Flight, Airfield Management, and installation BE will review requirement documents prior to submission to Contracting office. **(T-1)** Appropriate safety, fire, and health requirements will be included in contract specifications. **(T-1)** This is normally accomplished by including appropriate Federal Acquisition Regulation (FAR) provisions or clauses in the contract. Occupational Safety office, F&ES Flight, Airfield Management, and installation BE will assist the contracting officer and using organization establish appropriate requirements. **(T-1)** If a contractor procedure or condition requires correction, action will be initiated through the Contracting Officer. **(T-1) Note**: Contractors are responsible for compliance with all OSHA requirements, as applicable, while performing work on military installations.

24.17.2. Construction Contracts. The contracting officer will call a pre-construction conference before the contractor begins construction on a DAF installation. **(T-1)** Occupational Safety office, Flight Safety Office, F&ES Flight, Airfield Management, installation BE, the using organization, installation CE, contractor representatives, and other affected agencies, as appropriate, will be present. **(T-1)** The Contracting Officer will ensure the contractor knows all necessary DAF safety requirements associated with the contract. **(T-1) Note**: This guidance does not apply to US Army Corps of Engineers contracts.

24.17.3. Non-Construction Contracts. Most non-construction contracts on DAF installations involve persons or companies providing goods and services to base personnel and activities. During requirement development, requiring activity coordination with the Occupational Safety office, F&ES Flight, Airfield Management, installation 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, Occupational Safety office, F&ES Flight, Airfield Management, installation BE, contract representatives and the using organization will review the contract to ensure its continued adequacy. **(T-1)**

Chapter 25

CIVIL ENGINEERING

25.1. Scope. Installation CE is typically involved in numerous planning, maintenance and fire prevention activities that have a high risk for mishaps. Safe management of the workforce, 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 PPE, proper tools, human factors, and risk management should all be addressed and accomplished prior to starting tasks.

25.1.1. Interruption of services, injury to employees, and equipment damage can occur when electrical, gas, and steam lines are broken during digging operations. Ensure DAF Form 103, *Base Civil Engineering Work Clearance Request,* is obtained prior to digging. **(T-1)**

25.1.2. The use of propane, gasoline, or diesel-powered equipment, e.g., forklifts and materials handling carts, can produce hazardous gases. Employee exposure to hazardous gases may be excessive if such operations are conducted in low ceiling, enclosed, or poorly ventilated areas. Proper ventilation will always be used. **(T-0)**

25.1.3. 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 will be IAW 29 CFR § 1910.1001, *Asbestos.* **(T-0)** Employees will not be exposed to unsafe levels of airborne asbestos. **(T-0)** Consult installation BE prior to all planned asbestos projects. Immediately notify installation BE and installation CE if asbestos is suspected or confirmed during a project. Employees will not resume work until receiving proper guidance from installation BE. **(T-1)** Refer to DAFMAN 48-146, *Occupational Health Program Management,* AFI 32-1001, *Civil Engineer Operations,* 15 U.S.C. **Chapter 53**, *Toxic Substances Control Act,* 42 U.S.C. **Chapter 85**, *Air Pollution Prevention and Control,* and 29 U.S.C. **Chapter 15**, *Occupational Safety and Health Act,* for additional guidance.

Table 25.1. Relevant CE-related References.

Subject	Reference
Fire Protection and Prevention	**Chapter 6** DAFI 32-2001, Fire and Emergency Services (F&ES) Program UFC 3-600-01, Fire Protection Engineering for Facilities UFC 3-601-02, Fire Protection Systems Inspections, Testing, and Maintenance
Electrical	**Chapter 8** UFC 3-560-01, Operation and Maintenance: Electrical Safety 29 CFR § 1910, Subpart S – Electrical NFPA 70E, Standard for Electrical Safety in the Workplace
Fall Protection	**Chapter 7** **Chapter 13** **Chapter 24** 29 CFR § 1910, Subpart D – Walking-Working Surfaces 29 CFR § 1910.140, Personal Fall Protection Systems
Machinery and Tools	**Chapter 11** TO 32-1-101, Use and Care of Hand Tools and Measuring Tools 29 CFR § 1910, Subpart O – Machinery and Machine Guarding

	29 CFR § 1910, Subpart P – Hand and Portable Powered Tools and Other Hand-Held Equipment
Materials Handling Equipment	**Chapter 12** 29 CFR § 1910, Subpart N – Materials Handling and Storage 29 CFR § 1926, Subpart CC – Cranes and Derricks in Construction
Personal Protective Equipment	**Chapter 14** AFI 90-821, Hazard Communication (HAZCOM) Program 29 CFR § 1910, Subpart I – Personal Protective Equipment
Hot Work	**Chapter 20** AFI 32-2001, Fire and Emergency Services (F&ES) Program AFI 90-821, Hazard Communication (HAZCOM) Program 29 CFR § 1910, Subpart Q – Welding, Cutting and Brazing
Hazardous Energy Control	**Chapter 21** AFMAN 32-1065, Grounding and Electrical Systems NFPA 70E, Standard for Electrical Safety in the Workplace
Flammables and Combustibles	**Chapter 22** 29 CFR § 1910, Subpart H – Hazardous Materials 29 CFR § 1910.106, Flammable Liquids 29 CFR § 1910.119, Process Safety Management of Highly Hazardous Chemicals 29 CFR § 1910.120, Hazardous Waste Operations and Emergency Response 29 CFR § 1910.134, Respiratory Protection 29 CFR § 1926.152, Flammable Liquids NFPA 30, Flammable and Combustible Liquid Code
Confined Spaces	**Chapter 23** DAFI 23-201, Fuels Management AFI 90-821, Hazard Communication Program TO 1-1-3, Inspection and Repair of Aircraft Integral Tanks and Fuel Cells 29 CFR § 1910.146, Permit-Required Confined Spaces 29 CFR § 1926, Subpart AA – Confined Spaces in Construction
Training Systems	**Chapter 15** AFI 10-217, Management of Air Force Operational Training and Undergraduate Aircrew Training Systems UFC 3-600-01, Fire Protection Engineering for Facilities UFC 3-601-02, Fire Protection Systems Inspection, Testing, and Maintenance
Note: Specific AFIs, AFMANs, DAFIs, DAFMANs or TOs may include PPE for specific operations. **Note**: Specific OSHA standards may include PPE for specified operations conducive to that standard.	

25.2. Supervisory Responsibilities. Supervisors will comply with the requirements of DAFI 91-202, AFMAN 32-1065, UFC 3-560-01, and applicable NFPA standards to ensure a safe work environment. **(T-1)**

25.2.1. Supervisors must recognize workplace hazards and apply risk management when existing guidance, e.g., manufacturer's instructions, does not sufficiently address operational concerns or requirements. **(T-0)** Refer to AFI 90-802, *Risk Management,* for additional information and guidance on risk management.

25.2.2. Supervisors will not require personnel to work in environments or conditions that are hazardous to their safety or health without first employing adequate hierarchy of controls. **(T-1)** These controls include, hazard elimination, substitution, isolating employee from the hazard, administrative controls, to include changes in work procedures, e.g., written policy, rules, training – identified through a JHA. **Note**: Use of PPE is the least preferred method.

25.2.3. The supervisor will frequently inspect job sites, work methods, materials, and equipment used. **(T-0)** Any unsafe equipment or material will be tagged and rendered inoperative or physically removed from the workplace. **(T-0)**

25.2.4. The supervisor will permit only qualified personnel to operate equipment and machinery according to safe work practices. **(T-0)**

25.2.5. Ensure industrial shops and sites have a basic first aid kit, or suitable substitute that is approved by medical services, available to care for employees' injuries until professional help arrives, or they can obtain full medical care. **(T-1)** Refer to **Chapter 8** for additional guidance.

25.3. Compressed Air.

25.3.1. All employees will be aware of the inherent dangers of using compressed air. **(T-0)** Alternate methods of cleaning surfaces should be sought. Compressed air may be used if no alternative method of cleaning surfaces is acceptable. Compressed air will never be used to blow debris off a person's body. **(T-0)** 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, safety goggles, and hearing protection are required when cleaning with compressed air. **(T-0)**

25.3.2. All personnel assigned to shops with air compressors will comply with compressor operating and maintenance instructions. **(T-0)**

25.3.3. The following are requirements for air compressors:

25.3.3.1. Air compressors will be maintained IAW manufacturer's instructions or applicable TO. **(T-1)**

25.3.3.2. The compressed air tank will be drained IAW manufacturer's instructions to prevent moisture buildup. **(T-1)**

25.3.3.3. Air tanks will be protected by safety relief valves. **(T-0)** These valves will be tested at regular intervals (as required by manufacturer's specifications) to ensure they are in good operating condition. **(T-0)**

25.3.3.4. The pressure controller and gauge will be maintained in good operating condition. **(T-0)**

25.3.3.5. The maximum working pressure of compressed air lines will be identified in psi. **(T-1)** Pipeline outlets will be tagged or marked showing maximum working pressure immediately adjacent to the outlet. **(T-0)**

25.3.4. Air supply lines will be protected from damage by vehicles, tools, and equipment. **(T-0)** They will be inspected regularly and maintained in good condition. **(T-1)** Air supply lines will be marked or tagged to identify the maximum psi on the lines. **(T-0)**

25.3.5. Compressed Air Systems. Employees will be trained and authorized to inspect, maintain, or install compressed air systems. **(T-1)**

25.3.6. Safe use of pneumatic power tools will comply with 29 CFR § 1926.302. **(T-0)**

25.4. Shoring and Trenching. The walls and faces of excavations and trenches five feet in depth or more, where employees may be exposed to danger of a cave-in, will be guarded by a shoring system, slope excavation, bench excavation, or some other equivalent means consistent with 29

CFR § 1926, Subpart P – *Excavations.* **(T-0)** Trenches less than five feet deep with hazardous soil conditions will also be effectively protected. **(T-0)** Refer to 29 CFR § 1926.650, *Scope, Application and Definitions Applicable to Subpart P,* 29 CFR § 1926.651, *Specific Excavation Requirements,* and 29 CFR § 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 or benching system, or some other equivalent means. **(T-0)**

25.5. Barricades and Traffic Signs. Whenever a common area is disturbed by installation CE maintenance, repair, or construction operations and presents a hazard to personnel in the area (residents, other employees, or passers-by), care will be taken to warn these personnel and other engineering employees of the potential hazard. **(T-0)**

25.5.1. Appropriate barriers will be erected around excavations, open manholes, open electrical panels, etc., whenever they will be left unattended. **(T-0)**

25.5.2. Appropriate warning signs and steady or flashing warning lights for periods of reduced visibility (e.g., nighttime operations, inclement weather, fog) will be posted a sufficient distance from the hazard to give ample advance warning to approaching pedestrian or vehicular traffic. **(T-0)** For vehicular traffic, comply with DOT's *Manual on Uniform Traffic Control Devices.* **(T-0)**

25.5.3. Traffic control signs or devices will conform to the DOT's *Manual on Uniform Traffic Control Devices.* **(T-0)**

25.5.4. Employees exposed to vehicle traffic will be provided with and required to wear warning vests marked with or made of reflector-type or high visibility material. **(T-0)** **Chapter 14** provides additional guidance for these requirements. In some situations, the use of flagmen to control the flow of traffic may be necessary. Employees in equipment operations, pavement maintenance, plumbing, heating maintenance, and exterior electrical career fields will be trained in traffic control procedures. **(T-1)**

25.6. Sanitation.

25.6.1. Shop supervisors will ensure employees use protective clothing and equipment that will protect them from hazards to the work they perform. **(T-0)** The employee is responsible for keeping their PPE clean, serviceable, sanitary, and in a state of good repair always, and use the proper equipment, when required.

25.6.2. Employees will keep their hands and face clean, change clothes when they are contaminated with solvents, lubricants, or fuels, and keep their hands and soiled objects from contacting their skin, eyes, or mouth. **(T-0)** No food or drink will be brought into or consumed in areas exposed to toxic materials, chemicals, or industrial shop contaminants. **(T-0)** After exposure to any contaminant, employees will wash their hands before eating or smoking. **(T-0)** Safe drinking water will be provided in or reasonably near all shops. **(T-0)** Waste food from the lunch area will be kept in a receptacle that is tightly covered and kept clean. **(T-1)** Restrooms must be provided with hot and cold running water and will be kept clean and in a sanitary condition. **(T-0)**

25.6.3. Employees required to wear protective clothing will be provided with changing rooms equipped with clothing lockers having separate storage facilities for clean and soiled clothing.

(T-0) Shower facilities will be provided when necessary to remove contamination from skin. **(T-0)**

25.6.4. Clothing used daily and issued by the shop will be cleaned and stored in shop lockers or fenced areas within the building. **(T-0)** Employees will inspect clothing and protective equipment daily for serviceability. **(T-0)** In addition, supervisors or a designated employee will spot check equipment and clothing. **(T-0)** Refer to 29 CFR § 1910.141, *Sanitation,* for additional guidance.

25.7. Restrictions. Clothing worn will be suitable for weather conditions and work being done. **(T-1)** Highly combustible garments or coveralls made of a synthetic material such as nylon will 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. **(T-0)** Refer to AFMAN 32-1065 for additional guidance.

25.8. Equipment Operations and Pavements. Training outlines for operator qualifications will be tailored to the equipment and will be updated as new equipment is received, or new processes are implemented. **(T-0)** All equipment operators must be trained in specific safe operating procedures by a person qualified in the manufacturers or sellers' requirements. **(T-0)** DAFI 24-301 contains general requirements applicable to construction equipment. All required PPE will be used. **(T-0)**

25.8.1. Joint Seal Kettle-Melter.

25.8.1.1. Kettles will not be operated without F&ES Flight approval. **(T-1)** A permit will be obtained at least two working days prior to the placement of the tar kettle. **(T-1)**

25.8.1.2. Serious burns can result from improper operation. Loose-fitting clothing will be worn. **(T-1)** Pants will completely cover the legs and extend to below the tops of shoes. **(T-1)** Shirts will be long sleeved. **(T-1)** Loose-fitting gloves will be worn. **(T-1)**

25.8.1.3. Safety-toe shoes and a face shield will be worn. **(T-0)** The operator and personnel handling the heated kettle product will wear face shields and gloves. **(T-0)** All tripping hazards will be removed from the worksite. **(T-1)**

25.8.1.4. Containers will not be overfilled and will be allowed sufficient room for the bitumen (tar) to slosh without spilling when the container is moved. **(T-1)**

25.8.1.5. Appropriate number and type of fire extinguishers will be kept near the kettle. **(T-1)**

25.8.1.6. When adding bituminous or joint sealant materials to the kettle, the product will be eased into the kettle to prevent splashing of heated materials on the operator. **(T-1)** The kettle will be watched closely, and the products not heated above the safe heating temperature specified by the product manufacturer. **(T-1)**

25.8.1.7. Employees will never use direct heating of the materials. **(T-1)** No open flame or source of ignition will be permitted near asphalt material that is heated to a temperature near its flash point. **(T-1)** Wherever heating kettles are used, the temperature of the product will be controlled by thermostatic devices or checked at frequent intervals with an accurate thermometer to prevent overheating. **(T-1) Warning**: Gasoline or other highly volatile solvents will never be used for cleaning. **(T-1)**

25.8.2. Pavement Grinders (Line Eradicator or Paint Scraper). Employees will keep their hands and feet clear of the cutting wheels. **(T-1)** The operator and personnel within the immediate work area will wear safety-toe shoes, goggles, and hearing protection. **(T-0)**

25.8.3. Tampers. Employees will keep their hands and feet clear of the tamping tool. **(T-1)** A firm footing will be maintained while using this equipment. **(T-1)** Safety-toe shoes and hearing protection are required when operating tampers. **(T-0)**

25.8.4. Pneumatic Drill. Safety-toe shoes, goggles, and hearing protection will be worn during operation. **(T-0)** A firm grasp will be maintained on the tool. **(T-1)** It will be kept aligned with the hole to prevent binding. **(T-1)** The tool will not be forced. **(T-1)**

25.9. Carpentry and Structural Maintenance.

25.9.1. Potential physical and health hazards can be effectively controlled by following proper work procedures and controls. Prior to commencement of work, ensure personnel are not exposed to asbestos or lead-based paint. **(T-1)** Contact installation CE for asbestos and lead verification. **(T-1)** If lead or asbestos is identified or suspected, contact installation BE for an HRA and installation CE for remediation and disposal requirements. **(T-1)**

25.9.2. General Carpentry.

25.9.2.1. Employees will not leave power tools or machines running unattended nor attempt to clear, clean, or repair the machine while it is operating. **(T-0)** When maintenance or adjustments are necessary, the machine will be completely shut down and all energy sources de-energized with LOTO devices applied according to manufacturer's instructions in **Chapter 21**. **(T-0)** Supervisors will ensure periodic inspections are accomplished on all shop equipment IAW appropriate technical data and/or manufacturer's requirements. **(T-1)** Chips or dust will be removed from machinery using an appropriate tool and never by hand. **(T-1)** Machine guards and safeties will not be removed nor made inoperative except for authorized maintenance. **(T-0)**

25.9.2.2. PPE will be worn while operating tools and machinery. **(T-0)** Refer to **Chapter 14** for additional guidance on required PPE.

25.9.2.3. General Power Tool Safety. Supervisors will ensure compliance with equipment manufacturer's instructions as well as guidance provided in Chapter **11**, **29** CFR §§ 1910, Subpart O – *Machinery and Machine Guarding,* Subpart P – *Hand and Portable Powered Tools and Other Hand-Held Equipment,* 29 CFR § 1926 Subpart I – *Tools – Hand and Power,* and TO 32-1-101 for both carpentry and structural maintenance work methods or tools. **(T-0)**

25.9.3. Ventilation Systems.

25.9.3.1. Ventilation and exhaust systems will be installed and maintained IAW the manufacturer's instructions. **(T-1)** Contact installation BE for specific guidance, including information on flow rate requirements.

25.9.3.2. Dust and refuse discharged from an exhaust system shall be disposed of in such a manner that it will not result in harmful exposure to employees. **(T-0)**

25.9.4. Storage and Handling of Lumber. Refer to 29 CFR § 1910.265(c)(27), *Lumber Piling and Storage,* for guidance.

25.9.5. Roofing Operations. Refer to AFI 32-1001 for guidance.

25.9.6. Masonry. Refer to 29 CFR §§ 1926, Subpart H, *Materials Handling, Storage, Use, and Disposal,* and Subpart Q, *Concrete and Masonry Construction,* OSHA 3221-12N 2004, *OSHA Pocket Guide for Concrete Manufacturing,* for additional guidance and ANSI/ASSP A10.9, *Safety Requirements for Concrete and Masonry Work,* for additional information.

25.10. Protective Coating Maintenance. Interior spray, airless, and electrostatic painting facilities and requirements are addressed in **Chapter 27.** Refer to **Chapter 14** for additional PPE information. Ventilated lockers for clothing and shower facilities will be provided and located separately from the office areas and breakroom. **(T-0)**

25.11. Plumbing Maintenance. Plumbing maintenance normally includes the installation, preventative maintenance, and repair of water supply systems, sewage and water disposal systems, natural, liquefied petroleum gas, 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. Refer to **Chapter 23** for permit-required confined space entry procedures and requirements.

25.11.1. Refer to **Chapter 14** for PPE guidance.

25.11.2. Hot Operations.

25.11.2.1. Torches and Furnaces. Work and storage areas for this equipment will be well ventilated. **(T-0)** Where flammable or explosive vapors or dust may be present, torches and furnaces will not be used until the atmosphere has been tested and the sources of such vapors or dust removed. **(T-1)** Refer to **Chapter 18, Chapter 20, Chapter 22,** and NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes,* for additional information.

25.11.2.2. Soldering and Brazing. Soldering and brazing is the joining of metal parts by melting a fusible alloy. When the solder used has a melting point above 800° F, the procedure is called brazing.

25.11.2.2.1. The concentration of toxic fumes and irritants at the breathing level of the operation will be checked. **(T-1)** Where required because of toxic fumes, a respirator or adequate ventilation will be provided. **(T-1)** Lead-tin, zinc, silver, cadmium, and antimony- tin solders can pose moderate to serious health hazards. If welding, soldering and brazing operations have not previously been evaluated during the unit's OH Assessment, contact installation BE for a HRA.

25.11.2.2.2. Electric soldering irons will be grounded unless made of double-insulation construction. **(T-1)** All soldering irons will be placed in suitable non-combustible receptacles when not in use. **(T-1)**

25.11.2.2.3. When required, a DAF Form 592 will be obtained for these operations. **(T-1)** Refer to **Chapter 27** for additional information.

25.11.3. Gas Systems. Maintenance of gas systems includes natural gas, liquefied petroleum gas, oxygen, nitrogen, or nitrous oxide. Shop personnel will be familiar with the properties of

gases in the systems they maintain. **(T-1)** Personnel entering the area will use PPE and respiratory protective devices. **(T-1)** Consult with the occupational safety office and installation BE with questions pertaining to PPE. Refer to **Chapter 14** for additional information.

25.11.4. Tunnels, Pits and Sumps. Where shop personnel are required to work in utility tunnels, pits, and sumps, the atmospheric conditions will be checked for explosive atmosphere or oxygen deficiency before allowing employees to enter. **(T-0)** Personnel will use proper protective equipment and respiratory protective devices while performing maintenance to underground utilities. **(T-0)** Consult with the occupational safety office and installation BE on questions pertaining to PPE and proper air quality testing. Refer to **Chapter 14** for information on PPE. All tunnels, pits or sumps known to contain contaminated materials will be appropriately signed and employees trained on the hazards. **(T-1)** Confined spaces determined to be permit required will be entered IAW **Chapter 23. (T-0)** When manhole covers are removed, barriers will be installed to prevent injury to personnel. **(T-0)**

25.12. Refrigeration and Air Conditioning Maintenance. Refer to DAFMAN 32-7002 for guidance.

25.13. Heating Systems and Central Heating Plant Maintenance. Refer to AFMAN 32-1068, *Heating Systems and Unfired Pressure Vessels,* for guidance.

25.14. Water and Wastewater Treatment. Refer to AFMAN 32-1067, *Water and Fuel Systems,* and DAFMAN 32-7002 for guidance.

25.15. Aircraft Arresting Systems. Personnel engaged in aircraft arresting systems operations and maintenance are exposed to several potential hazards, including exposure to flammable and combustible liquids and gases, and toxic and hazardous chemicals. Aircraft arresting systems personnel are exposed to physical injuries associated with aircraft arresting systems maintenance, and are also subject to noise, lifting hazards, and in underground facilities, permit-required confined space hazards (e.g., oxygen deficiency). Particular attention will be given to prevent exposure to hazardous noise levels since the effects of over-exposure are not always apparent immediately. **(T-1)** Potential physical and health hazards can be effective, by using the hierarchy of controls, e.g., elimination, substitution, engineering, administrative, and PPE. Refer to **Chapter 14**, TO 35E8-2-5-1, *Operation and Maintenance Aircraft Arresting System Mod BAK-12/E32A*, AFMAN 32-1040, *Civil Engineer Airfield Infrastructure Systems,* AFI 48-127, and FC 3-260-18F, *Air Force Aircraft Arresting Systems (AAS), Installation, Operation, and Maintenance,* for additional guidance.

25.16. Miscellaneous.

25.16.1. Mobile Cranes. A minimum of one person assigned to each 4FPET and 4FPAS Unit Type Code (UTC) will be qualified and certified within the respective Career Field Education and Training Plan. **(T-1)** Contact AFCEC for more information on operator certification, qualification, and currency training requirements. Refer to 29 CFR § 1926.1427, *Operator Training, Certification, and Evaluation,* and 29 CFR § 1926, Subpart CC – Appendix C, *Operator Certification—Written Examination—Technical Knowledge Criteria,* for minimum training requirements.

25.16.2. Dump Trucks. Dump truck operators will be trained IAW Air Force Qualification Training Package (QTP) 3E2X1-8 Earth Moving and Excavation Equipment. **(T-1)** This

course covers operational checks/maintenance, operations, and tailgate removal and installation. Members are required to complete the AFQTP and associated web-based training: Dump Truck Operator QTP and Dump Truck Tailgate Removal and Installation QTP. Additionally, there is a Dump Truck Training package for non-3E2s located at the Air Force e-Publications website.

Chapter 26

CRYOGENIC LIQUIDS

26.1. Specific Hazards. Follow manufacturer's instructions and applicable SDSs for proper handling, storage, dispensing and transporting of cryogenic liquids. The information contained within this chapter provides general guidance applicable to most cryogenic liquids.

26.1.1. Physical Hazards.

26.1.1.1. (LN_2 and LOX hazards are primarily associated with phase change and low temperature effects of cryogens. A tremendous volume increase occurs when either liquid undergoes a change from liquid to gas. When LN_2 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 cryogens may create a tremendous increase in pressure if liquid to gas conversion occurs, so a sealed container can burst explosively. Expansion on ratio of LN_2 can displace oxygen in an enclosed space, causing an asphyxiation hazard. Expansion of LOX can cause oxygen enrichment, producing fire and explosion hazards. See **paragraph 26.1.3** for additional information.

26.1.1.2. The cold temperature of LN_2 (-320° F) and LOX (-297° F) can alter the strength, ductility, thermal expansion, thermal conductivity, and heat capacity of materials. Mild carbon steel becomes brittle and failure-prone when exposed to cryogens. However, properly treated metals such as austenitic steels, nickel, aluminum, copper, and several alloys are safe for low temperature work.

26.1.1.3. LN_2 can liquefy oxygen from the air it contacts. Therefore, an open container of LN_2 will slowly condense air causing a LOX concentration buildup within the LN_2. The presence of LOX within LN_2 can cause unexpected chemical reactions with other materials. See paragraphs **26.1.3** and **26.1.4** for additional information on LOX reactivity with chemicals.

26.1.1.4. Nitrogen and Freon displace oxygen in air and will be handled carefully in poorly ventilated or confined spaces to minimize the potential for asphyxiation. **(T-1)** Freon is a fluorocarbon and requires stringent environmental controls IAW local procedures. Refer to TO 42B-5-1-2 for general safety guidance and requirements for compressed gases.

26.1.1.5. Liquid Hydrogen (LH_2). Hydrogen's flammability range is very wide (between 4 percent and 75 percent in air), compared to other gases. Under optimal combustion conditions (29 percent hydrogen-to-air volume ratio), the energy required to initiate hydrogen combustion is much lower than that required for other common fuels, e.g., a small spark will ignite it). However, low concentrations of hydrogen in air, the energy required to initiate combustion is similar to that of other fuels. Liquid hydrogen has different characteristics and different potential hazards than gaseous hydrogen, so different control measures are used to ensure safety. As a liquid, hydrogen is stored at -423° F, a temperature that can cause cryogenic burns or lung damage. Detection sensors and PPE are critical when dealing with a potential LH_2 leak or spill. Refer to 29 CFR § 1910.103, *Hydrogen,* for guidance.

26.1.1.6. Liquefied Natural Gas (LNG). LNG is natural gas (predominantly methane [CH4], with some mixture of ethane [C2H6]) that has been cooled down to liquid form for

ease and safety of non-pressurized storage or transport. It takes up about 1/600th the volume of natural gas in the gaseous state (at standard conditions for temperature and pressure). It is odorless, colorless, non-toxic, and non-corrosive. Hazards include flammability after vaporization into a gaseous state, freezing, and asphyxia. The liquefaction process involves removal of certain components, such as dust, acid gases, helium, water, and heavy hydrocarbons, which could cause difficulty downstream. The natural gas is then condensed into a liquid at close to atmospheric pressure by cooling it to approximately -162^{o} C (-260^{o} F) and maximum transport pressure is set at around 25 kPa (4 psi).

26.1.1.7. Incompatible materials will not be stored in close proximity to each other to prevent dangerous interactions. **(T-1)**

26.1.2. Physiological Hazards.

26.1.2.1. Evaporation of LN_2 in a poorly ventilated or unventilated enclosure may reduce the oxygen content of the air and lead to asphyxiation and death. Because the brain requires at least 19.5 percent oxygen to operate normally, 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.

26.1.2.2. The extremely cold temperature of LN_2 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_2 and LOX and will freeze to the skin on contact. Flesh can be badly burned and severely torn in any attempt to free it, which must be done immediately since the results of prolonged skin contact are worse than immediate removal.

26.1.2.3. LH_2 is a flammable liquefied gas that is extremely cold and forms explosive mixtures with air, and will condense moisture in the atmosphere, producing a vapor cloud. Avoid contact with cold liquid, vapor, or frosty condensation. LH_2 can freeze air, oxygen, and other gases. Contact with liquid or solid gases can cause severe frostbite, a burn-like injury. Flammable gas may spread from leaks. In the event of a suspected leak, evacuate immediately and make notifications per local emergency procedures. **(T-1)**

26.1.2.4. LNG is normally stored and transported in liquid form at a temperature of approximately -162^{o}C (-260^{o} F). If this cooled liquid is released from a storage facility, pipeline, or LNG transport ship, it begins to warm. As LNG warms above its storage temperature, the liquid begins to vaporize. The resulting gas produced by this warming is typically methane, which is the major component of natural gas and one of the most potent and hazardous greenhouse gases.

26.1.3. LOX Chemical Hazards.

26.1.3.1. 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.

26.1.3.2. 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 contact hydrocarbon materials when leaked or spilled, including all areas where LOX might flow after a spill. **(T-0)** 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.

26.1.4. Solvents and Chemical Hazards. Some solvents and chemicals used for LN_2 and LOX production and storage cause skin irritation or burns and can be absorbed through the skin. It may also cause liver damage and be poisonous if taken internally. Wear appropriate PPE when handling these chemicals IAW **Chapter 14**. **(T-0)**

26.1.5. Spill Hazards. LN_2 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 *Pocket Guide to Chemical Hazards* (**www.cdc.gov/NIOSH/npg/**) for additional information on handling cryogenic spills.

26.2. General Requirements.

26.2.1. Characteristics and Production of LN_2 and LOX.

26.2.1.1. Liquid Nitrogen. LN_2 is a colorless, odorless, nonflammable, nontoxic, and chemically inactive water-like fluid with a boiling point of -320° Fahrenheit (F). LN_2, less dense than water, weighs approximately 6.7 pounds per gallon. The expansion ratio for LN_2 (from LN_2 to gaseous nitrogen) is 695 to 1 at normal temperature and pressure. The critical temperature of LN_2 is -233° F at 493 pounds per square inch absolute. At temperatures higher than this, LN_2 cannot be liquefied regardless of pressure.

26.2.1.2. 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 per square inch absolute. At temperatures higher than this, LOX cannot be liquefied regardless of pressure. LOX is attracted to an electromagnet much like iron and will combine readily with other substances to actively support combustion.

26.2.2. 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 from the LN_2 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 in a cabinet at the front end of the tank. Storage tanks are manufactured in various sizes and will be certified by the manufacturer to be designed and constructed IAW ASME *Boiler and Pressure Vessel Code.* **(T-0)** Safety relief valves will be installed so moisture cannot collect, freeze, and interfere with proper operation of the valves. **(T-0)** Frangible disks will also be included in the design of pressurized tanks. **(T-0) Note**: Tanks operating at atmospheric pressure do not require pressure relief devices if adequately vented. Refer to 29 CFR § 1910.104, *Oxygen*, for additional guidance.

26.2.3. Characteristics of LH_2 and LNG.

26.2.3.1. Liquid Hydrogen. LH_2 is in a fully liquid state at an atmospheric pressure of 20.28K (-252.87° C or -423.17° F). It requires cryogenic storage technology, such as special thermally insulated containers and requires special handling common to all cryogenic fuels. This is like, but more severe than LOX. Even with thermally insulated containers, it is difficult to keep LH_2 low temperatures, and the hydrogen may gradually leak away (typically at a rate of 1% per day). It also shares many of the same safety issues as other forms of hydrogen, as well as being cold enough to liquefy, or even solidify atmospheric oxygen, which can be an explosion hazard.

26.2.3.2. Liquefied Natural Gas. LNG is condensed into a liquid at close to atmospheric pressure by cooling it to approximately -162° C (-260° F) for shipping and storage. LNG is normally warmed to make natural gas used in heating and cooking as well as electricity generation and other industrial uses. LNG can also be kept as a liquid to be used as an alternative transportation fuel. LNG is often regarded as extremely dangerous and toxic. LNG vapors are flammable and present safety hazards that must be managed, but those hazards are substantially less than for gasoline, diesel, and other liquid fuels.

26.3. Cryogenic Storage Facility Siting.

26.3.1. Safe Distance Criteria. The special hazards associated with LN_2, and LOX require care in siting these facilities. Storage facilities of 100 gallons or more will conform to the following minimum separation distances. **(T-0)** Refer to UFC 3-600-01 and TO 00-25-172. IAW DESR 6055.09_DAFMAN 91-201, if the cryogen is used as a propellant and/or fuel, the most stringent distance will apply.

26.3.1.1. Stationary Cryogenic Containers, Cylinders, and Tanks. Stationary containers located outdoors will be separated from exposure hazards IAW the minimum separation distances. **(T-0)** Refer to NFPA 55 for additional guidance.

26.3.1.2. Bulk oxygen systems (100 gallons or more) located outdoors will be separated from exposure hazards. **(T-0)**

26.3.2. Facility Requirements.

26.3.2.1. Security fencing and lighting will be IAW DAFI 23-201, *Fuels Management*. **(T-0)**

26.3.2.2. LOX storage facilities will be permanently placarded to indicate "OXYGEN—NO SMOKING—NO OPEN FLAMES" or an equivalent warning. **(T-0)**

26.3.2.3. Notify installation CE prior to installation, modification, or repair of utility services (water, electricity, sewage, telephone).

26.3.2.4. Joint sealer will be LOX-compatible in LOX handling and storage areas (where spills are most likely to occur). **(T-0)** This area will cover a 25-foot radius (minimum) from the LOX cart fill point during servicing. The LOX handling and storage tank area will be concrete (where spills are most likely to occur). **(T-1)** Refer to DAFI 23-201 for additional guidance.

26.3.2.5. A paved road will be provided to and from the facility for delivery, maintenance, and emergency vehicles. **(T-1)** Refer to DAFI 23-201 for additional guidance.

26.3.2.6. Storage and servicing tanks will have adequate grounding points. **(T-1)** Refer to DAFI 23-201 for additional guidance.

26.4. Occupational Health.

26.4.1. Solvents and Chemicals. Refer to paragraphs **26.1.3** and **26.1.4** for hazards of chemicals used in LN_2 and LOX storage area. Installation BE's OH Assessment identifies recommended controls to the organization.

26.4.2. 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_2 or LOX. Keep the victim warm and dry by wrapping exposed areas in a blanket. No attempt to re-warm frozen body parts will be made until the victim is under proper medical care. **(T-1)** Affected parts will not be rubbed because the tissues may be damaged. **(T-1)** Clothing that may restrict circulation to the frozen area will be loosened or removed. **(T-1)** 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 will be done only by medical services personnel. **(T-1)**

26.5. Safety Precautions When Working with LN_2, LOX, LH_2 and LNG.

26.5.1. PPE for LN_2 or LOX. PPE is of two distinct types — cryogenic and chemical protection; and may not be interchangeable. Supervisors will develop procedures to prevent hydrocarbon or chemical contaminated PPE from being used during cryogen transfers. **(T-1)**

26.5.1.1. Personnel handling or transferring LN_2 or LOX will follow PPE requirements in **paragraph 26.5.5** and **Chapter 14**. **(T-0)** Non-absorbent long sleeves will extend to the gloves. **(T-0)** Cuff-less trousers will be worn outside leather boots or over high-top leather shoes to shed spilled liquid. **(T-0)** Installation BE-approved foot protection will have no mesh sides or air holes and will be tightly laced to prevent spilled cryogen seeping inside. **(T-0)** Only tightly woven materials will be worn during LN_2 or LOX operations. **(T-0)** A face shield, eye protection (safety goggles or safety glasses with side shields), and apron (leather or other installation BE-approved) will be worn. **(T-0)**

26.5.1.2. When transferring LN2/LOX, personnel will wear protective footwear IAW **paragraph 26.5.5.1.11**.

26.5.1.3. LN_2 and LOX both can saturate clothing. Such contact holds the LN_2/LOX against the skin and may be more hazardous than a direct splash. Remove contaminated clothing, hang and air dry for at least one hour. **(T-1)**

26.5.1.4. LH_2 is a hazard for cold injuries due to its cold temperature. LH_2 should be kept away from heat or flames due to its flammability unless ignition is intended. **Note:** LH_2 burns with an invisible flame.

26.5.1.5. LNG is not explosive and cannot ignite. For LNG to burn, it must first vaporize, then mix with air in the proper proportions (the flammable range is 5 to 15 percent by volume), and then be ignited. In the case of a leak, LNG vaporizes rapidly, turning into a gas (methane plus trace gases), and mixing with air. If this mixture is within the flammable range, there is a risk of ignition, which would create fire and thermal radiation hazards.

26.5.2. Low Temperature Precautions.

26.5.2.1. Avoid splashing on exposed skin. Cryogenics burn on contact.

26.5.2.2. 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.

26.5.2.3. Assume all surfaces are cold until proven otherwise. External frost may not always be present.

26.5.3. Equipment and Materials Precautions.

26.5.3.1. Most metal becomes very brittle at cryogenic temperatures and will shatter or crack under stress.

26.5.3.2. 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.

26.5.3.3. Most glass and some plastics will shatter on contact with LN_2 or LOX due to thermal stress.

26.5.4. Asphyxiation Prevention.

26.5.4.1. Small amounts of liquid generate large amounts of gas. Avoid using cryogenics in small unventilated rooms.

26.5.4.2. LN_2, 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.

26.5.4.3. LH_2 is biologically inert and, as a vapor, displaces oxygen and results in asphyxiation.

26.5.5. LOX/LN_2 Transfers.

26.5.5.1. When transferring LOX, personnel will wear the following PPE (all items will be clean and free of grease, oil, and fuel):

26.5.5.1.1. Head covering. **(T-0)**

26.5.5.1.2. Eye protection (goggles). **(T-0)**

26.5.5.1.3. Face shield or locally purchased hard hat face shield combination. **(T-0)** **Note**: Face shield is secondary eye protection and must be worn in conjunction with primary eye protection (goggles). **(T-0)**

26.5.5.1.4. Gloves (loose fitting), leather, welder's gauntlet cuff, medium with gloves, cloth, work, cotton knit, medium as an insert; or

26.5.5.1.5. Gloves (loose fitting), leather with glove inserts, wool, or other installation BE-approved hand protection. **(T-0)**

26.5.5.1.6. Apron. **(T-0)**

26.5.5.1.7. Coveralls, cotton white (mandatory). **(T-0)**

26.5.5.1.8. Cuff-less trousers. **(T-0)**

26.5.5.1.9. Long sleeve shirt. **(T-0)**

26.5.5.1.10. Jacket (optional).

26.5.5.1.11. Foot protection, which fits closely around the top, with rubber soles and heels. **(T-0)** Boots, shoes, or other installation BE-approved foot protection will have no mesh sides or air holes and will be tightly laced to prevent spilled cryogen seeping inside. **(T-0) Note:** A leather boot approximately eight inches in height with close fitting top and rubber soles and heel is recommended, since LOX spills expose an employee's foot to a freeze burn hazard. **(T-0)**

26.5.6. Oxygen Carts. Oxygen carts will be kept clean and free of moisture, oil, and grease. **(T-1)** Oxygen carts will not be parked in grassy, sodded, or asphalt-covered areas nor exposed to extreme weather conditions, or allowed to accumulate ice or snow. Gaseous oxygen (GOX) carts will not be parked in direct sunlight. LOX carts will not be parked in hangars, nose docks, or shelters unless designed or modified for this purpose. LOX carts will be transported with vent valve closed and parked with vent valve open. **(T-1)** IAW TO 00-25-172, cylinders should be isolated from any incompatible or combustible material storage by a barrier of noncombustible material at least five feet high that has a minimum fire resistance rating of 30 minutes; 50 feet from any combustible structure or sources of ignition, such as heavy traffic areas, areas where equipment is in operation and smoking areas; and 75 feet from parked aircraft and 25 feet from fuel servicing safety zones. Refer to TO 00-25-172, TO 42B5-1-2 and applicable aircraft TOs for more information on gaseous oxygen and LOX handling, servicing, and storage.

26.6. Fire Prevention and Protection.

26.6.1. 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.

26.6.2. 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.

26.6.3. Static electricity may ignite combustible materials in an oxygen-rich atmosphere. Employees will wear only approved clothing and will ground themselves before beginning LOX operations. **(T-0)**

26.6.4. Never use LOX for cooling people, parts, equipment, or food.

26.6.5. Avoid open containers of LN_2. Although inert, LN_2 is colder than LOX. It liquefies oxygen from the surrounding air and, therefore, an open container of LN_2 will slowly condense oxygen from the air causing a LOX concentration buildup within the LN_2. When the LN_2 is

pale blue in color, there is LOX present in the mixture. LOX contamination can cause unexpected chemical reactions with other materials.

26.6.6. Consult F&ES Flight on fire protection and compatible firefighting agents for LN_2 and LOX production and storage facilities. Both LN_2 and LOX create the risk of severe damage to unprotected skin and eyes of occupants and first responders. LN_2 (nitrogen) will not support combustion but will displace oxygen and create a risk of asphyxiation to personnel. LOX (oxygen) is a vigorous oxidizing agent and supports combustion of many materials not usually flammable in air. 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. **(T-1)** A LOX fire cannot be extinguished with carbon dioxide (CO_2), dry chemicals 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. Firefighting agents appropriate for the combustible materials can be employed once the hazards of LN_2 and LOX are mitigated.

26.6.7. Always maintain a clear and unobstructed access to and from LN_2 and LOX facilities for firefighting equipment. **(T-1)**

26.6.8. Do not permit LOX to come in contact with organic material or flammable substances. Some materials react violently with oxygen under certain atmospheric conditions. 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.

26.6.9. LH_2 leaks evaporate quickly because of its low boiling point, rising in the atmosphere due to its low density in comparison to normal air. Combustion products of LH_2 are non-toxic.

26.6.10. LNG vapors are extremely flammable and can be ignited by heat, sparks, flames, static electricity, and other sources of ignition, such as pilot lights, mechanical/electrical equipment, and electronic devices that are not intrinsically safe. Vapors may travel considerable distances to a source of ignition where they can ignite, flash back, or explode. Vapors may accumulate in confined spaces. High concentrations of LNG vapors may displace oxygen, especially in a confined space. LNG and its vapors do not exhibit the characteristic odor of natural gas. Containers of LNG are typically under pressure and temperature-controlled conditions, containers may explode if heated or if temperature control is not maintained.

26.7. Electrical Safety. LN_2 and LOX tank support equipment may require electrical service up to 480 volts alternating current. Use 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. Always ground LN_2 and LOX storage tanks. **(T-0)** Personnel must be arc flash and CPR trained prior to performing duties on electrical systems. **(T-0)**

26.8. Housekeeping.

26.8.1. 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 will be kept clean and free of all hydrocarbons. **(T-1)**

26.8.2. Dirty tools and equipment are sources of hydrocarbon contamination. All tools and equipment used with oxygen components and systems will be kept clean and properly stored. **(T-1)**

26.8.3. Store LH_2 IAW manufacturer's instructions or other applicable safety guidance. Store in a segregated and approved area. Ensure the area is dry, cool, and well-ventilated, and away from incompatible materials. Eliminate all ignition sources. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52° C (125° F). Keep containers tightly closed and sealed until ready for use.

26.8.4. When handling LNG, wear all PPE as identified by installation BE to prevent contact of material with eyes, skin, or clothing. Handle only with adequate ventilation and do not breathe LNG vapors. Eliminate all sources of ignition, such as flames, sparks (including from internal combustion engines) or high temperatures when working in areas where vapors may be present. Ground and bond all lines to avoid static discharge buildup when transferring product, e.g., truck loading/unloading. Use non-sparking tools when working around LNG transfer lines and equipment. Electrical equipment used in UL-listed Class I, Division I, Group D hazardous locations will be rated and marked with UL-certification for use in that location. Do not use cell phones in an area where LNG is stored or transferred. Polyester clothing may cause static discharge and must not be worn at LNG locations. Avoid cold burns from transfer lines or process equipment.

26.9. Receipt, Storage and Issue of LN_2 or LOX.

26.9.1. Due to the catastrophic consequences of mixing LN_2 and LOX in storage tanks and carts, employees will exercise care in verifying the correct product is transferred to the correct storage tank or cart. **(T-1)** Refer to TO 42B6-1-1, *Quality Control Aviators Breathing Oxygen and Aviators Gaseous Breathing Oxygen*, and TO 42B7-3-1-1, *Quality Control of Nitrogen*, for detailed procedures.

26.9.1.1. Fittings specifically designed for LOX will be used. No adapters will be allowed. **(T-1)**

26.9.1.2. Fittings specifically designed for LN2 will be used. No adapters will be allowed. **(T-1)**

26.9.2. At least two trained employees, knowledgeable in applicable safety criteria and operational procedures, will be within normal voice or eye contact when generating or transferring cryogenic fluids. **(T-1)** This also applies to maintenance actions on cryotainers or production and storage facilities where cryogenic fluids are present in the system. Personnel requirements for aircraft servicing operations will be IAW TO 00-25-172. **(T-1)**

26.9.3. All transfers of LN_2 and LOX will be closely monitored to minimize the extent of spills or leaks. **(T-1)** The use of drip pans is required. **(T-1)** Asphyxiation or oxygen enrichment hazards will exist if a spill occurs within a building or confined space. Appropriate local emergency procedures will be developed for this contingency. **(T-1)**

26.10. Common Cryogenic Liquids, Their Properties, and Precautions.

26.10.1. While LOX and LN_2 are widely used cryogens, other cryogens are also used within the DAF, such as LH_2 and LNG. As with LOX and LN_2, 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.

26.10.2. Liquefied carbon dioxide (CO_2) does not meet the definition for a cryogen, at minus 70.6° F (minus 57° C) it is cold and can burn exposed skin. It will be treated as a cryogen. **(T-1)**

26.10.3. Employees will read the SDS and safety precautions for all cryogens used. **(T-0)**

26.10.4. Use of Cryogenic Liquids.

26.10.4.1. 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.

26.10.4.2. Skin or eye contact with cryogenic liquids, cold equipment, and materials used in conjunction with cryogens, 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.

26.10.4.3. Installation BE's HRA of the cryogenic liquid work processes identify hazards and recommend controls. Typical PPE for work with cryogenic liquids includes safety goggles, insulated gloves, apron, face shield and leather boots. Gloves should be loose enough to easily toss off in the event spilled cryogens enter the gloves. Supervisors will review SDSs as well as contact installation BE for proper PPE. **(T-0)**

26.10.4.3.1. Wear a long sleeve shirt and cuffless pants. **(T-0)** Pants will be worn over the tops of boots. **(T-0)**

26.10.4.3.2. Wear foot protection IAW **paragraph 26.5.5.1.11** or other installation BE-approved foot protection. **(T-0)**

26.10.4.3.3. Do not wear jewelry or other materials that could trap spilled liquid against the skin.

26.10.4.3.4. Stay out of cryogen vapor pathway. **(T-1)**

26.10.4.3.5. Always use tongs when handling objects in liquid. **(T-1)**

26.10.4.3.6. Only use materials approved for use with cryogens. **(T-0)** Unapproved materials such as plastic, rubber, wrought iron, and carbon steel will become brittle and shatter. (Chemical ensemble vinyl over-boots will not be worn while handling cryogens, except when threat of chemical/biological threat exists, as determined by the organization commander.)

26.10.4.3.7. Periodically inspect equipment and remove ice and frost blockages from openings to prevent over pressurization. **(T-1)**

26.10.4.3.8. Do not tamper with pressure relief valves. Report any leaky or improperly set relief valves to maintenance personnel or the manufacturer. **(T-1)**

26.10.4.3.9. Keep equipment clean without using corrosive cleaning materials that could damage the metal jacket. **(T-1)**

26.10.5. Dispensing and Transport of Cryogenic Liquids. Follow manufacturer's instructions and SDSs for proper handling, storage, dispensing, and transporting of cryogenic liquids.

26.10.5.1. Precautions will be taken to prevent spills while dispensing or transporting cryogens and minimize exposure to liquids and vapors. **(T-1)** The high liquid to vapor expansion ratio can rapidly displace all oxygen in a room and result in asphyxiation. Personnel using cryogens will:

26.10.5.1.1. Wear proper PPE when dispensing or transferring cryogenic liquids. **(T-0)**

26.10.5.1.2. Add a small amount of cryogenic liquid to cool the secondary container prior to receiving liquid from a large dispensing dewar or cylinder. **(T-1)** Dispense slowly to mitigate thermal stress and prevent splashing. **(T-1)** 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.

26.10.5.1.3. Ensure the secondary container is secured when manually pouring liquid into a smaller dewar. **(T-1)** 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.

26.10.5.2. Additional Precautions.

26.10.5.2.1. Two personnel will transport cryogenic liquids indoors. **(T-1)** Use handcarts equipped with brakes to transport large dewars and cylinders. **(T-1)** Avoid traveling in an elevator with a dewar. For buildings with multiple floors, take necessary steps to prevent people from traveling in the elevator with the unattended cylinder/dewar. **(T-1)** Spills or elevator failures may be dangerous in this restricted space as oxygen could be displaced if the cylinder failed or leaked. Prior to transport, signage will be placed on each floor stating a dewar is not to be accompanied during transport on the elevator. **(T-1)**

26.10.5.2.2. Personnel will use care when handling full dewars. **(T-1)** Damage to dewars could cause loss of vacuum, increased evaporation, or leaks.

26.10.5.2.3. Personnel will wear PPE when carrying a dewar and hold the dewar as far away from the face as possible. **(T-0)** Containers that cannot be easily and safely carried will be placed on a stable wheeled cart designed for the dewar. **(T-0)**

26.10.5.2.4. One person transporting LOX and LN2 carts to the flightline is acceptable if carts are equipped with a pintle hook and towed behind a vehicle.

26.10.6. Storage of Cryogenic Liquids. Unsealed cryogenic liquid storage containers, leaking containers, or a catastrophic failure of a storage container could create an oxygen deficient atmosphere. To reduce the likelihood of this occurring, users will ensure:

26.10.6.1. Glass dewars have an exterior coating/cover/plastic mesh to minimize projectiles if an explosion occurs. **(T-1)**

26.10.6.2. Size the ventilation system for dewars storage to supply and exhaust a minimum of six room volumes per hour. **(T-1)** If the ventilation rate is unknown, contact installation 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.

26.10.6.3. Cryogenic liquids will not be stored with corrosive or flammable chemicals. **(T-1)**

26.10.6.4. Dewars are placed so vents and openings are positioned away from personnel and lab equipment. **(T-1)**

26.10.6.5. Bulk cryogenic storage and dispensing facilities follow the siting process in **paragraph 26.3**. **(T-1)**

26.10.6.6. Bulk cryogenic liquid dispensing areas within buildings will be well ventilated. **(T-0)** Consult installation BE for recommended continuous oxygen monitoring equipment. All new installations will be designed with an oxygen monitoring system and alarm. **(T-0)**

26.10.6.7. Cryogenic dewars will not be stored in hallways, unventilated closets, environmental rooms, or stairwells. **(T-0)**

26.10.7. 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:

26.10.7.1. Supervisors will contact installation BE to assess cryogen engineering and work practice controls. **(T-1)**

26.10.7.2. Keep all combustible materials away from flammable liquids and oxygen. **(T-1)**

26.10.7.3. Supervisors will ensure “No Smoking” signs are posted, and no sources of ignition are present. **(T-1)**

26.10.7.4. Ensure oxygen dewars and equipment are kept clean as surface contamination can ignite if oxygen leaks from the dewar. **(T-1)**

26.10.7.5. Ensure stationary equipment is properly grounded and mobile equipment is properly bonded when dispensing cryogens. **(T-1)**

26.10.7.6. Ensure valve operation is performed slowly to prevent ignition of contaminants in the system.

26.10.7.7. Ensure flammable gas venting is independent from other ventilation systems and a nitrogen purge is used when needed.

26.10.8. Emergency Procedures.

26.10.8.1. 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 F&ES Flight and installation BE immediately if ice blockages occur.

26.10.8.2. If a spill occurs, immediately exit the area, and contact F&ES Flight to monitor oxygen levels in the area and determine when it is safe to re-enter.

26.10.8.3. If experiencing symptoms such as lightheadedness, dizziness, or confusion, immediately seek fresh air and medical attention.

26.10.8.4. An unconscious employee in a cryogenic liquid storage area will only be retrieved by personnel using a self-contained breathing apparatus. **(T-1)** Once the person is relocated to fresh air, provide rescue breathing or CPR until paramedics arrive.

26.10.8.5. If eyes or skin comes in contact with cryogenic liquid or gases, follow first aid procedures, then immediately seek medical attention. Refer to **paragraph 26.4.3** for additional guidance.

26.10.8.5.1. 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.

26.10.8.5.2. Do not apply dry heat or rub damaged flesh or eyes.

26.10.8.5.3. Seek treatment at the nearest medical treatment facility.

26.10.8.5.4. Employees will notify their supervisor of injuries.

Chapter 27

INTERIOR SPRAY FINISHING

27.1. Scope. Painting, doping, and paint removal hazards include exposure to toxic materials and flammable or explosive mists, aerosols, 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. Three of the more toxic pigment ingredients are lead, antimony and chromates. Their use should be avoided. Refer to **Chapter 2** of this instruction, 29 CFR § 1910.107, *Spray Finishing Using Flammable and Combustible Materials,* AFI 90-821, and installation BE OH Assessment for additional guidance and information.

27.2. Safety.

27.2.1. Functional managers will ensure spray painting operations are closely supervised and equipment is maintained in serviceable condition. **(T-0)**

27.2.2. Painter's ladders, scaffolds, lifelines, and other equipment will be inspected prior to use to ensure all equipment is in a safe condition. **(T-0)** Refer to Chapters **7** and **13** for additional guidance and information. Powered industrial trucks, man lifts, and other aerospace ground equipment will meet the requirements of Chapter **12** and **29** CFR § 1910.178, *Powered Industrial Trucks*, for Class I, Division I locations. **(T-0)**

27.2.3. Paint Mixing. Paint or dope mixing will be performed in designated areas, which will be adequately ventilated rooms constructed of fire-resistant materials. **(T-0)** The mixing of paint may be accomplished outdoors with approval from the installation CE. Otherwise, paint will only be mixed in a covered, dust-controlled area and will not exceed local air emission standards. **(T-0)** All sources of ignition will be prohibited in mixing areas. **(T-0)** All electrical fixtures or equipment within 20 feet of designated paint preparation areas will meet the requirements of NFPA 70 for Class 1, Division 1 locations. **(T-0)** Mixing rooms will have spill control and cleanup measures in place for cleaning up large and small spills. **(T-0)**

27.2.4. 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 will be cleaned up promptly. **(T-0)** Work clothing will be stored in metal lockers that are vented at top and bottom. **(T-0)** Street clothing and protective clothing will be kept in separate lockers. **(T-0)**

27.2.5. Paint rooms, booths, etc., will be kept clean with equipment stored in a proper and orderly manner. Rags or waste soiled with sprayed materials will be deposited in approved self-closing metal waste containers immediately after use. **(T-0)**

27.2.6. IAW 29 CFR § 1910.107(g)(3), *Residue Disposal,* the contents of waste containers will be disposed of at the end of each shift or at least once daily. **(T-0)**

27.2.7. Contact installation CE for waste disposal guidance. Paint stored in workshops will be kept in tightly covered metal containers and meet the requirements of **Chapter 22**. **(T-0)**

27.2.8. Personal Protective Equipment. Personnel engaged in painting and paint removal will wear protective clothing, respiratory devices (if required) and appropriate face, eye, and hand protection. **(T-0)** Clothing will be changed, as needed, to minimize body contamination and

reduce the fire hazard. **(T-0)** Personnel engaged in the application of dopes and paints will wear an apron or equivalent protection impervious to paints, solvents, and dopes. **(T-0)** These aprons and clothing will be kept clean and, when not in use, hung in ventilated metal lockers. **(T-0)** Refer to **Chapter 14** for additional guidance.

27.2.9. Eye Protection. Personnel using abrasive techniques to prepare surfaces for painting will wear suitable eye protection to protect their eyes from chips and flying particles. **(T-0)** Eye protection and rubber gloves will be worn when using acids, lye, or noxious cleaning materials. **(T-0)** Refer to **Chapter 14** for additional guidance.

27.2.10. Respiratory Protection. Installation BE will conduct an HRA during the unit's OH Assessment and determine respiratory protection requirements. Paints containing epoxy or polyurethanes can cause respiratory sensitization. Respiratory sensitization results from an allergic reaction to a given substance and 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 sensitizing material can produce a severe reaction. Refer to **Chapter 14** for additional guidance.

27.3. Health/Environmental Protection.

27.3.1. Radioactive Luminous Paint. This paint presents a potential health hazard and will not be used without approval of the IRSO (usually assigned to installation BE). **(T-0)** Refer to AFMAN 40-201, *Radioactive Materials (RAM) Management,* for additional guidance.

27.3.2. Protective Creams. Hand protective creams are available and may be used by employees 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 installation BE's OH Assessment for additional guidance.

27.3.3. Personal Hygiene. IAW 29 CFR § 1910.134(g)(1)(i)(A), personnel required to wear tight fitting respiratory protection will be clean shaven so facial hair will not interfere with the face- piece seal of the respirator. **(T-0)** Employees will keep hands and face clean, clothes will be changed when contaminated, and hands and soiled objects will be kept out of the mouth. **(T-0)** No food or drink will be brought into or consumed in paint and dope shops. **(T-0)** Employees will wash their hands prior to smoking or consuming food outside the work area. **(T-0)**

27.3.4. 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 will be disposed of IAW DAFMAN 32-7002, and as specified and approved by the installation CE. **(T-0)**

27.4. Fire Prevention.

27.4.1. Fire Prevention. Painting operations may pose fire hazards, e.g., paint removal, solvent wipe, and paint application by means of spray apparatus. Refer to **Chapter 6,** NFPA 10, *Standard for Portable Fire Extinguishers*, NFPA 13, and NFPA 33, *Spray Applications Using Flammable and Combustible Materials*, for additional guidance.

27.4.2. Paints. Certain paints, lacquers, dopes, varnishes, shellacs, solvents, thinners, and distillates are very flammable. Other paints, under certain conditions, will burn energetically.

These paints, for control purposes, are classified as flammable, unless specifically stated by the manufacture as being combustible.

27.4.3. Paint Remover. Paint removers are corrosive and are considered flammable or combustible based on their flash point. They contain volatile ingredients and the residue after evaporation may also be flammable or combustible.

27.4.4. Solvents. Solvent materials used for residual cleanup, after the initial removal, have a flashpoint of 140° F or above. Cleaning operations using flammable or combustible solvents will be conducted inside spray areas with ventilating equipment operating. **(T-0)**

27.4.5. Methyl Ethyl Ketone. Methyl ethyl ketone is extremely flammable with a flashpoint of 21° F. At normal working temperatures, methyl ethyl ketone presents a constant fire hazard. Use caution to ensure there are no ignition sources in the area and ventilation is adequate to remove flammable vapors. Employees will use approved respiratory protection IAW AFI 48-137 and minimize skin contact. **(T-1)**

27.4.6. Storage. Paints and solvents will be stored IAW **Chapter 22**. **(T-0)**

27.4.7. 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 will be handled carefully, and precautions are in order even for those having higher flashpoints. **(T-0)**

27.4.8. Housekeeping. Solvent or paint-soiled rags, paper towels, and kraft paper can produce spontaneous ignition. Contaminated materials will be removed and placed in approved self-closing metal containers plainly marked to indicate the contents. **(T-0)** At the end of each shift or at least once daily, these containers will be emptied or removed to an approved location outside the shop for pickup and disposal. **(T-0)** Contact installation CE for waste disposal guidance. Refer to 29 CFR § 1910.107(g)(3) for additional guidance.

27.4.9. Sprinklers. Fire suppression sprinklers installed in spray finishing areas will conform to NFPA 13. **(T-0)** 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.

27.4.10. Extinguishers. Portable fire extinguishers will be installed near all paint spraying areas. Refer to **Chapter 6** for additional guidance. **(T-0)**

27.5. Ventilation Systems.

27.5.1. Ventilation. Each spray area will be provided with mechanical ventilation capable of confining, controlling and/or removing vapors, mists, and combustible residues, dusts, and deposits. **(T-0)** Mechanical ventilation will 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. **(T-0)** An adequate supply of makeup air, e.g., fresh outside air flowing through a building via ventilating (heating or cooling) equipment, will be provided. **(T-0)** Consult installation BE for questions concerning makeup air requirements. **(T-0)** Ventilation and exhaust systems will 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*

Particulate Solids. **(T-0)** Refer to' ACGIH *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance,* for additional information.

27.5.2. Exhaust and Ventilation Units. The rotating elements of the exhaust fan will be of nonferrous materials, or the fan will be constructed so that a shift of the impeller or shaft will not permit two ferrous parts to rub or strike together. **(T-0)** There will be ample clearance between the rotating element and fan casing to avoid a fire caused by friction. **(T-0)** Necessary allowances will be made for ordinary expansion and loading, and to prevent contact between moving parts and the duct or fan housing. **(T-0)** Fan blades will be mounted on a shaft rigid enough to maintain alignment when the fan is operating under full load. **(T-0)** All bearings will be of the self-lubricating type or will be lubricated from a point outside the duct and, preferably, will be located outside the duct and the booth. **(T-0)** Refer to NFPA 30 and NFPA 91 for additional guidance**.**

27.5.3. Exhaust Ducts. Exhaust ducts will be protected against mechanical damage, properly supported, and will normally have a separation of at least 18 inches from combustible materials. **(T-0)** Ducts will be periodically inspected for accumulation of paint deposits and will be cleaned as needed. **(T-0)**

27.5.4. Exhaust. Exhaust air from spray operations will be directed so it will not contaminate makeup air introduced into the spraying area or other ventilation intakes. **(T-0)** Unless the spray booth exhaust is from a water wash spray booth, the terminal discharge point will 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. **(T-0)**

27.5.5. Drying. Freshly sprayed articles will only be dried in spaces with adequate ventilation to prevent the accumulation of explosive vapors. **(T-0)** If adequate and reliable ventilation is not provided, such drying spaces will be considered as spraying areas. **(T-0)**

27.5.6. Motors. Unless approved for use in a flammable vapor/dust environment, electric motors driving exhaust fans will be placed outside of booths or ducts. **(T-0)** Drive belts will not enter the duct or booth unless the belt and pulley within the duct or booth are enclosed and guarded. **(T-0)**

27.5.7. Installation CE and BE will evaluate the design of new and upgraded ventilation and exhaust systems. **(T-1)** Installation BE will determine flow-rate requirements and periodic testing of new and existing systems using the most current edition of ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance.* **(T-0)**

27.6. Storage and Handling.

27.6.1. 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. **(T-0)** Storage in process areas will be no more than three approved flammable liquids storage cabinets in any single process area without the approval of the authority having jurisdiction. **(T-1)** Storage will be listed or designed and constructed to meet the requirements of NFPA 30. **(T-0)** Any single cabinet will contain a total of no more than120 gallons (454 liters) of Class I, Class II, or Class IIIA liquids. Only no more than 60 gallons (227 liters) will be Class I and Class II liquids. **(T-0)** Bulk storage of these liquids will be in a separate detached building or in rooms specifically designed and constructed to meet

flammable storage requirements, e.g., inside smaller paint booth installations. **(T-0)** Operations involving water-based latex paints are exempt from the above requirements. Refer to **Chapter 22** for additional guidance and information.

27.6.2. Containers. Flammable or combustible liquids brought into spray finishing rooms will be in original closed containers, approved portable tanks, approved safety cans, or by a properly arranged system of piping. **(T-0)** Containers will be marked IAW AFI 90-821. **(T-1)** Open or glass containers will not be used. **(T-0)**

27.6.3. Liquid Transfer. The withdrawal of liquids from containers and the filling of containers, including portable mixing tanks, will be done only in a mixing room or in a spraying area. **(T-0)** The ventilating system will be in operation. **(T-0)** Employees will take precautions to prevent liquid spillage. **(T-0)**

27.6.4. Grounding. Whenever flammable or combustible liquids are transferred from one container to another, both containers will be effectively bonded and grounded. **(T-0)** Piping systems used to transfer fluids will also be properly bonded and grounded. **(T-0)**

27.7. Electrical.

27.7.1. Electrical Wiring. Electrical wiring and equipment will conform to the provisions of NFPA 33. **(T-0)** 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. **(T-0)** 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.

27.7.2. 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 will be of a non-spark-producing design. **(T-0)** This equipment will also conform to the provisions of the NFPA 70 for Class 1 or Class 1, Division 2 locations, as applicable. **(T-0)** 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 will be considered non-hazardous except for the space within three feet (in all directions) of any opening in the booth or room. **(T-0)**

27.7.3. Electric Lamps. Electric lamps outside of, but within 20 feet, of any spraying area and not separated by a partition, will be totally enclosed to prevent hot particles from falling should breakage occur, and will be protected from mechanical damage by guards or by location. **(T-0)** Portable electric lamps will not be used in any spraying area during spraying operations. **(T-0)**

27.7.4. Grounding. All metal parts of spray booths, exhaust ducts, and piping systems conveying flammable or combustible liquids or aerated combustible solids will be electrically grounded. **(T-0)**

27.7.5. Heaters. If a heater is used to heat the liquid being sprayed, it will be low-pressure steam, low-pressure hot water, or electricity. **(T-0)** If electric, it will be approved and listed for the specific location in which it is used. **(T-0)** Heaters will not be in spray booths or other locations subject to the accumulation of combustible residue. **(T-0)** Agitators, if used, will be driven by compressed air, water, low-pressure steam, or electricity. **(T-0)** If powered by an electric motor, the motor will meet the requirements of NFPA 33. **(T-0)**

27.8. Location of Paint Shops, Dope Shops, and Spray-Finishing Operations.

27.8.1. Paint Shops. Paint and dope shops will be in separate one-story buildings with fire-resistant floors, walls, and ceilings. **(T-1)** They may be in specially constructed rooms if separated from other operations by fire-resistant walls. Paint and dope shops will be provided with automatic sprinkler protection. **(T-0)** Supervisors will avoid locating these shops near ignition sources. **(T-1)** Refer to NFPA 33 for additional guidance.

27.8.2. Spray Booths. When possible, paint spray booths will be in the paint and dope shop. In industrial facilities, spray-finishing operations will be located and protected to minimize possible damage to other property by fire or by extinguishing agents. **(T-1)** All spray booths will be installed and conform to the requirements in NFPA 33 and the installation BE OH Assessment using ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. **(T-1)**

27.8.3. Prohibited Locations. Spray-finishing operations will 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. **(T-0)**

27.9. Paint Spray Booths.

27.9.1. Design. Installation BE uses ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Design,* and 29 CFR § 1910.107(b), *Spray Booths,* for guidance on the design of paint booths.

27.9.2. Exhaust Filters.

27.9.2.1. Filter pads and filter rolls will be inspected after each painting operation. **(T-0)** The number of hours in use will be tracked and logged to determine replacement frequency. **(T-0)** Consult the manufacturer's instructions or the installation CE for the proper replacement interval.

27.9.2.2. Automatic-advanced roll filters will be equipped with interlocks to stop the spraying operation should the roll advance mechanism fail. **(T-0)**

27.9.2.3. Filter pads and rolls will be made of noncombustible materials. **(T-0)**

27.9.2.4. Both filter pads and rolls will be changed when changing coating materials if the two materials are susceptible to spontaneous combustion when in contact with each other. **(T-0)**

27.9.2.5. Discarded filter pads and rolls will be removed from the area daily unless water-filled metal containers are provided to hold them immersed until disposal. **(T-0)**

27.9.3. Baffle Plates. Baffle plates, if used, will be made of noncombustible material and readily removable or accessible on both sides for cleaning. **(T-0)** Such plates will be grounded. **(T-0)**

27.9.4. Portable Fire Extinguishers. The appropriate type and size portable fire extinguishers will be located within the work area IAW NFPA 10 and F&ES Flight. **(T-0)** Refer to **Chapter 6** for additional guidance.

27.9.5. Floor Covering. The floor of paint spray booths will be covered with a noncombustible mat, removable for cleaning or disposal. **(T-0)** If overspray covering is not feasible, consult the occupational safety office for additional guidance.

27.9.6. Flame-Producing Devices. Using or carrying matches, lighters, or other spark or flame-producing devices in or adjacent to paint spray booths is prohibited.

27.9.7. Containers. Containers supplying spray nozzles will be a closed type or provided with metal covers, which will be kept closed. **(T-0)** Original shipping containers will not be subjected to air pressure above atmospheric for supplying spray nozzles. **(T-0)** Containers under pressure exceeding atmospheric pressure will be designed and approved for such use, will be provided with a visible pressure gauge, and will be provided with both a relief valve and a shutoff valve. **(T-0)**

27.9.8. Hoses and Couplings. Pressure hoses and couplings will be regularly inspected for condition and will be replaced, as needed. **(T-0)** When positive displacement pumps are used, a relief valve will be installed in the discharge line to prevent overpressure. **(T-0)**

27.10. Compressed Air Paint Spraying.

27.10.1. On compressed air spraying equipment, a pressure regulator valve will be installed in the air line between the compressor and painting equipment. **(T-0)** Refer to the compressor manufacturer's operating instructions for proper configuration, operation, and pressure adjustments for the type of paint being used. **Warning**: Compressed air will not be directed toward a fellow employee. **(T-0)**

27.10.2. Air Hoses. Inspect hoses prior to each shift to ensure proper connection at both ends and condition of hose. **(T-0)** Air hoses will 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. **(T-0)** Hose couplings must be incompatible with airline respiratory protection hoses and/or respirators. **(T-0) 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.

27.10.3. Any hose showing signs of wear, deterioration, leakage, or weakness will be removed from service and repaired or replaced. **(T-0)**

27.10.4. Portable Paint Spray Equipment**.**

27.10.4.1. 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.

27.10.4.2. Compressor. The air compressor will 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. **(T-0)** The equipment will be securely mounted on a wheeled carriage for portability. **(T-1)** For interior painting, where the compressor will be located inside the facility, only electric motor-driven equipment will be used. **(T-0)**

27.10.4.3. Overpressure Protection. When separate paint pressure tanks are used, they will be equipped with a gauge and a relief valve to prevent overpressure. **(T-0)** Hoses will be rated for the maximum working pressure of the system. **(T-0)**

27.10.5. Maintenance.

27.10.5.1. A preventive maintenance program covering periodic inspection and testing of all components will be implemented by all organizations using this equipment. **(T-1)**

27.10.5.2. Compressors, hoses, paint pressure tanks, and spray guns will be stored in areas designated and approved by F&ES Flight. **(T-1)**

27.10.5.3. All paint pressure tanks and spray guns will be cleaned after use and before the equipment is stored. **(T-1)** If solvents are used in the cleaning process, provisions of **Chapter 22** will be followed. **(T-1)**

27.10.5.4. Respiratory Protection. If the process is not already evaluated, contact installation BE for an HRA. Respiratory protective devices will meet the requirements of AFI 48-137. **(T-1)**

27.11. Drying Ovens.

27.11.1. Overview. 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 SDS for the specific equipment to use.

27.11.2. Fire Prevention. When used to dry flammable finishes, the ovens must meet or exceed NFPA 86, *Standard for Ovens and Furnaces*. **(T-0)** 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.

27.11.3. Ventilation. Adequately vent the exhaust air from the oven. The oven will have its own ventilation system. **(T-1)** If spray booth ventilation systems are utilized, the oven vent will enter the system downstream from filters and baffles. **(T-1)** In addition, an interlock will 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. **(T-1)**

27.11.4. Electrical Wiring. Make sure electrical wiring for drying ovens and associated equipment conforms to NFPA 70. **(T-0)**

27.11.5. Grounding. Ensure metal parts of drying ovens are bonded and grounded. **(T-0)**

27.11.6. Warning Signs. Post signs in the vicinity of operating drying ovens to warn of heat and to caution against conducting spraying operations. **(T-0)**

27.12. Spray Painting of Aircraft.

27.12.1. Aircraft Painting. Spray painting of an entire aircraft is permitted only in hangars specifically designed for this purpose. **(T-1)**

27.12.2. Fire Prevention. When painting aircraft, the aircraft will be isolated and adequate fire prevention measures will be taken. **(T-1)** Solvents used for cleaning operations will have

flashpoints at or above 100° F. **(T-1)** The aircraft will be properly grounded, and all sources of ignition removed from the area. **(T-0)** All electrical devices and equipment will be of an approved explosion-proof type. **(T-0)** Except when essential to perform concurrent operations, all aircraft electrical systems will be de-energized during cleaning, painting, and paint removal. **(T-0)** Smoking is prohibited. **(T-0)** To prevent the accumulation of static charges, all materials, or objects will be effectively grounded. **(T-0)** Refer to **Chapter 6** for additional guidance.

27.12.3. Ventilation. Ventilation will be provided, and installation BE will periodically check the adequacy of ventilation IAW **paragraph 27.5.7**. **(T-1)**

27.12.4. Housekeeping. All spraying areas will be kept free from the accumulation of deposits of combustible residues. **(T-0)** Cleaning will be conducted daily. **(T-1)** Scraping tools will be non- sparking. **(T-0)** Roof trusses, light fixtures and other overhead equipment will be checked for accumulation of over-spray at least annually. **(T-1)** Rags or waste soiled with sprayed materials will be deposited in approved self-closing metal waste containers immediately after use. **(T-0)** IAW DAFMAN 32-7002 and 29 CFR § 1910.107(g)(3), the contents of waste containers will be disposed of at the end of each shift or at least once daily. **(T-0)**

27.12.5. Limited Painting. Refer to TO 1-1-8, *Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment,* for additional guidance and information.

27.12.6. Grounding. Aircraft surfaces will be grounded to preclude the build-up of static electricity whenever operations involving sanding, rubbing, painting, or wiping surfaces are performed. **(T-0)**

27.13. Painting Radio and Radar Equipment.

27.13.1. Fire Prevention. The paints used to spray coat radio and radar equipment are very flammable and will not be used near any open flames. **(T-0)** IAW Chapters **6** and **22,** smoking is prohibited within 50 feet of painting operations. **(T-1)**

27.13.2. These paints are toxic and will only be used in ventilated spray booths. **(T-1)** Installation BE uses guidance provided in ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, to ensure ventilation meets requirements. **(T-1)**

27.13.3. Personal Protective Equipment. Paint shop personnel will wear PPE as identified in installation BE's OH Assessment. **(T-1)** Refer to **Chapter 14** for additional guidance.

27.13.4. Drying. Radio and radar equipment that has been spray painted will be placed in the open air for several hours or, if possible, for a full day. **(T-1)** This will prevent vapors from off gassing during the drying process being ignited by sparks generated when the equipment is put into operation. Emery paper or steel wool will not be used on radio or radar equipment until the vapors have totally dissipated. **(T-1)**

27.14. Electrostatic Paint Spraying.

27.14.1. Overview. 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 attachment to a grounded conveyor.

27.14.2. 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 will be checked regularly with particular attention given to automatic sprinkler heads. **(T-0)** Sprinklers protecting spraying areas will be kept free from deposits by frequent or daily cleaning. **(T-0)** Portable fire extinguishers will be available for use. Refer to **Chapter 6** for additional guidance.

27.14.3. Daily Inspection. Spraying equipment, including spray gun tips, will be checked daily. **(T-0)** The entire electrostatic unit will also be checked daily, including the electrical terminals, electrodes, and insulators. **(T-0)** On humid days, condensation will be removed from insulators. **(T-0)** The conveyor system will be checked for jerky operation, loose hooks, or other defects that could permit swinging of the units being painted. **(T-0)** Moisture will be removed from the compressed air storage tanks. **(T-0)** Refer to the manufacturer's operating instructions or **Chapter 25** for drainage requirements.

27.14.4. Insulators. The insulators on electrodes and conductors will be kept dry and cleaned frequently to prevent flashover. **(T-0)**

27.14.5. Maintenance. Before cleaning a nozzle or attempting any work on a spray gun, the power unit will be turned off and the nozzle will be grounded to discharge any static charge remaining in the system. **(T-0)** Maintenance will not be completed until enough time has elapsed to permit the solvent vapors to be drawn out of the area. **(T-0)** In the absence of automatic grounding equipment, sufficient time will be allowed to permit any remaining electrical charge to drain off. **(T-0)** Only approved spark-resistant tools will be used during cleaning operations unless other types of tools are permitted by the equipment manufacturer or TO. **(T-0)**

27.14.6. Grounding. All metal parts, including guard rails, shields, barriers, and enclosures in the vicinity of a unit, will be grounded to prevent static build-up. **(T-0)** Manual grounding wires will be available, and employees will be familiar with their use. **(T-0)** Grounding will be IAW AFMAN 32-1065. **(T-1)** Items painted in an interior spray booth will be bonded or grounded to lessen the possibility of static discharge and explosion. **(T-0)**

27.14.7. Manual Spraying. To prevent build-up of a static charge on the operator's body, the spray gun handle will 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. **(T-0)**

27.14.8. Personnel. Only properly trained, qualified and physically fit personnel will be permitted to work around electrostatic apparatus. **(T-0)** Medical examinations will be scheduled with base medical services, as needed. **(T-0)**

27.14.9. Warning Signs. Signs will be conspicuously posted, designating the process zone as dangerous, and indicating the necessity for grounding personnel entering the spray area. A red *ON* light will be installed to the interlocked power transformer circuit. **(T-0)**

27.15. Airless Paint Spraying.

27.15.1. 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 for most jobs.

27.15.2. Operation.

27.15.2.1. Paint can be hypodermically injected into the body by high operating pressures. Injected paint may be life threatening and requires immediate medical treatment. **Warning:** Never point an airless spray gun at any part of the body.

27.15.2.2. 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.

27.15.2.3. When handling the gun, but not actually spraying (e.g., when changing parts or work position), hold the gun with the grip and remove the fingers from the trigger. This will prevent the gun from being activated if the operator's hold will inadvertently tighten due to slipping or stumbling. **Note**: Guns will be equipped with trigger guards and a safety lock. **(T-0)** The lock will be positioned to prevent operation, except when the gun is in use. **(T-0)**

27.15.2.4. Ensure all hose connections and fittings are tight and not leaking, and are compatible with the pressure the system uses. **(T-1)** Where equipped, the hose, gun, and pressure vessel will have special fittings that are not interchangeable with low pressure fittings or any other fittings.

27.15.2.5. Employees will inspect hoses for weak or worn spots prior to use. **(T-0)** Damaged hoses will be tagged and removed from service. **(T-1)** Make certain the hoses do not contact moving parts of machinery, lie over or around sharp edges and corners, or contact other objects that would damage them. **(T-0)** Also, check for deterioration caused by exposure to chemicals for damage. **Warning**: High-pressure leaks from hoses or connections may also cause hypodermic injection of paint.

27.15.2.6. Cleaning. Consult the manufacturer's operating instructions for cleaning procedures. **(T-1)**

27.15.2.7. Ground the object sprayed and the spray gun, to prevent accumulation of static electricity; a static electric discharge may ignite vapors. Fluid hoses with a ground wire prevent the accumulation of a static charge where the airless unit and the object being sprayed are grounded. Periodic continuity checks will be performed to ensure hose grounding is intact. **(T-0)**

27.15.2.8. Operators will wear eye protection and gloves to guard against accidental contact with the spray. **(T-0)** Installation BE-approved respiratory protective equipment will be worn where exhaust ventilation is inadequate or not available. **(T-0)**

27.16. Aerosol Cans of Spray Paint.

27.16.1. Precautions. The same general safety and health precautions apply to spray painting from pressurized cans as to spray painting by other means.

27.16.2. Storage. Spray paint cans will be considered flammable materials and stored IAW criteria in **Chapter 22**. **(T-1)** Office desks will not be used to store cans of spray paint. **(T-1)** Office storerooms will not be used to store cans of spray paint unless the storage area has been approved by F&ES Flight. **(T-1)**

27.16.3. Disposal.

27.16.3.1. Dispose of empty and malfunctioning cans IAW DAFMAN 32-7002, 29 CFR § 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. **(T-0)** Contact installation CE for local guidance.

27.16.3.2. Rags and other hazardous waste materials will be disposed of in self-closing metal containers labeled to indicate the contents and IAW the procedures established by the installation CE, DAFMAN 32-7002, 29 CFR § 1910.107(g)(3), other approved hazardous waste disposal procedures, and applicable environmental regulations. **(T-0)** Do not dispose of cans of spray paint, rags, and other hazardous waste materials in office waste receptacles. **(T-0)**

27.16.3.3. PPE. Refer to other sections of this chapter and **Chapter 14** for additional guidance.

27.17. Powder Coating.

27.17.1. Overview. 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. **(T-0)** Refer to manufacturer's specifications and NFPA 33 for fluidized bed use.

27.17.2. Fire Prevention. Electrostatic fluidized beds and associated equipment will be approved types. **(T-0)** The maximum surface temperature of equipment in the coating area will not exceed 150° F. **(T-0)** The high voltage circuits will 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. **(T-0)** Transformers, power packs, control apparatus, and all other electrical portions of the equipment, except for the charging electrodes and their connections to the power supply, will be located outside the powder coating area. **(T-0)**

27.17.3. Ventilation. Forced exhaust ventilation is mandatory to maintain a safe atmosphere. **(T-0)** Dust collectors will be incorporated within the ventilation system to trap all excess powder. **(T-0)** Where applicable, exhaust ventilation will be sufficient to maintain the atmosphere below the lowest explosive limits for the materials being applied. **(T-0)** The electrical equipment will be interlocked with the ventilation system so the equipment cannot be operated unless the ventilation fans are in operation. **(T-0)**

27.17.4. Housekeeping. All areas will be kept free of the accumulation of powder coating dusts, including horizontal surfaces such as ledges, beams, pipes, hoods, booths, and floors. **(T-0)** Surfaces will be cleaned in a manner that does not scatter powder or create dust clouds.

(T-0) Vacuum sweeping equipment, where used, will be of a type approved for use in hazardous locations. **(T-0)** Water-saturated cleaning cloths will be used to remove powder dust and to preclude scattering dust deposits. **(T-0)**

27.17.5. Grounding. Objects being coated will be maintained in contact with the conveyor or other support to ensure proper grounding. **(T-0)** Hangers will be regularly cleaned to ensure effective electrical contact and areas of contact will be sharp points or knife edges where possible. **(T-0)** The powder coating equipment will 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. **(T-0)**

27.18. Organic Peroxide Coating.

27.18.1. 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.

27.18.2. Training. Only designated personnel, trained to use and handle organic peroxide formulations, will be permitted to use these materials. **(T-0)**

27.18.3. Fire Prevention. Do not exchange equipment used for organic peroxide coating with that used for any other application. **(T-0)** Peroxides are oxidizers and will not be mixed with other materials. **(T-0)** Promptly clean up any overspray or spills. **(T-0)** Use noncombustible absorbent material for cleanup purposes. **(T-0)** Do not store or place organic peroxide materials near any source of heat. Avoid rough handling, since these materials are sensitive to shock. **(T-0)**

27.18.3.1. Smoking is prohibited and *NO SMOKING* signs will be posted in any area where organic peroxides are stored, mixed, or applied. **(T-0)** Use non-sparking tools in areas where these materials are stored, mixed, or applied. **(T-0)** Dispose of this material IAW AFMAN 32-7002, 29 CFR § 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. **(T-0)**

27.18.3.2. Contact installation CE for local guidance. Copper beryllium tools must not be purchased, kept, or dressed. **(T-0)** If there is no copper beryllium non-sparking tool substitute, consult with installation CE to determine how to apply for an exception to this requirement. **Note:** If a copper beryllium tool is found that has lain undisturbed for more than three years, coordinate with installation CE and BE for assistance in removal. **(T-0)**

27.18.4. Protective Equipment. Respirators, gloves, and protective clothing will be used IAW installation BE's OH Assessment. **(T-0)**

27.18.5. Ventilation. Ensure all spraying operations involving the use of organic peroxides are conducted in spray booths meeting the requirements of the installation BE OH Assessment determined IAW ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance* and NFPA 13. **(T-0)**

27.18.6. Storage of Organic Peroxides. Personnel will maintain a minimum quantity of peroxides needed for daily operations in the processing area. **(T-0)** Organic peroxide formulations will be stored IAW NFPA 400 and the manufacturers' recommendations. **(T-0)**

27.18.7. Mixing of Organic Peroxides with Promoters. Organic peroxide formulations will not be mixed directly with any cobalt compounds or other promoters or accelerations, as violent decomposition or explosion can result. **(T-0)** To minimize the possibility of such accidental mixing, these materials will not be stored adjacent to each other. **(T-0)**

Chapter 28

COMMUNICATION CABLE, ANTENNA AND COMMUNICATION SYSTEMS

28.1. Scope. This chapter addresses safety requirements for communications systems professionals when installing and maintaining radars, cable and wireless systems, antennas, and airfield and weather systems. Communications systems personnel are inherently susceptible to electrical, hazardous energy, climbing towers and utility poles, radiation, chemicals, falling from heights, soldering, and confined space hazards. Personnel will be thoroughly familiar with safety-related work practices that prevent injuries resulting from falling from heights, direct or indirect contact with electrical contacts, or work performed near or on equipment or circuits, which are or may be energized. **(T-0)**

28.2. General Safety Practices.

28.2.1. Electrical Hazards. Specific safety-related work practices will be consistent with the nature and extent of the associated electrical hazards or any other potential release of hazardous energy. Refer to **Chapter 8** or **Chapter 21** for specific and additional requirements.

28.2.1.1. 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 need immediate medical attention. Some effects of electrical exposure to the body are:

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

28.2.1.1.2. 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.

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

28.2.1.1.4. Serious internal injuries to nerves and bones 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.

28.2.1.2. Arcing. When a metal object, such as a tool, contacts an electric current, it will become a conductor. The electric current may result in an arc, which can cause serious burns to the body and temporary or permanent blindness.

28.2.2. Other. A natural reaction after contacting 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.

28.2.3. Climbing Hazards. The primary hazards associated with climbing are falls and contact with electrical systems. A record of climbing certification will be maintained on DAF Form 1098, *Special Task Certification and Recurring Training,* or an electronic-approved product, for military and government civilian personnel. **(T-1)** 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. **(T-1)** The amount of training required will be determined by the climbing instructor. **(T-1)** Records will be updated whenever recertification is accomplished. **(T-1)** Refer to **paragraph 28.7** for additional guidance. (**Warning**: Pole Top rescue will only be attempted by personnel who are certified or in a training status under the supervision of an instructor.) **(T-0)** Examples of climbing hazards include:

28.2.3.1. 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.

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

28.2.3.3. 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.

28.2.3.4. Improper clothing such as badly worn shoes (e.g., loose heels, thin soles), low-cut shoes, trousers not worn correctly or securely inside of climbing irons.

28.2.3.5. 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.

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

28.2.3.7. Wearing climbers while working on wooden poles and tower structures.

28.2.3.8. Failure to maintain good physical condition.

28.2.4. Radiation Hazards.

28.2.4.1. Non-ionizing Radiation. Refer to AFI 48-109 and 29 CFR § 1910.97, *Nonionizing Radiation*, for additional guidance on management of hazards associated with non-ionizing radiation. Employees with implanted medical devices must notify their supervisors before work and seek medical assessment before performing assigned duties. **(T-0) Caution**: Work in areas where exposure to non-ionizing radiation or electromagnetic fields occur could affect employees with pacemakers and other electrically active implanted medical devices by interrupting their proper operation.

28.2.4.2. Ionizing Radiation. Radioactive material contained in electron tubes presents no significant hazard if 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 hazards. Further, a broken radioactive tube is potentially hazardous since the radioactive material may be inhaled or ingested. 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 your immediate supervisor and the IRSO of the exposure. 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 IRSO. 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,* and AFMAN 48-148 for guidance on hazards associated with ionizing radiation.

28.2.5. Chemical Hazards. Chemicals used in conjunction with communications equipment maintenance may present health hazards due to liquid-to-skin contact and/or inhalation of toxic vapors. All employees who may be potentially exposed to chemical hazards during work will require HAZCOM training IAW AFI 90-821, *Hazard Communication (HAZCOM) Program,* upon initial assignment and thereafter when a new hazard or chemical is introduced into the work area, a new employee is assigned, or existent tasks are reevaluated with possible new hazards. **(T-0)** Disposal of hazardous waste will be coordinated with installation CE. **(T-1)** Supervisors will ensure all personnel have access to SDSs for chemicals used in work processes. **(T-0)** Refer to AFI 90-821 and 29 CFR § 1910.1200, *Hazard Communication*, for additional guidance.

28.2.6. Compressed Gases. When using or transporting compressed gas cylinders (such as dry nitrogen cylinders) in a horizontal position, special compartments, racks, or adequate blocking will be provided to prevent cylinder movement and the cylinders will be secured with safety straps or chains. **(T-0)** Regulators will be removed, and safety caps installed before a cylinder is transported or when not in use. **(T-0)** Refer to **Chapter 19,** *Compressed Gases,* for additional guidance.

28.2.6.1. Compressed gas cylinders will be kept away from excessive heat and protected from direct rays of the sun and will not be stored where they might be damaged or knocked over by passing or falling objects. **(T-1)** Cylinders will be secured and stored at least 50 feet away from combustible materials. **(T-0)** Refer to TO 42B5-1-2, *Gas Cylinders Use, Handling, and Maintenance,* for additional information.

28.2.6.2. Cylinders will be stored and used in a vertical position only, valve-end up. **(T-0)**

28.2.6.3. Dispose of compressed gas cylinders in a manner consistent with approved hazardous waste disposal procedures and applicable environmental regulations. **(T-0)** Contact installation CE for guidance.

28.2.7. Falling from Heights. The potential of falling from heights is the main hazard encountered during climbing activities. Any work that requires employees to work at heights above four feet will require a fall protection program and the appropriate safety gear. **(T-0)** Refer to **Chapter 13** and **paragraph 28.7.6** for additional guidance on fall protection program requirements and personal fall arrest system.

28.2.8. Soldering Precautions. Ensure fire extinguishers are accessible in the soldering area. **(T-1)** Remove combustible materials from the work area to prevent fires. **(T-1)** Never sling excess solder from a soldering iron, use a damp cloth or sponge to wipe away the excess. **(T-1)** Always place the soldering iron in the proper holder when not in use, and never leave the iron plugged in and unattended. **(T-1)**

28.2.8.1. Wear a face shield or safety goggles when soldering. **(T-1)** Normal prescription glasses or plain safety glasses may be used in place of safety goggles for light electronic equipment soldering, such as electronic circuit boards.

28.2.8.2. Ensure the work area where soldering is performed is well ventilated IAW the requirements in the installation BE OH Assessment derived from ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance.* **(T-0)** Ensure all power unit exhausts are vented to the building exterior. **(T-0)** Use approved respiratory protection when working in permit-required confined spaces where ventilation does not remove the hazard. **(T-0)** Refer to AFI 48-137, for additional guidance and information.

28.2.9. Confined Spaces. Employees required to enter confined spaces, such as manholes or underground vaults, will be trained to safely accomplish their duties and rescue procedures specifically to the permit-required confined space entered. **(T-0)** Employees who enter non-permit-required confined spaces will be trained and equipped to enter those spaces. **(T-1)** Refer to **Chapter 23,** applicable TOs and 29 CFR § 1910.146, *Permit-Required Confined Spaces,* for additional requirements.

28.2.10. Grounding and Bonding. Most electricians and electronics employees 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 wire for the system will be white. **(T-1)** The other wire is the hot wire, and it may be any color other than white or green. In a three-wire system, the third wire is the ground wire, and it is always green or green with one or more yellow stripes. Bonding, on the other hand, consists of interconnecting two or more pieces of conductive equipment with a suitable wire or strap to equalize the resistance and, in effect, make them as one piece of equipment as far as electrical potential is concerned. For specific guidance, refer to AFMAN 32-1065.

28.2.10.1. Electrical and electronics equipment will be grounded so a potential cannot exist between the unit and the ground. **(T-0)** Fixed electrical equipment will be electrically bonded to a grounding connector. **(T-0)** Special protection will be provided to safeguard grounding wires from mechanical damage. **(T-0)** Metal workbenches and metal framed or legged workbenches used for requiring and testing of electronic equipment will be grounded. **(T-0)** The size and type of material for grounding conductors will be selected according to NFPA 70, *National Electric Code,* Article 250, *Grounding.* **(T-0)** All workbenches used for "power on" maintenance of any electronic equipment will be provided with a means for grounding the equipment. **(T-0)** This will be interconnected to the facility ground system. **(T-0)**

28.2.10.2. Grounding circuits, as a minimum, will have a separate circuit for each chassis, cabinet, and frame. **(T-0)** Each chassis ground may terminate at its cabinet or frame ground. Additionally, ground circuits will have a neutral circuit and connections that are mechanically secured by:

28.2.10.2.1. A spot-welded terminal lug. **(T-0)**

28.2.10.2.2. A portion of the chassis or frame that has been identified as a grounding point. **(T-0)**

28.2.10.2.3. The use of a terminal on the ground wire by a lock washer and screw or a lock washer and nut. **(T-0)**

28.2.10.3. 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 removable or hinged need not be equipped with grounding braids. **(T-0)**

28.2.10.4. System grounding within mobile equipment will be by means of a grounding conductor. **(T-0)** As these grounding conductors are replaced, they will be of the appropriate gauge and will have a green insulated cover. **(T-0)**

28.2.10.5. Bus bars will be clean and free of corrosion, splices will be tight, and paint will be removed from all vertical angles at the point of attachment to the ground bus bar. **(T-0)**

28.2.11. Respiratory Precautions. Respiratory protection is required if prolonged breathing of chemical aerosols, mists and vapors is expected or if working in permit-required 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. The installation BE's OH Assessment will identify recommended controls. Refer to DAFMAN 48-146, *Occupational Health Program Management,* for additional guidance.

28.2.12. Miscellaneous.

28.2.12.1. Fluid/Chemical Leakage. Employees will be watchful for any sign of oil or fluid leakage from transformers or similar devices. **(T-1)** Where the possibility the leaked liquid contains high concentrations of polychlorinated biphenyl, which is extremely toxic, report leakage to the installation CE. **(T-1)** Where leakage is found, do not touch or disturb the leaking fluid until approval to clean and dispose of the material is provided. **(T-1)** Employees will use required PPE and dispose as required by installation CE. **(T-1)**

28.2.12.2. Heaters and Torches Used in Ground and Aerial Tents. Flame-type heaters will not be used within ground tents or on platforms within aerial tents unless the tent covers are constructed of fire-resistant materials and adequate ventilation is maintained. **(T-0)** 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 use. The tent will be ventilated while the torch is in use. **(T-0)**

28.2.12.3. Notifications. Provide F&ES Flight and the emergency response units with maps indicating routes to locations of remote sites. **(T-1)** Where practical, establish a memorandum of understanding with F&ES 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. **(T-0)** Off-base facilities/sites will coordinate and plan with the nearest local area medical facility for emergency medical services if the medical facility is too far to provide immediate emergency medical attention. **(T-1)**

28.2.12.4. Safety Observers. When installing or repairing commercial and industrial systems, communication cables and antenna systems that may expose employees to energized equipment, high voltage circuits, 600 volts or above, or low voltage power if it has a high current flow, work will not begin until a qualified safety observer is present. **(T-0)** An individual will not be assigned other duties while serving as safety observer. **(T-1)** Normally, the supervisor is also the safety observer.

28.2.12.4.1. When repairing or troubleshooting energized high voltage communications equipment, the safety observer does not have to be proficient in the task being observed.

28.2.12.4.2. Safety observers will be trained IAW **paragraph 1.9** and be familiar with local procedures to obtain medical assistance. **(T-1)**

28.2.12.4.3. While the task is being performed, the safety observer will stand where they 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. **(T-0)** If unable to maintain visual contact with the main power switch, the hazardous energy control procedure will be used. **(T-0)** Additionally, the safety observer will have ready access to safety equipment when high voltage is involved. **(T-0)**

28.3. Training. All training will be documented on the DAF Form 55, *Employee Safety and Health Record,* DAF Form 623, *Individual Training Record Folder,* or an approved computer automated system IAW DAFI 91-202. **(T-1)** A record of climbing certification will be maintained on DAF Form 1098 or approved computer automated system. **(T-0)**

28.3.1. Climbing. Pole top rescue will only be attempted by personnel who are certified or in a training status under the supervision of an instructor. **(T-1)** A record of climbing certification will be maintained on DAF Form 1098 for military and civilian personnel, or an approved automated computer system. Personnel who have not climbed within the last 12 months as a part of their normal job require refresher training under the supervision of a qualified instructor. **(T-1)** The amount of training required will be determined by the climbing instructor. **(T-1)** Training records will be updated whenever the recertification is accomplished. **(T-1)** Refer to **paragraph 28.7** for additional guidance.

28.3.2. Confined Spaces. Employees required to enter confined spaces, such as utility holes or underground vaults, will be trained in rescue requirements as found in Chapter **23** and **29** CFR § 1910.146 to include how to safely self-rescue. **(T-0**) Safety observers or attendants will be trained rescue procedures for each type of permit-required confined space entered. **(T-0)**

28.3.3. Hazard Communication Training. All employees who may be potentially exposed to chemical hazards during the course of work will complete hazard communication training IAW AFI 90-821 and 29 CFR § 1910.1200 upon initial assignment, when a new hazard or chemical is introduced into the work area/shop or an employee is assigned new or different tasks with new hazards. **(T-0)** Safety precautions for materials will be covered in the pre-task safety briefing prior to any task requiring the use of or exposure to hazardous materials. **(T-0)**

28.4. Safety Equipment and Devices.

28.4.1. Manholes, Aerial Cables, and Pole Lines. Motor vehicle traffic is a hazard to personnel working in and around manholes, aerial cable installation, and pole line construction along streets and highways. Warning devices, barriers, and guarding will be used to protect personnel. **(T-0)** Ventilation equipment will be positioned so the air intake is located away from vehicular exhaust. **(T-0)** Refer to TO 31W3-10-12, *Air Force Communications Command (D-1 Standard) – Outside Plant Cable Placement*, for additional guidance on guarding requirements and warning devices.

28.4.2. Safety Straps, Harnesses, and Lanyards. Nylon straps, not leather safety straps, will be used on steel structures. **(T-0)** Safety harnesses, straps, and lanyards will be provided, and supervisors will ensure their use when work is performed at positions more than four feet above the ground. **(T-0)** 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 feet while wearing climbing equipment, fall arrest procedures and equipment guidance in **Chapter 13**, UFC 3-560-01, 29 CFR § 1910.140 and 29 CFR § 1926, Subpart M, Appendix C, *Personnel Fall Arrest Systems – Non-Mandatory Guidelines for Complying with 1926.502(d)*, will be followed. **(T-0)** Safety straps and harnesses will also be worn when working at elevated positions on poles, towers, or similar structures, which do not have adequately guarded work areas IAW 29 CFR § 1910.268. **(T-0)** Supervisors will ensure all safety climbing equipment is inspected daily by authorized employees to determine if it is in safe working condition. **(T-0)** Each person using safety harnesses, straps, and lanyards will inspect the equipment prior to each use. **(T-0)**

28.4.3. Climbing Safety Devices. Climbing safety devices will be installed on all fixed ladders 24 feet or more in length that are an integral part of the antenna support. **(T-0)** Where climbing safety devices are not installed, installation or maintenance will be performed only by a certified climber using prescribed fall protection. **(T-0)** Personnel climbing metal antenna support poles equipped with metal steps will use climbing safety devices. **(T-0) Note**: All Cyber Support field technicians required to climb un-stepped communication poles will use the squeeze pole fall protector (pole choker) arrest system. **(T-0)** 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 personal fall arrest ystem equipment. **(T-0)**

28.4.4. Markings. All antenna support, power, telephone, and transmission line poles will be marked 12-feet from the butt of the pole to determine the depth of the pole. **(T-0)** The 12-foot mark will be indicated with aluminum pole tags or marker nails. **(T-0)** If these are not available, 1-inch galvanized steel roofing nails will be driven into the pole to form the numerals "12." **(T-0)**

28.4.5. Proximity Warning Devices. These devices may be used on cranes or aerial lifts. Refer to Chapters **12** and **16** of this manual, 29 CFR § 1910.67, *Vehicle-Mounted Elevating and Rotating Work Platforms,* and 29 CFR § 1910.180, *Crawler Locomotive and Truck Cranes*, for additional guidance.

28.4.6. Electrical Safety Boards. Refer to **paragraph 8.12** for required items in an emergency equipment kit or board.

28.4.7. Head Protection. Electrical workers will wear Class G safety helmets/hard hats. **(T-0)** The preferred color for hard hats is yellow due to its high visibility during inclement weather and darkness. Hard hats will not be painted. **(T-1)** Markings on hard hats will be for the stick-on type and will be limited to the name of the owner (letters no more than 1/2 -inch high by ½-inch wide) and a unit emblem (no more than 3-inches in diameter). **(T-1)** All markings will be conservative and will not degrade the effectiveness or non-conductivity of the hard hat. **(T-1)** Refer to **paragraph 14.3.5.2** for additional guidance.

28.4.8. Rubber Insulating Floor Matting. Refer to **paragraph 8.11.5** for insulating matting specific guidance.

28.5. Tools and Equipment. Refer to **Chapter 11** for additional information.

28.5.1. Nonconductive tools will be used while performing work on energized communications systems equipment. **(T-0)** Taping or plastic coating is not an acceptable means of insulation. Wooden handle tools will not be used on energized communications systems equipment. **(T-0)**

28.5.2. All tools will be kept clean and free of grease, oil, paint, or other foreign material IAW TO 32-1-101. **(T-0) Exception**: This does not prevent the use of a light film of oil on tools for rust protection.

28.5.3. Ladders. Refer to **Chapter 7** for additional guidance.

28.5.4. Equipment and/or Component Cleaning. Vacuuming is the preferred method of cleaning electronic equipment. If compressed air is used, employees will limit the air pressure to less than 30 psi, use effective chip guarding, and wear required PPE. **(T-0)** When using canned compressed air, wear eye protection. **(T-1)**

28.5.5. Test equipment will be designed, constructed, and installed to provide safe work procedures and to minimize personnel exposure to hazardous work situations. **(T-0)** When tests involve live circuits, the area will be closed. **(T-0)** Only authorized personnel who have been trained about the potential hazards involved will be in this area when tests are performed. **(T-0)** At least one safety observer will be present when high voltage is involved. **(T-0)**

28.5.5.1. Set Up. Test operators and technicians will follow the procedures for adjustment, operation and repair of test equipment provided in TOs, manufacturer's instructions and manuals or applicable diagrams. **(T-0)** Employees will be trained on the characteristics and safe operation of the various instruments before authorized use. **(T-0)** Before voltage is applied, cable conductors will be isolated. **(T-0)**

28.5.5.2. Approved warning signs and/or signals will be used to indicate when power is on. **(T-0)** A means of emergency power shutdown will be provided outside the test area in addition to the main power switch within the test area. **(T-0)**

28.5.5.3. Connections to test tables, bus bars, plug racks, terminal cabinets, and distribution boards will be secure. **(T-0)**

28.5.6. PPE. All employees involved in test operations will be provided with appropriate PPE. **(T-0)** Refer to Chapter **14**, **29** CFR § 1910.268(e) and 29 CFR § 1910.268(i) for additional requirements.

28.6. High Voltage.

28.6.1. High voltage is defined as greater than 600 volts (root-mean-square) nominal or greater. However, much lower voltage can be lethal. The design and development of all military electronic equipment will provide fail-safe features for safety of employees during the installation, operation, maintenance, or interchanging of a complete equipment assembly or component part. **(T-1)** Operators and technicians will not attempt to adjust any electronic equipment when there is a possibility of injury from unprotected high voltage. **(T-0)** Adjustments on operating high voltage equipment, other than those specified by TO or

manufacturer's instructions, will only be authorized by the commander. **(T-1)** The commander will consider all operational requirements, TOs, manufacturer's instructions, safety precautions and emergency procedures before authorizing work to proceed. **(T-1)** Employees using high voltage to troubleshoot and/or test cables will be instructed in the precautions necessary for their safety and the safety of others. **(T-0)** Employees will be warned to stay clear while voltage is applied. **(T-0)**

28.6.2. Only qualified personnel will perform work near energized overhead power lines. **(T-0)** Approach distances for qualified employees will be IAW UFC 3-560-01, Table 3-1. **(T-0)** Before starting any communications work near overhead power lines, coordinate the work with installation CE's electrical shop. **(T-1)** Safety precautions IAW 29 CFR §§ 1910.268 and 1910.333, *Selection and Use of Work Practices*, will be considered when working near overhead power lines. **(T-0)**

28.6.3. If an aerial lift or equipment contacts an electrical conductor, the vehicle, equipment, and attachments will be considered energized. **(T-0)**

28.6.4. Tree branches hanging on an energized conductor will be removed only with appropriate electrically insulation equipment, and only by authorized personnel. **(T-0)**

28.6.5. Line employees' electrical safety boots will be worn to provide additional protection against electrical hazards. **(T-0)** Rubber footwear or line employees' overshoes will not be worn. **(T-0)**

28.6.6. Warning signs will be prominently posted in all areas housing high voltage equipment; the highest expected voltage will also be posted. **(T-0)**

28.7. Aerial Work.

28.7.1. Only properly trained and certified personnel, or individuals in training status and under the direct observation of a qualified instructor, are authorized to climb poles and towers. Appropriate safety equipment will be worn while performing aerial work. **(T-0)**

28.7.2. Commanders will designate, in writing, all personnel required to maintain climbing proficiency. **(T-2)** Restrict climbing authorizations to structures that must be climbed to accomplish mission requirements. **(T-1)** Organizations will coordinate with installation CE to ensure real property structures have current inspection and maintenance completed. **(T-1)** Ensure employees who must climb structures are provided access to inspections/maintenance records. **(T-1)**

28.7.3. Installation CE will maintain records on the inspection and maintenance of poles and towers considered real property IAW DAFI 32-9005, *Real Property Accountability and Reporting,* and the *Real Property Handbook.* **(T-1)**

28.7.4. The Occupational Safety office will review these records during annual inspections to ensure they are current. **(T-1)**

28.7.5. Initial Certification Procedures. Upon assignment to a unit, everyone whose future duties will require climbing poles and towers where they may be subject to a fall of four feet or more in height will be trained and certified. **(T-1)** For Air Force Specialty Codes other than 3D1X7, commanders will restrict climbing authorizations to those structures that must be climbed to accomplish mission requirements. **(T-1)**

28.7.6. Climbing Certifier Requirements. Climbing certifier must:

28.7.6.1. Complete a climbing certification training course or commercial equivalent. **(T-1)**

28.7.6.2. Be designated, in writing, by the commander to conduct climbing certification. **(T-1)**

28.7.6.3. Be current in CPR and first aid training. **(T-1)**

28.7.6.4. Demonstrate ability to perform and teach complex tasks aloft. **(T-1)**

28.7.6.5. Be certified to train individuals on rescue on the following structures when present on the installation. **(T-1)**

28.7.6.5.1. Pole Top.

28.7.6.5.2. Tower.

28.7.6.6. Use a training plan to conduct rescue training and climbing certification on the following structures when present on the installation: **(T-1)**

28.7.6.6.1. Pole Top.

28.7.6.6.2. Tower.

28.7.6.7. Maintain climbing proficiency and knowledge of current OSHA requirements found in 29 CFR § 1910.268, *Telecommunications,* and 29 CFR § 1910 Subpart D, *Walking-Working Surfaces,* and Subpart I, *Personal Protective Equipment.* **(T-0)**

28.7.6.8. Determine and arrange for the specific climbing safety equipment needed for performance evaluations. **(T-1)**

28.7.6.9. Evaluate students using a written knowledge test and hands-on performance review. **(T-1)**

28.7.7. Climber's Responsibilities.

28.7.7.1. Each team member has the responsibility to ensure all personnel are prepared for the climbing task.

28.7.7.2. Personnel will conduct a pre-inspection of the climbing equipment to evaluate serviceability using manufacturer's instructions. **(T-0)**

28.7.7.3. Climbers must maintain three points of contact while climbing. For example, either one hand and two feet, or two hands and one foot must always be in contact with the tower or pole while ascending or descending.

28.7.8. Safety Observers. When performing aerial work on communication cable and antenna systems, a safety observer will be present. **(T-1)** Safety observers must:

28.7.8.1. Be qualified to operate the equipment in use. **(T-1)**

28.7.8.2. Have a current climbing certification. **(T-1)**

28.7.8.3. Be proficient in CPR and first aid. **(T-1)**

28.7.8.4. Know the procedures for obtaining medical assistance. **(T-1)**

28.7.9. Tower and Pole Climbing Precautions. Refer to TO 31-10-19, *Antenna Systems—Anchors and Supports,* and TO 31R-10-5, *Air Force Comm Commands (E-I Standards) – Antenna Systems, Maintenance, Repair and Testing,* for requirements on tower and pole climbing.

28.7.10. Steps and Ladders. When installed, steps and ladders will be equipped with appropriate climbing safety devices. **(T-0)** Refer to Chapter 7, 29 CFR § 1910.29, *Fall Protection Systems and Falling Object Protection – Criteria and Practices,* 29 CFR § 1910.25, *Stairways,* and 29 CFR § 1910.23, *Ladders,* for additional guidance on steps and ladders.

28.7.11. Radome Installation, Maintenance, or Removal. Employees engaged in radome work will be experienced riggers and work under the direction of a qualified supervisor. **(T-0)**

28.7.11.1. Those who work on or in the immediate vicinity of the radome will wear hard hats and safety-toed shoes. **(T-0)**

28.7.11.2. Employees will make frequent checks with the supporting DAF weather organization to allow time to lash down equipment for impending inclement weather. **(T-1)** Employees will never try to replace panels when the wind is blowing more than 30 miles per hour and will never remove more than one panel at a time under normal conditions. **(T-0)**

28.7.11.3. Employees will use the maintenance rope to lift the maintenance ladder to the top of the radome. **(T-0)** Prior to each use, the rope will be inspected for frayed or worn spots and replaced, if required. **(T-0)**

28.7.11.4. When mixing resin for repairs, employees will follow the manufacturer's instructions. **(T-0)**

28.8. Ground-Controlled Approach Radars. The supervisor will inform all nearby personnel that work is being performed on the roof before ascending to the roof of the ground-controlled approach trailer or other rotating antenna location. The following will be accomplished: **(T-1)**

28.8.1. The surveillance antenna control switch will be turned off, locked out, and a warning sign or tag is placed on the high voltage power supply switch IAW hazardous energy control procedures. **(T-0)** Refer to **Chapter 21** for additional guidance on hazardous energy control requirements.

28.8.2. TO 35-1-3 requires rooftops of mobile ground-controlled approach vans be painted to warn personnel of rotating antenna hazards. **Exception**: In combat areas, the sweep area covered by antenna rotation may be indicated by a broken line of ¾ inch-wide red dashes.

28.9. Single Phase Portable and Vehicle-Mounted Generators.

28.9.1. 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:

28.9.1.1. The generator supplies only equipment mounted on the generator and/or cord and plug-connected equipment through receptacles mounted on the generator.

28.9.1.2. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

28.9.2. 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:

28.9.2.1. The frame of the generator is bonded to the vehicle frame.

28.9.2.2. 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.

28.9.2.3. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

28.9.3. Neutral Conductor Bonding. A neutral conductor will be bonded to the generator frame when the generator is a component of a separately derived system. **(T-0)** The bonding of any conductor other than a neutral within the generator to its frame will not be required.

28.9.4. Power Tools. The tools and equipment being powered by generators will contain three-wire cords with ground plugs. **(T-0)**

28.9.5. Fixed Wiring Systems. Portable and vehicle-mounted generators that supply fixed wiring systems will be grounded IAW NFPA 70, Article 250, *Grounding*. **(T-0)**

28.10. Repairs and Adjustments.

28.10.1. Repairs and adjustments will be made to energized circuits only when a power-on condition is essential. **(T-1)** Refer to applicable TO for additional guidance.

28.10.2. Repairs and adjustments of components, when the equipment slides are extended from their cabinets and voltages are applied, will be permitted only when specified by applicable TOs, manufacturer's instructions or approved isolation and troubleshooting methods. **(T-1)** Personnel not essential to the operation will be removed from the area while work is in progress. **(T-1)** When high voltages are present or transmitters of 1-kW power rating or higher are involved, the commander will approve procedures and adjustments not specified by TO or manufacturer's instructions. **(T-1)** Use identified PPE directed by TOs or manufacturer's instructions. **(T-1)** Insulated matting will be used and a qualified safety observer will be present. **(T-1)**

28.11. Power Distribution Panels.

28.11.1. Power Distribution Panels and Interlocks. Power distribution panels and interlocks will be secured to prevent personnel contacting energized circuits. **(T-0)** When equipment must be removed from service for inspection or repair, the appropriate circuit breaker or interlock will be locked open (off) and posted with a danger tag, warning sign, visual aid, or other suitable identification until the equipment is again ready for use. **(T-0)** Tape will not be used to "lock" open circuit breakers. **(T-0)** Refer to **Chapter 21** for additional guidance on hazardous energy control procedures.

28.11.2. Fuses and Circuit Breakers. The inside cover of fuse(s) and circuit breaker panels (or area adjacent if not equipped with a cover) will indicate in writing the equipment controlled by each fuse or circuit breaker. **(T-0)** Over-current devices will be installed in electrical circuits of a size and type to interrupt the current flow when the current exceeds the current rating of the equipment or exceeds the capacity of the conductor, whichever is smaller. **(T-0)** Replace blown fuses by the type required by the manufacturer or manufacturer's instructions. **(T-0)**

Use insulated fuse pullers when removing or replacing clip type or flat-mount cartridge fuses. Wire, foil, solder, and similar materials will not be used as substitutes for fuses. **(T-0)**

28.11.3. Carbon Blocks and Heat Coils. Prior to removal of operating carbon blocks or heat coils, a measurement of line potential will be made using a voltmeter having a minimum input impedance of 20,000 ohms per volt to ensure the foreign electromotive force which energized these protective devices is no longer present. **(T-1)** Do not remove carbon blocks and/or heat coils if the foreign electromotive force is still present. **(T-1)**

28.12. Radar and Microwave Equipment.

28.12.1. Radar and microwave equipment are sources of non-ionizing radiation. Instruct personnel on the hazards of non-ionizing radiation and do not expose them to levels above the permissible exposure limits outlined in AFI 48-109. **(T-0)**

28.12.2. Exercise caution when working on or adjacent to transmitter antennas. A transmitter connected to an antenna under inspection or repair will be de-energized IAW hazardous energy control procedures in **Chapter 21**. **(T-1)** Secure adjacent antennas creating hazardous levels of RF radiation at the work location to prevent exposure. **(T-1)** Employees will remove all jewelry prior to performing any task on equipment. **(T-0)** Review the site standard operating procedures 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, or other suitable will be posted on the console of the transmitter and in all other critical locations. **(T-1)**

28.12.3. Employees will not look into an open waveguide that is connected to an energized source of microwave radiation. **(T-1)**

28.12.4. A non-ionizing radiation warning sign will be posted in areas where a hazard may exist. **(T-1)** Refer to AFI 48-109 for additional guidance.

28.13. Entering Manholes, Handholes, and Unvented Vaults. All requirements in **Chapter 23** will be met before, during and after any entry operation.

28.13.1. Manholes, vaults, and handholes will be positively identified as to utility type (e.g., communication, electrical power distribution, sewer, etc.) and classification prior to entry. **(T-0)** Where confined space evaluation has not occurred, shop supervisors will coordinate with the occupational safety office to schedule a confined space evaluation. **(T-1)**

28.13.2. Unidentified cables will be evaluated to identify their utility type. **(T-1)** Cables will be evaluated using a nonintrusive device, such as a clamp-on voltmeter, to determine the presence of electrical voltage prior to beginning any work. **(T-1)** Although discouraged, a small percentage of manholes, vaults, or handholes may contain more than one utility type. In these few instances, caution will be used, and the cable will be positively identified before work is initiated. **(T-1)** When requested, installation CE will provide an electrician to determine safe procedures. **(T-1)**

28.14. Cables.

28.14.1. 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. **(T-0)** If minimum distances cannot be maintained, de-energize the power line before performing

installation or maintenance work. Employees will comply with the minimum approach distance requirements in UFC 3-560- 01, Table 3-1. **(T-0)**

28.14.2. Observe caution when installing messenger strand so the loose ends do not contact power lines. **(T-0)**

28.14.3. When crossing over roadways, railroads, walkways, etc., ensure proper overhead clearances are maintained. **(T-0)**

28.14.4. Before riding or placing a ladder against an aerial strand, test the strand by suspending approximately 300 pounds in the middle of the span. **(T-0)** An easy test method is to place a rope over the strand and have two employees suspend their weight on it.

28.14.5. Cable cars will not be ridden over power lines (primary or secondary). **(T-0)**

28.14.6. Check handlines for serviceability prior to use. **(T-0)** The line employee will remove the handline from the safety harness when they reach the work position and secure it to the pole. **(T-0)**

28.14.7. Use safety straps and safety harnesses while working on elevated work platforms such as aerial splicing platforms, pole platforms, ladder platforms, and terminal balconies. **(T-0)** Wear insulating rubber gloves when handling suspension strand that is being installed on joint-use poles. **(T-0)**

28.14.8. Underground and Buried Cables. Refer to TO 31W3-10-12 for guidance and requirements.

28.14.9. Pressurized Cables. Refer to TO 31W3-10-16, *Outside Plant Cable Pressurization*, for information and guidance.

28.14.10. Trenching and Excavations. Refer to TO 3lW3-10-12, *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.

28.15. Special Purpose Vehicles.

28.15.1. Inspection. Prior to operation, visually inspect the vehicle and check vehicle documentation, e.g., AF Form 1800, *Operator's Inspection Guide and Trouble Report,* to determine if it is serviceable. **(T-1)** Inspect for correct assembly, storage of equipment, and worn equipment. **(T-1)** 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. **(T-1)** Refer to AFI 24-302 for additional guidance.

28.15.2. 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 clear of the winch when used. **(T-0)** Winches are extremely powerful and caution will be exercised when used. **(T-0)** The winch operator will be trained on both the operation of a winch gear train and power takeoff lever movement. **(T-0)** Winch operators will wear leather gloves when handling a winch line and never hand feed the line onto the drum. **(T-1)** Inspect the winch line before use for defects such as broken or worn strands, kinks, flat spots, and worn eye loops. **(T-1)** Remove damaged or badly kinked winch lines from service. **(T-1)** Winch lines will not

be rigged to pull against the flange of the winch drum. **(T-1)** Some winches are designed for pulling while others are designed for raising or lowering. Winches will be used for their design purpose. **(T-1)**

28.15.3. Cable Reels. The safe handling, moving, and positioning of cable reels require trained operators in good physical condition. Pre-planning the move and final positioning will determine the best methods to use and identify any problems with the surface condition. **(T-1)** Use a spotter when backing cable reel trailers. **(T-1)** Caution will be used when handling cable reels and cable reel trailer as a full reel of large cable may weigh as much as 10 tons. Carefully control the movement of the reel to prevent the reel from tilting and provide a substantial runway of heavy planks when or uneven or soft ground. **(T-0)** 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. **(T-0)**

Chapter 29

BATTERIES – MAINTENANCE, HANDLING, AND STORAGE REQUIREMENTS

29.1. Scope. DAF 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 will use approved TO and manufacturer's instruction. **(T-1)** Commercial manufacturers' manuals are not authorized for DAF use on aircraft batteries and must be converted to technical data by the appropriate DAF Engineering Support Office or Systems Program Office. **(T-1)** The battery shop, room, or area will be designed to eliminate certain hazards associated with battery maintenance. **(T-1)**

29.1.1. Refer to UFC 3-520-05, *Stationary and Mission Batteries,* 29 CFR § 1926.403, *General Requirements (Electrical),* 29 CFR § 1926.441*, Batteries and Battery Charging,* and NFPA 70, including Article 480, *Storage Batteries*, and **Chapter 5**, *Special Occupancies*, for requirements regarding battery maintenance and operations. **(T-0)**

29.1.2. Refer to DAFMAN 32-1084 for guidance on battery facility requirements. 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 will be obtained from the applicable base agency. **(T-1)**

29.2. Safety.

29.2.1. Installation BE will accomplish an HRA on battery maintenance and operations. **(T-1)** The assessment will include engineering controls, PPE requirements, and required battery maintenance and operations procedures. **(T-1)**

29.2.2. Electrical components and systems will be de-energized and isolated from other energized circuits and/or power sources before working on, servicing, removing, or replacing a battery, unless directed by a TO or other documented requirement. **(T-1)** Refer to **Chapter 21** for additional guidance on hazardous energy control.

29.2.3. Battery Equipment and Charging Operations. Only trained and qualified personnel will be permitted to change, maintain, or charge batteries. **(T-1)** Qualified personnel or those accompanied by qualified personnel will be allowed access to battery shops, rooms, or areas. **(T-1)**

29.2.4. When working with corrosives, an emergency shower or eyewash unit will be provided for emergency use. **(T-0)** Refer to **Chapter 9** for additional information on emergency showers and eyewash units.

29.3. General Facility and Equipment Requirements for Battery Rooms and Areas. This paragraph addresses general requirements for lead acid and lithium type batteries utilized in aerospace, ground transportation, electrical ground infrastructure, office equipment, etc.

29.3.1. There are three common lead-acid battery technologies: flooded, gel and absorbed glass mat. A valve-regulated lead-acid battery, e.g., the absorbed glass mat and the gel battery (gel cell), is a type of low- maintenance lead-acid rechargeable battery. Because of their construction, valve-regulated lead-acid batteries do not require regular addition of water to the cells. The charging, maintaining, or storage of each battery type will follow the manufacturer's instructions and recommendations. **(T-1)**

29.3.2. For the architectural requirements for the storage, charging, ventilation, exhaust, and thermal management of Lithium Ion (Li-Ion) batteries for mobile applications and equipment, refer to UFC 3-520-05. **(T-0)** The installation of stationary battery applications using Li-Ion technologies are prohibited in occupied facilities per UFC 3-520-01. Installation BE will use ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance,* to determine ventilation requirements. **(T-0)**

29.3.3. Doors. Battery shop exit doors will swing outwards. **(T-1)** Refer to **paragraph 2.7** for roll up door requirements.

29.3.4. Floors, walls, ceilings, doors, and other painted surfaces in battery rooms and areas will be painted with an acid-alkali-resistant epoxy-poly-urethane paint. **(T-1)** These paints provide the most protection against corrosion.

29.3.5. All mechanical equipment and fixtures will be designed and specified to withstand the corrosive acid-alkali atmosphere from battery operations. **(T-1)**

29.3.6. Racks and Tools. Racks used to support batteries during charging will be made of or coated with non-sparking materials and designed to permit free access for servicing batteries. **(T-1)** Metal racks will be protected with an acid-alkali resistive coating, and the actual supports on which a battery rests will be made of non-conductive materials or be suitably insulated. **(T-1)** Tools used during battery charging or servicing will be non-conductive or coated with non-conductive materials. **(T-1)**

29.3.7. Work Surfaces. Work surfaces will be non-conductive, and resistant to both acid and alkali. **(T-1)** Whenever possible, battery servicing and maintenance will be performed on elevated, non-conductive racks. **(T-1)** These racks will allow air to flow under the battery to provide additional cooling to dissipate heat generated during charging and discharging. **(T-1)**

29.3.8. Charging Bench Floor Matting. Provide three-foot wide non-slip matting in front of all charging benches. **(T-1)** Matting protects personnel from electric shock and slipping hazards. Matting will conform to TO 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application.* **(T-1)**

29.3.9. Battery Charging of Powered Industrial Trucks. Refer to 29 CFR § 1910.178(g) for additional guidance.

29.3.9.1. Chargers will be turned off before a battery is connected or disconnected. **(T-1)** 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 will be through a mating plug or connector assembly. **(T-1)** Before performing work on charger plug contacts, employees will ensure chargers are turned off and disconnected from the input power source. **(T-1)**

29.3.9.2. Work will not be conducted on batteries while they are being charged or discharged unless otherwise specified by the applicable TO. **(T-1)** Refer to **Chapter 21** for additional guidance.

29.3.9.3. Charger leads will be kept off the floor and out of aisles to avoid damage and potential tripping hazards. **(T-1)** Overhead leads will be plainly marked and be high enough to keep personnel from walking into them. **(T-1)**

29.4. Fire Prevention.

29.4.1. 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 will be prohibited in the immediate vicinity of batteries that are being charged or discharged. **(T-1)**

29.4.2. Protection from Sparks. The following spark ignition sources will not be permitted in the vicinity of batteries:

29.4.2.1. Shorting out a battery with metal tools or objects. **(T-1)**

29.4.2.2. Connecting or disconnecting batteries while they are in use. **(T-1)** 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.

29.4.2.3. Vent cap removal. **(T-1)** If the battery is equipped with removable vent caps and removal is required for service by the battery manufacturer, combustible gases will be flushed out of each cell with a gentle stream of air (the use of proper mechanical ventilation), or manually (e.g., by fanning each vent opening with a stiff piece of cardboard or other suitable non-conductor). **(T-1)** PPE, to include face and hand protection, will be worn. **(T-0)**

29.4.2.4. Installing or replacing electrical components in the presence of flammable or combustible liquids. **(T-1)** The employee will keep battery ground cable disconnected until liquids are no longer present. **(T-1)**

29.4.2.5. Cleaning batteries or terminals. **(T-1)** Never clean batteries with metal brushes or other metal devices, which may generate sparks or contact both terminals and short circuit the cells.

29.5. Ventilation Systems.

29.5.1. The ventilation system will ensure the maximum gas-air mixture generated during charging is maintained below 25 percent of the lower explosive limit. **(T-1)** The installation BE's HRA will identify ventilation needs for battery shops, rooms, and areas IAW ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. **(T-1) Note**: NFPA 70 requires adequate ventilation to prevent classification of a battery location as a hazardous (classified) location. Without adequate ventilation, NFPA 70 requires installation of explosion proof lighting fixtures and receptacles.

29.5.2. Ventilation in battery charging rooms will be sufficient to keep rooms or areas maintained between 68°F and 85°F, unless permitted by a TO or other appropriate guidance. **(T-1)**

29.5.3. Batteries should not be operated, charged, or discharged at temperatures above 120° F to ensure normal service life. Floor fans with explosion-proof motors can help keep battery temperature from rising above 120ºF.

29.6. Storage and Handling.

29.6.1. Chemical Spills and Environmental Issues.

29.6.1.1. Precautions will be taken to prevent the electrolyte from spilling. **(T-1)** Batteries will not be laid on their side unless permitted by TO. **(T-1)** Batteries will not be transported without being properly secured with straps or other restraint devices. **(T-1)**

29.6.1.2. Spill control procedures will be developed and coordinated with the Occupational Safety office, installation BE, and CE. **(T- 1)**

29.6.1.3. Dispose of waste batteries and fluids in a manner consistent with approved hazardous waste disposal procedures and applicable environmental regulations. Contact installation CE for waste disposal guidance.

29.6.2. Vented lead-acid and vented nickel-cadmium batteries will be maintained and stored in separate rooms or areas. **(T-0)** The battery shop supervisor will 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. **(T-1)** If maintenance is performed while visitors are in the battery shop, the visitors will also wear required PPE and prescribed in **paragraph 29.2.1**. **(T-1)**

29.6.3. Sealed lead-acid batteries and sealed nickel-cadmium batteries do not require a dedicated battery room or area and can be charged in the same battery room or area with a five-foot minimum clearance between the different batteries.

29.6.4. The electrolyte in lead-acid batteries contains water. These batteries are subject to damage in freezing temperatures and will be stored in temperature-controlled areas. **(T-1)** Lower battery charges will allow for freezing at higher temperatures. **(T-1)**

29.6.5. Batteries of different chemistries will be stored as directed by the occupational safety office, installation BE, and CE. **(T-1)** Ensure nickel-cadmium 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. **(T-1)**

29.6.6. Batteries received during cold weather, or which cannot be disposed of during warm weather, will 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. **(T-1)**

29.6.7. 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 will not be attempted without proper equipment. **(T-1)** The battery weight is usually stamped on the steel tray near one of the lifting ears. The battery manufacturer will be consulted if the weight of a battery is not known and cannot be weighed. **(T-1)**

29.7. Electrical.

29.7.1. Electrical test equipment will be de-energized prior to being disconnected from circuits or power sources unless specifically directed by the appropriate TO. **(T-1)**

29.7.2. Receptacles and lighting switches will be located outside the battery maintenance or storage area. **(T-1)** Lighting fixtures will be protected from physical damage by guards or isolation. **(T-1)**

29.7.3. Flexible cords used for charging will be suitable for the type of service used and approved for extra-hard usage. **(T-1)** Connectors will have a rating not less than the current-carrying capacity of the cord. **(T-1)**

29.7.4. Refer to **paragraph 2.3** on the wear of jewelry and eyeglasses/safety goggles.

29.7.5. Refer to **Chapter 8** for additional guidance on electrical safety.

29.8. Installation and Care of Vehicle and Support Equipment Batteries.

29.8.1. Batteries will be installed in a level position to prevent leakage of electrolyte. **(T-1)** Excessive tightening of hold-down brackets can distort or crack the battery case. Cable clamps will not be pounded on battery terminals but will be spread until they can be seated properly. **(T-1)**

29.8.2. When removing a battery from a vehicle, the battery ground cable will be disconnected first to prevent the possibility of a spark. **(T-1)** Upon reinstallation, the battery ground cable will be installed and tightened last to prevent a short or spark and possible explosion. **(T-1)**

29.8.3. 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 will consult the appropriate TO for proper maintenance and procedures working on vehicles with two or more batteries. **(T-1)**

29.8.4. When removing or replacing a battery, if there is a possibility of shorting out the battery, the battery terminals will be covered with a non-conductive material, such as rubber or a piece of plywood. **(T-1)**

29.8.5. Vehicle Battery Jump-Starting. Battery jump-starting procedures will only be accomplished by trained personnel. **(T-1)** Follow TO guidance for proper jump-start procedures. If not available, follow the manufacturer's instructions.

29.8.6. The battery in most industrial trucks also serves as a counterweight for the carried load. A replacement battery will never be installed when its service weight is not within the range of battery weights marked on the truck nameplate. **(T-1)** A lighter weight battery could change the truck's center of gravity and upset a loaded truck.

29.8.7. Visual inspections are usually sufficient to determine the condition of contacts, which will be cleaned or replaced if they show evidence of oxidation or pitting. **(T-1)** Excessive heating of current-carrying parts indicates poor electrical contact which will be investigated and repaired. **(T-1)**

29.9. Aircraft Battery and Electrical System Specific Requirements.

29.9.1. Aircraft Electrical System Maintenance. Only trained personnel on aircraft battery and electrical systems will perform maintenance on aircraft battery and electrical systems. **(T-1)** Specialists will follow TO guidance whenever troubleshooting aircraft electrical systems. **(T-1)** When the TO does not cover a specific troubleshooting procedure, reference the aircraft wiring schematics.

29.9.2. Electrical systems will be de-energized TO requirements with a provision to effectively lockout and tagout the power source. **(T-1)** When the approved TO procedure requires work on an energized circuit, other maintenance personnel will be informed. **(T-1)** Use an AFTO Form 492, *MX Warning Tag*, as prescribed in technical data, lock out procedures, or both. **(T-1)** Refer to **Chapter 21** for additional guidance on hazardous energy control.

29.9.3. Aircraft Battery Shop Requirements. Batteries will not be charged while in the aircraft, unless permitted by the aircraft TO. **(T-1)** Battery chargers will carry at least one permanently affixed warning sign, which reads: *Warning—Keep 25 Feet Clear of Aircraft Engines and Fuel Tank Areas*. **(T-1)** Refer to NFPA 70 for additional guidance on Class I locations and aircraft hangars.

Chapter 30

MOTOR VEHICLE – OPERATIONS AND MAINTENANCE

30.1. Scope. This chapter provides information on general safety guidelines for vehicle maintenance facilities and operations, including refueler maintenance facility operations, equipment usage, and ventilation and exhaust requirements. Additionally, it covers the use, handling, and storage of solvents, such as MIL-PRF-680C, *Performance Specification: Degreasing Solvent,* welding operations, mobile maintenance, and vehicle repair pit requirements. Refer to **Table 30.1** for a list of additional references for motor vehicle operations and maintenance guidance.

Table 30.1. Motor Vehicle Guidance—Operation and Maintenance (O&M).

AFI 24-302, Vehicle Management
DAFI 24-301, Ground Transportation
DAFMAN 48-146, Occupational Health Program Management
TO 36-1-191, Technical and Managerial Reference for Vehicle Maintenance
TO 42B5-1-2, Gas Cylinders (Storage Type) Use, Handling and Maintenance

30.2. Specific Hazards.

30.2.1. Vehicle maintenance hazards include hazardous noise, compressed gases, pressurized air, toxic materials, flammable or explosive mists, aerosols, 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 aerosols 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.

30.2.2. Many chemicals including solvents can cause skin irritations, burns, and/or defatting of the skin. These chemicals, including solvents, can also be absorbed through the skin and cause internal damage. Paints containing epoxy or polyurethanes can cause employee sensitization, which is an allergic reaction to a given substance. Sensitivity usually occurs after exposure of a few days to a few months, and after sensitivity is established, even small exposures could produce a severe reaction. Refer to AFI 90-821 for additional guidance and information on chemical exposures.

30.3. General Safety.

30.3.1. Keep street clothing and protective clothing in separate lockers. **(T-0)** Work clothing will be stored in metal lockers, vented at top and bottom. **(T-1)**

30.3.2. Approved self-closing metal waste containers will be provided wherever rags or waste are impregnated with flammable or combustible materials and all such rags or waste deposited therein immediately after use. **(T-1)** IAW 29 CFR § 1910.107(g)(3), the contents of waste containers will be disposed of at least once daily or at the end of each shift. **(T-0)** Contact installation CE for waste disposal guidance. **(T-1)**

30.3.3. Backing of government-owned motor vehicles.

30.3.3.1. Government-owned motor vehicles equipped with back-up warning alert systems will be kept operational and not modified. **(T-0)**

30.3.3.2. Backing of government-owned motor vehicles and the usage of spotters will be IAW DAFI 24-301.

30.3.3.2.1. Government-owned motor vehicle operators will immediately stop if they lose visual contact with the spotter or notice the spotter is dangerously positioned between the vehicle and another object. **(T-1)** In such cases, vehicle operators will secure the vehicle, exit, and make an on-the-spot correction before continuing operations. **(T-1)**

30.3.3.2.2. Spotters will position themselves away from the vehicle's path of travel where they maintain visual contact with the vehicle operator. **(T-1)**

30.3.4. Respiratory protection is required where breathing of chemical vapors, mists or fumes is expected or if working in permit-required 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. Installation BE's OH Assessment identifies recommended controls to the unit.

30.4. Occupational Health.

30.4.1. Refer to **paragraph 2.2.2** for additional guidance on noise level surveys.

30.4.2. Stationary internal combustion engine-driven equipment will not be operated inside buildings unless an exhaust system, approved by installation BE, is installed, and used. When equipment is operated adjacent to buildings, the exhaust will be directed away from the building. **(T-1)** Ventilation will be adequate to provide fresh air and prevent accumulation of fuel vapors, carbon monoxide and other contaminants. **(T-1)** Refer to **paragraph 30.6** for additional guidance on ventilation.

30.4.3. Jet engine fuels containing toxic aromatics will be handled with the same precaution(s) as gasoline. **(T-1)**

30.4.4. First Aid. First aid kits will be approved by medical services IAW **paragraph 1.9**. **(T-1)**

30.5. Facility and Equipment Requirements for Vehicle Maintenance Operations.

30.5.1. Proper layout, spacing and arrangement of equipment and machinery are essential. The occupational safety office, F&ES Flight, installation BE, and installation CE will coordinate on all layout plans. **(T-1)** Refer to **Chapter 7** for additional guidance.

30.5.2. Only authorized shop personnel will be allowed on the shop floor, including escorted personnel. **(T-1)**

30.5.3. Vehicle operators and mechanics will sound vehicle horns before backing and intermittently during the entire backing operation unless vehicles are equipped with backup alarms. **(T-1)** Vehicle operators will stop and sound the horn prior to entering and leaving the maintenance shop. **(T-1)** A spotter will be posted when moving large equipment and vehicles backwards or in close quarters. **(T-1)** Refer to **paragraph 12.2.7** for additional backing/spotter guidance.

30.5.4. Shop entrances and exits will be clearly marked and lighted to prevent mishaps. **(T-0)** Appropriate traffic signs will be posted at entrances and exits. **(T-1)** To minimize mishaps, a maximum speed limit of five miles per hour will be enforced in and around shops. **(T-1)**

30.5.5. Floor slopes, drains and oil/water separators in shops will be constructed and maintained using guidance from installation CE. **(T-1)** Oil separators will be cleaned at a frequency determined by installation CE. **(T-1)** The shop supervisor will maintain the letter identifying the cleaning frequency and document compliance. **(T-1)** Drains will not be connected to sanitary sewers, except for the effluent from oil separators. **(T-0)**

30.5.6. When jacking a vehicle, consult the vehicle manuals for proper jacking procedures.

30.5.7. Do not perform work with high risk of injury, unless you are within quick communication with another person to assist in an emergency.

30.5.8. Machinery and Machine Guarding. Supervisors will maintain technical data, as well as manufacturer's operator instructions for all machinery and shop equipment in their area of responsibility. Machinery and shop equipment will be maintained and operated by trained personnel. Machine and power transmission guarding not covered in this manual, will be IAW equipment manufacturer's instructions and 29 CFR § 1910, Subpart O, *Machinery and Machine Guarding*. Refer to **Chapter 11** for additional guidance.

30.5.9. Portable Powered and Non-powered Hand Tools. Specific requirements unique to each tool will be contained in the technical data of that tool. **(T-1)** To determine required tools and equipment, consult TO 32-1-2. Allowance Standards 403, *General Purpose Tools*, Allowance Standards 457, *Vehicle Maintenance, Locomotive Maintenance, and Vehicle Operations*, and General Services Administration catalogs for requirements necessary for a particular maintenance mission. **(T-1) Note**: Refer to **Chapter 11** for specific requirements on hand tools.

30.5.10. Roll-up Doors. Refer to **paragraph 2.7** for roll up door requirements.

30.6. Fire Prevention.

30.6.1. The F&ES Flight will be consulted for specific shop requirements. **(T-1)** Refer to **Chapter 6** for additional guidance.

30.6.2. Open Flames. Flame-producing equipment will not be used in refueler maintenance shops. **(T-1)** Other vehicle maintenance shops may use flame-producing equipment if all safety procedures are followed and requirements in **Chapter 20** are complied with.

30.7. Ventilation.

30.7.1. Local Engine Exhaust Ventilation.

30.7.1.1. Vehicle maintenance shops will 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. **(T-1)** In shops with under floor systems, adapters will be used on equipment having vertical exhaust stacks to move the exhaust to the floor connections. **(T-1)** Hazardous gas concentrations will be monitored by installation BE and levels kept under exposure limits listed in DAFMAN 48-146. **(T-1)** The facility owner/operator will ensure a proper calibration schedule for the airborne gas analyzer. **(T-1)**

30.7.1.2. Exhaust ducts will be protected against mechanical damage. **(T-1)** In-floor ducts will be flushed with the floor, level when closed and capable of withstanding vehicle and equipment traffic or the maintenance operation being performed. **(T-1)** In-floor ducts will be equipped with a fluid collection system that prevents drainage into the sanitary sewage system. **(T-1)** 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 will be properly supported and located to avoid damage from moving vehicles and equipment. **(T-1)**

30.7.1.3. When not in use, ducting will be stowed in a way that prevents damage to the equipment and does not cause a hazard to personnel. **(T-1)**

30.7.2. General Engine Exhaust Ventilation. Supervisors will contact installation BE for a HRA IAW DAFMAN 48-146, if not previously assessed during the unit's OH Assessment, to determine the appropriate ventilation required to remove vehicle exhaust gases and fuel vapors. **(T-1)**

30.7.3. The following operations or processes may produce airborne contaminants that exceed exposure limits. The vehicle maintenance supervisor will request an evaluation by installation BE, who will document the results:

30.7.3.1. Spray painting, spray cleaning, solvent cleaning or stripping operations. **(T-1)**

30.7.3.2. Open surface tanks (e.g., dip tanks, etc.). **(T-1)**

30.7.3.3. Welding, soldering, torch cutting, and metalizing. **(T-1)**

30.7.3.4. Abrasive blasting operations. **(T-1)**

30.7.3.5. Metal cutting, grinding, buffing, and polishing operations. **(T-1)**

30.7.3.6. Machine shop operations (e.g., lathes, etc.). **(T-1)**

30.7.3.7. Battery shops. **(T-1)**

30.7.3.8. Open tanks on refueler vehicle. **(T-1)**

30.7.3.9. Brake disservice. **(T-1)**

30.7.3.10. Clutch linings.

30.7.4. If ventilation system deficiencies exist, contact installation BE to determine interim control measures. **(T-1)**

30.7.5. Periodic Testing. IAW DAFMAN 48-146, installation BE will perform periodic evaluations. **(T-1)** Installation BE will provide evaluation results to the vehicle maintenance supervisor. **(T-1)** 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 installation BE and shop supervisor.

30.8. Cleaning With Solvents.

30.8.1. General Requirements.

30.8.1.1. A metal tank or container approved for flammable or combustible liquid will be used to immerse articles or materials for cleaning, finishing, treating or similar processes whenever flammable or combustible cleaning materials are used. **(T-1)** The metal tank or

container will be labeled with the contents. **(T-1)** Care will be taken to avoid solvent spillage.

30.8.1.2. Care will 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 flammability, thus the need to understand the difference between solvents.

30.8.1.3. The following items will not be used as cleaning solvents: acetone, benzene, carbon tetrachloride, gasoline, isopropyl alcohol, methanol, methyl ethyl ketone, naphtha (solvent), perchloroethylene, toluene, trichloroethylene, or turpentine. **(T-1)** Commercial cleaning solvents or other non-flammable emulsion type cleaning liquids should be considered for use whenever possible.

30.8.1.4. Flammable cleaning solvents, jet fuel or AVGAS will not be used to clean floors or clothing. JP-8 may be used for parts cleaning provided the requirements of **paragraph 30.9.1.1** and any TO or manufacturer's restrictions are met.

30.8.1.5. Cleaning rooms will be equipped with adequate mechanical ventilation system blowers, and exhaust systems that conform to NFPA 91. **(T-1)** Installation BE will consult ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance,* and DAFMAN 48-146 for guidance. **(T-1)**

30.8.1.6. There will be no open flames, spark-producing devices, or heated surfaces having a temperature sufficient to ignite vapors in any vapor area. **(T-1)**

30.8.1.7. There will 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. **(T-1)**

30.8.1.8. There will be no open flames or spark-producing devices in any floor space outside a vapor area or within 20 feet (not separated by tight partitions), except as specifically permitted in NFPA 86. Areas in the vicinity of dip tanks will be kept as clear of combustible stock and will be kept free of combustible debris. **(T-1)**

30.8.1.9. Periodic inspection or tests of all dip tank facilities, including associated ventilation and fire protection equipment, will be made. **(T-1)** Any defects will be promptly corrected. **(T-1)**

30.8.1.10. *DANGER - NO SMOKING* signs will be conspicuously posted in the vicinity of dip tanks. **(T-1)**

30.8.1.11. Areas in the vicinity of dip tanks will have manual fire extinguishers suitable for combustible liquids. **(T-1)** Protection systems will be provided for tanks of 150-gallon capacity or more, or 10 square feet or more of liquid surface area. **(T-1)** Refer to NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*, for additional guidance.

30.8.2. Specific Requirements.

30.8.2.1. Personal Protective Equipment.

30.8.2.1.1. All personnel will wear protective gloves and keep the inside of gloves clean and dry while handling parts that are cleaned in degreasing solvent. **(T-1)**

Protective gloves and an apron will be worn when acids are poured or dumped. **(T-1)** Eye protection with side shields, certified by the manufacturer to be compliant with ANSI/ISEA Z87.1, will also be worn. **(T-1)** Refer to installation BE OH Assessment for specific PPE requirements. Refer to **Chapter 14** for additional guidance.

30.8.2.1.2. Employees will advise supervisors if they wear contact lenses. **(T-1)** Contact lenses may trap toxic or dangerous substances that are harmful to the eye. Contact lenses decrease the effectiveness of emergency eyewash fountains and can compound the severity of an injury. Soft contact lenses may absorb and be contaminated by chemicals, their vapors and/or fumes. Supervisors will contact installation BE for advice on contact lens wear while performing work in the shop. **(T-1)**

30.8.2.2. Vehicle Engine Cleaning. Follow TO 36-1-191 when cleaning installed engines. Employees will wear PPE IAW the installation BE's OH Assessment. **(T-1)** Refer to **Chapter 14** for additional guidance.

30.8.2.3. Solvent Storage, Handling and Usage. Bulk solvents will be stored in well-ventilated rooms, physically separated from other storage and operations. **(T-1)** Caution and warning labels will not be removed.

30.8.2.3.1. Stored leaking drums will be removed outdoors immediately so vapors or liquid will not collect and become a hazard. **(T-1)** Contact installation CE for proper disposal guidelines for leaking drums.

30.8.2.3.2. Drip pans will 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 will be used. **(T-1)**

30.8.2.3.3. The supervisor will be notified prior to using cleaning tanks located in an isolated room or facility. **(T-1)** Supervision should consider a buddy system to ensure immediate assistance is available if a mishap or emergency occurs.

30.8.2.3.4. Installation BE will determine the adequacy of ventilation in areas where solvents will be used, prior to their use. **(T-1)**

30.8.2.4. Oil and Hydraulic Fluid Spills. The owning organization will contain and clean the spill using the applicable method, such as compound, oil and water absorbent. **(T-1)** Contact installation CE for additional guidance.

30.9. Paint Shop.

30.9.1. General Requirements. To ensure safe and efficient operation, all painting activities will be performed IAW accepted safety standards and **Chapter 27.**

30.9.2. Specific Requirements.

30.9.2.1. Personal Protective Equipment. The installation BE's OH Assessment identifies recommended PPE. Refer to **Chapter 14** for additional guidance.

30.9.2.2. Housekeeping. Good housekeeping is essential to safe paint shop operations. Paint rooms will be kept clean, and their equipment stored in an orderly manner.

30.9.2.3. Spray Booths. All high-volume, low-pressure spraying will be accomplished in a paint booth to minimize health, fire, and explosion hazards. **(T-1)** The walls of these booths will be made of fire-resistant material that can be easily and frequently cleaned. **(T-1)** Refer to **Chapter 27** for additional guidance.

30.9.2.3.1. 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. Replace coverings frequently to prevent the accumulation of deposits. **(T-1)** This paper will be removed and disposed of IAW state and federal hazardous waste regulations. **(T-1)** Contact installation CE for disposal guidelines. Protective paper wall coatings will 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. Paint facilities with overhead sprinklers will have sprinkler heads covered with a paper bag to prevent paint overspray from clogging the heads. **(T-1)**

30.9.2.3.2. Direction of Spray. Personnel will 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. **(T-1) Warning:** Spray guns will never be pointed toward other personnel.

30.9.2.3.3. Hand Work. Ensure all recommendations and warnings listed on the container label are followed. **(T-0)** Adequate NIOSH-approved respiratory protection will be worn during the entire painting process. **(T-1)** Adequate exhaust ventilation will be provided in booths when hand-spray painting. **(T-1)** Refer to installation BE‘s OH Assessment for recommended controls. **Caution**: Some paints and additives contain toxic isocyanates that carry specific respiratory protection requirements. When applicable, the installation BE’s OH Assessment will outline specific respiratory protection required for isocyanate exposure. Refer to Chapter **14** and **29** CFR § 1910.134 for additional guidance.

30.9.2.4. Ventilation. Mechanical ventilation will be provided in all paint spray booths to prevent accumulation of flammable and injurious vapors. **(T-0)** Refer to the installation BE’s OH Assessment and 29 CFR § 1910.107, *Spray Finishing Using Flammable and Combustible Materials,* for additional guidance.

30.9.2.5. Interlocks. Electrical equipment for electrostatic hand spraying will be interlocked with spray booth ventilation controls so spraying cannot be done unless the ventilation fans are operating. **(T-0)** Refer to 29 CFR § 1910.107 for additional guidance.

30.9.2.6. Ensure hoses do not present a tripping hazard for personnel or are cut by passing vehicles. **(T-0)**

30.10. Air Compressors.

30.10.1. General Requirements.

30.10.1.1. Only trained personnel will repair or adjust pressure-regulating equipment. **(T-0)**

30.10.1.2. All personnel operating air compressors will be familiar with air compressor operating instructions. **(T-0)**

30.10.2. Specific Requirements.

30.10.2.1. All new air tanks and safety valves will be constructed, installed, and maintained IAW manufacturer's instructions. **(T-1)** The ASME's code seal is permanently stamped on tanks meeting this criterion. Refer to ASME's *Boiler and Pressure Vessel Code, Section VIII,* for additional information.

30.10.2.2. Air receivers will be installed so all drains are easily accessible. **(T-1)** Air receivers will be installed with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces. **(T-1)**

30.10.2.3. A drainpipe and valve will be installed at the lowest point of the air receiver to remove accumulated oil and water. **(T-1)** The drain valve will be opened, and the receiver completely drained daily to prevent accumulation of excessive amounts of liquid in the receiver. **(T-1)** Air receivers will be stenciled to reflect this requirement (exclude air receivers with automatic drains). **(T-1)**

30.10.2.4. Every air receiver will be equipped with a readily visible pressure indicating gauge and with one or more spring-loaded safety valves. **(T-1)** The total relieving capacity of such valves will prevent receiver pressure exceeding the maximum allowable working pressure by more than 10 percent. **(T-1)**

30.10.2.5. No valve of any type will be placed between the air receiver and its safety valve or valves. **(T-1)**

30.10.2.6. All safety valves will 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. **(T-1)**

30.10.2.7. Installed compressed airline outlets will have the delivered air pressure tagged or marked showing maximum working pressure. **(T-1)**

30.10.2.8. Air hoses will not be placed where they may create tripping hazards. All hoses will be inspected to ensure they are properly connected to pipe outlets before use. **(T-1)** Hoses will not be kinked to stop air flow. The control valve will be used to turn off the air. **(T-1)** Water hose type clamps or wire connections will not be used to replace or repair broken fittings.

30.10.2.9. When used for approved cleaning, compressed air will be regulated to less than 30 psi and only when effective chip guarding and eye protection is used. **(T-0)** Compressed air will not be used to blow dry parts since this process can increase the inhalation hazards to employees. **(T-1)**

30.10.2.10. Vehicles will not be parked or left running near air intakes of compressors used to supply breathing air. **(T-1)**

30.10.3. 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 will be used when cleaning with compressed air. **(T-0)**

30.10.3.1. A vacuum system or water hose will be used to remove dust, etc., from large surfaces. **(T-1)**

30.10.3.2. Compressed air will not be used to clean clothing or body parts.

30.10.3.3. Compressed air will not be used to "spin-dry" or "air-dry" bearings, unless permitted by the applicable TO.

30.10.3.4. Never point compressed air toward other personnel.

30.10.3.5. Assume all brakes contain asbestos, unless proven otherwise. Personnel will 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*. **(T-0)** Cleaning materials will be disposed of IAW local guidance. **(T-1)** Consult installation CE for further disposal guidelines. **Note:** Never use compressed air to clean clutch and brake assemblies.

30.11. Compressed Gas Cylinders. 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 DOT regulations and bear the DOT identification. This stamping is generally found near the neck of the cylinder. Subsequent re-inspections will be stamped in the same area. **(T-0)** The cylinder contents will be legibly marked on each cylinder in large letters. **(T-0)** Non-government owned cylinders will be tagged or otherwise marked to indicate cylinder contents. **(T-0)** Refer to **Chapter 19**, MIL-STD-101, 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.

30.12. Lifting Devices.

30.12.1. Inspection. Many lifting device problems can be detected prior to use if properly inspected. Periodic inspections will be performed by qualified inspection or maintenance personnel. **(T-1)** Test and certification of cranes and hoists will be performed by qualified inspectors. Certification, inspection, and test reports will be available on the premises where the crane or hoist is located, in the supervisor's office or in a central maintenance shop. **(T-1)** Refer to **Chapter 12** for additional inspection guidance.

30.12.2. Responsibilities. Responsibilities for periodic inspection, records, maintenance, and test of lifting devices and separate lifting aids will be as follows:

30.12.2.1. Permanently Installed Equipment (Real Property Installed Equipment). Installation CE will be responsible for Real Property Installed Equipment inspection requirements. **(T-1)** Real property installed-equipment includes installed equipment attached to and made part of buildings and structures, e.g., air conditioning/heating systems, but not movable equipment such as plant equipment.

30.12.2.2. Mobile Equipment. The vehicle maintenance officer and/or superintendent will be responsible for mobile equipment inspection requirements. **(T-1)**

30.12.2.3. Fixed Shop and Portable Equipment (Equipment Authorized Inventory Data). The owning organization will be responsible for fixed shop and portable equipment inspection requirements. **(T-1)**

30.12.2.4. Hoists and Cranes. Refer to specific technical data. If none is available, consult installation CE or occupational safety representatives. Refer to **Chapter 12** for additional guidance.

30.12.3. Specific Requirements.

30.12.3.1. Hydraulic Vehicle Lifts.

30.12.3.1.1. When operating hydraulic lifts, employees will:

30.12.3.1.1.1. Stand to one side of the vehicle as it is driven on or off the lift. **(T-1)**

30.12.3.1.1.2. Ensure the load rests squarely on the lift. **(T-1)**

30.12.3.1.1.3. 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. **(T-1)** This applies to vehicle lifts equipped with automatic locking devices that will not allow the vehicle to descend with loss of power.

30.12.3.1.1.4. Know the load limits of the lift and adapter and ensure it is not overloaded. **(T-1)**

30.12.3.1.1.5. Not lock the hoist controls in the open or shut position but operate them manually. **(T-1)**

30.12.3.1.1.6. Ensure vehicle lifts are equipped with a safety device to prevent accidental lowering. **(T-1)** 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 will be equipped with a lock which prevents raising by air if the oil supply is low. **(T-1)** 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.

30.12.3.1.2. Roll-on lifts will be equipped with stop chocks to prevent the vehicle moving while the lift is hoisting, lowering, or in the elevated position. **(T-1)** Stop chocks will be automatic (springing into position when the vehicle is on the lift). **(T-1)**

30.12.3.1.3. All vehicle lifts will be marked with the manufacturer's name, lift capacity and date of installation. **(T-1)** These markings will be stamped or etched on a metal plate permanently attached to the lift in a position where it can be inspected. **(T-1)**

30.12.3.1.4. All vehicle lifts will be equipped with "dead man" controls, which automatically return to *NEUTRAL* or *OFF* when released by an operator. **(T-1)** Controls will be located near the lift. **(T-1)**

30.12.3.1.5. A lift will not be used, and a hazard warning tag will be attached when it:

30.12.3.1.5.1. Jerks or jumps when raised. **(T-1)**

30.12.3.1.5.2. Slowly settles downward after being raised. **(T-1)**

30.12.3.1.5.3. Slowly rises, either when in use or when not in use. **(T-1)**

30.12.3.1.5.4. Comes down very slowly. **(T-1)**

30.12.3.1.5.5. Blows oil out of the exhaust line. **(T-1)**

30.12.3.1.5.6. Leaks oil at the packing gland. **(T-1)**

30.12.3.2. Electric Vehicle Lifts.

30.12.3.2.1. Inspect the lift daily; do not operate it if it has damaged parts which render it unsafe. **(T-1)** Repairs with original equipment manufacturer parts, or suitable substitute. **(T-3)**

30.12.3.2.2. Operating controls are designed to close when released. Do not block open or override them.

30.12.3.2.3. Do not exceed the manufacturer's rated capacity as shown on the lift nameplate. **(T-1)**

30.12.3.2.4. Do not operate the lift if any safety device is inoperative. **(T-1)**

30.12.3.2.5. Allow only trained and authorized personnel to position the vehicle and operate the lift. **(T-1)**

30.12.3.2.6. Never raise the vehicle with anyone inside, except to facilitate repairs. **(T-0)** Do not allow anyone under the vehicle when raising or lowering the lift. **(T-1)** When operating the lift, stand outside of it and keep hands clear of moving parts. **(T-0)** **Note**: This applies to vehicle lifts with automatic locking devices that do not allow the vehicle to descend with loss of power.

30.12.3.2.7. Keep the lift area free of obstructions, grease, oil, trash, and other debris. **(T-1)**

30.12.3.2.8. 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.

30.12.3.2.9. Position the vehicle on the lift to ensure contact with the manufacturers recommended lifting points. **(T-1)** Raise the lift until supports contact the vehicle. Check supports for secure contact with vehicle. Raise the lift to desired working height. Raise the lift high enough for the locking device to engage whenever someone is working under the vehicle.

30.12.3.2.10. Do not attempt to move the vehicle when it is lifted off the ground.

30.12.3.2.11. 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.

30.12.3.2.12. When performing maintenance on electrical lifts, ensure electrical power is disconnected unless required for checking unit operation.

30.12.3.2.13. Before lowering lift, ensure tool trays, stands, etc., are removed from under the vehicle and vicinity of the lift. **(T-1)** Release locking devices before attempting to lower the lift.

30.12.3.2.14. Lower lift slowly.

30.12.3.2.15. Before removing vehicle from the lift area, position lift arms and supports to provide an unobstructed exit.

30.12.3.3. Jacks. Vehicle maintenance personnel will not use hydraulic floor jacks, post jacks, or mechanical jacks to support vehicles while repair is accomplished. The vehicle

will be blocked and placed on approved axle or frame stands before a repair operation is started. **(T-1)**

30.12.3.3.1. The rated load of the jack will be legibly and permanently marked in a prominent location by casting, stamping, or other suitable means. **(T-1)**

30.12.3.3.2. Shop personnel will not use a leaking or faulty jack. **(T-1)** Defective jacks will be taken out of service immediately, tagged, and not used until repaired. **(T-1)**

30.12.3.3.3. Shop personnel will position jacks under vehicles to ensure the cap is properly located to preclude the jack slipping after the load is applied. **(T-1)** 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.

30.12.3.3.4. All jacks will be lubricated at regular intervals using lubricants recommended by the manufacturer. **(T-1)**

30.12.3.3.5. Improper jacking can cause serious injury or property damage. The following jacking procedures will be used:

30.12.3.3.5.1. Equipment will be chocked prior to jacking. **(T-1)**

30.12.3.3.5.2. Jack stands will be used any time equipment is under extended maintenance. **(T-1)**

30.12.3.3.5.3. Equipment will be removed from jacks as soon as possible. **(T-1)**

30.12.3.3.5.4. Equipment will be jacked to the minimum height required for the task. **(T-1)**

30.12.3.3.5.5. Personnel will only remain under a jacked unit for the time required to place axle or frame stands for support. **(T-1)**

30.12.3.3.5.6. Personnel will not position any portion of themselves under the tire or wheel of jacked equipment. **(T-1)**

30.12.3.3.5.7. Supervisors are responsible for ensuring jacks and jack stands of sufficient capacity are available and utilized.

30.12.3.3.5.8. Employees will ensure placement of jack does not cause damage. **(T-1)**

30.12.3.3.5.9. Jacks and jack stands will be inspected and maintained IAW equipment TOs or manufacturer's instructions. **(T-1)** Refer to 29 CFR § 1910, Subpart P, *Hand and Portable Powered Tools and Other Hand-Held Equipment,* for additional guidance.

30.12.3.3.5.10. Defective jack stands will be taken out of service immediately and tagged for disposition. **(T-1)**

30.13. Wheel and Tire Maintenance.

30.13.1. Employee Training.

30.13.1.1. 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, all personnel involved in wheel dismantling or

buildup operations will use applicable TOs, rim manuals, OSHA 3421, *Servicing Multi-Piece and Single-Piece Rim Wheels*, and this publication for the wheel involved. **(T-1)** Review procedures prior to starting tire maintenance operations.

30.13.1.2. Supervisors will ensure all employees who service multi-piece or single piece rims are trained in the proper servicing techniques and practices. **(T-0)** Employee's proficiency will be established by demonstrating their knowledge and use of the information contained in charts, rim manuals, TOs and this publication. **(T-0)**

30.13.1.3. Supervisors will ensure each employee demonstrates and maintains the ability to service wheels safely, including the following tasks:

30.13.1.3.1. Inspection of wheel components. **(T-0)**

30.13.1.3.2. Mounting of tires, including inflation within a restraining device or other safeguard required by this chapter. **(T-0)**

30.13.1.3.3. Use of the restraining device, barrier, and other equipment required by this chapter. **(T-0)**

30.13.1.3.4. Handling of rim wheels. **(T-0)**

30.13.1.3.5. Inflation of tire when a rim wheel is mounted on the vehicle. **(T-1)**

30.13.1.4. The supervisor will evaluate each employee's ability to perform these tasks and to service rim wheels safely and will provide additional training as necessary to ensure each employee maintains proficiency. **(T-1)**

30.13.2. Tire Servicing Equipment.

30.13.2.1. Supervisors will ensure servicing multi-piece rim wheels will be completed in a cage or rack to contain components during explosive separation. **(T-0)**

30.13.2.2. When servicing single piece rim wheels, the employee will use a restraining device or barrier, except where the rim wheel is bolted to the vehicle during inflation. **(T-0)**

30.13.2.3. Supervisors will ensure cages or racks meet the following requirements:

30.13.2.3.1. Each cage or rack will withstand the maximum force transferred to it during an explosive rim and tire separation occurring at 150 percent of maximum tire specification pressure for the type of wheel being serviced. **(T-0)**

30.13.2.3.2. Cages and racks will prevent rim wheel components being thrown outside or beyond the cage or rack for any rim wheel positioned within the device. **(T-0)**

30.13.2.3.3. A cage or rack will 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. **(T-0)**

30.13.2.3.4. Cages and racks will be visually inspected prior to each day's use and after any explosion or explosive separation of the rim wheel components. **(T-1)** Any Cage or rack exhibiting damage such as the following defects will be immediately removed from service:

30.13.2.3.4.1. Cracks at welds. **(T-0)**

30.13.2.3.4.2. Cracked or broken components. **(T-0)**

30.13.2.3.4.3. Bent or sprung components caused by mishandling, abuse, tire explosion or rim wheel separation. **(T-0)**

30.13.2.3.4.4. Pitting of components due to excessive corrosion. **(T-0)**

30.13.2.3.4.5. Rust or other structural damage. **(T-0)**

30.13.2.3.4.6. Inoperative air pressure warning light or gauge. **(T-0)**

30.13.2.3.4.7. Leaking, cracked, or deteriorating hoses. **(T-0)**

30.13.2.3.5. NDI techniques may be used to verify existence of cracks or other damage to welds whenever a tire/wheel failure occurs inside a cage or rack, a weld is found to be severely rusted or whenever a weld's integrity is in doubt. Accomplish a one-time NDI of all welds on locally manufactured cages racks.

30.13.2.3.6. Cages or racks removed from service and requiring structural repair, such as component replacement or re-welding, will not be returned to service until certified, by the manufacturer or a Registered Professional Engineer. **(T-0)** This certification will ensure the cage or rack 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. **(T-0)**

30.13.2.4. The supervisor will ensure a hose assembly consisting of the following components is used for inflating rim wheels:

30.13.2.4.1. A clip-on chuck. **(T-0)**

30.13.2.4.2. A sufficient length of hose to allow the employee to stand outside the trajectory. **(T-0)**

30.13.2.4.3. An in-line valve with a pressure gauge or an adjustable regulator. **(T-0)**

30.13.2.5. An approved tire inflator cage appropriately sized for tires being serviced will be used for inflating multi-piece wheels. **(T-0)** A regulator gauge, shutoff valve, service hose, and lock-on type chuck will be used with the cage to control the air when inflating. **(T-0)** In addition, a bleed valve will be used to relieve pressure in the hose when the tire is filled. **(T-0)** Refer to TO 36-1-191 for additional guidance.

30.13.2.6. A current OSHA 3421, along with OSHA charts entitled "*Demounting and Mounting Procedures for Truck/Bus Tires,*" and "*Multi-piece Rim Matching Chart*," will be available and posted in the service area. **(T-1)**

30.13.2.7. A current rim manual and TO 36-1-191, containing instructions for the types of wheels being serviced, will be available in the service area. **(T-1)**

30.13.2.8. The supervisor will ensure only tools recommended in the rim manual for the type of wheel being serviced are used to service rim wheels. **(T-0) Warning**: Failure to observe precautions outlined in this publication 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.

30.13.3. Wheel Component Acceptability.

30.13.3.1. Multi-piece wheel components will not be interchanged except as provided in the charts or applicable rim manual. **(T-0)**

30.13.3.2. Multi-piece wheel components and single piece wheels will be inspected prior to assembly. **(T-0)** Any wheel part bent out of shape, pitted from corrosion, broken, or cracked will not be used and will be rendered unserviceable and discarded. **(T-0)** Replace damaged or leaky valves. **(T-0)**

30.13.3.3. Rim flanges, rim gutters, rings, bead seating surfaces, and bead areas of tires will be free of any dirt, surface rust, scale or loose, or flaked rubber build-up prior to mounting and inflation. **(T-0)**

30.13.3.4. The size, including bead diameter and tire/wheel widths, and type of both the tire and wheel will be checked for compatibility prior to assembly of the rim wheel. **(T-0)**

30.13.4. Safe Operating Procedure – Multi-piece Rim Wheels. The supervisor will establish a safe operating procedure for servicing multi-piece rim wheels and will ensure employees are instructed in and follow that procedure. **(T-0)** The procedure will include, at least, the following elements:

30.13.4.1. Tires will be completely deflated by removing the valve core before a rim wheel is removed from the axle. **(T-1)** 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. Employees will use mechanical devices, such as dollies, to help them remove or mount large, heavy tires. **(T-1)**

30.13.4.2. A nonflammable rubber lubricant will 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. **(T-0)**

30.13.4.3. Tires mounted on multi-piece rims will only be inflated when constrained by a restraining device or placed in a tire cage. **(T-0)** Tires on multi-piece rims mounted on vehicles that are more than 20 percent under-inflated will not be re-inflated until inspected by a qualified person and the tire certified safe to re-inflate. **(T-0)** Safeguards, such as chains or remote-control inflation systems, will be used to encase the wheel and tire during the re-inflation process. **(T-0)** Supervisors will ensure no personnel are in the trajectory area during tire re-inflation. **(T-0)** Heat will not be applied to a multi-piece rim. **(T-1)**

30.13.5. Safe Operating Procedure – Single Piece Rim Wheels. The supervisor will establish a safe operating procedure for servicing single piece rim wheels and will ensure employees are instructed in and follow that procedure. **(T-0)** The procedure will include as a minimum the following elements:

30.13.5.1. Tires will be completely deflated by removing the valve core before demounting. **(T-0)** Mechanical devices, such as dollies, will be used to mount or remove large, heavy tires. **(T-0)**

30.13.5.2. Mounting and demounting of tire will be performed only from the narrow ledge side of wheel. **(T-0)** Avoid damage to tire beads while mounting tires on wheels. **(T-0)** Tires will be mounted only on compatible wheels of matching bead diameter. **(T-0)**

30.13.5.3. A nonflammable rubber lubricant will be applied to bead and wheel mating surfaces before assembly of the rim wheel and inflation of tire. **(T-0)**

30.13.5.4. If a bead expander is used to seat the beads, it will be removed before the valve core is installed and as soon as the rim wheel becomes airtight (the tire bead slips onto the bead seat). **(T-0)**

30.13.5.5. Tires may be inflated only when contained within a cage or rack, positioned behind a barrier, or bolted on the vehicle with lug nuts fully tightened. **(T-0)** Tires will never be serviced above the pressure stamped on the tire sidewall unless the manufacturer recommends a higher pressure. **(T-1)**

30.13.5.6. When inflating a tire, employees will not place a rim wheel where it will rest against or within one foot of any flat solid surface, as measured from the sidewall. **(T-0)**

30.13.5.7. Tires will not be inflated to more than their recommended operating pressure. **(T-1)** 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 TO or owner's manual. If this information is not available, TO 36-1-191 will be used to obtain the recommended tire pressure. **(T-1)**

30.13.5.8. Employees will stay out of the trajectory when inflating a tire. **(T-0)**

30.13.5.9. If the tire beads are not fully seated by the time the tire is inflated to its recommended pressure, the tire will be deflated, and rim wheel disassembled. **(T-1)** The wheel and tire will be rechecked for compatibility, re-lubricated, repositioned and then re-inflated IAW TOs and manufacturer's requirements. **(T-1)**

30.13.5.10. No heat will be applied to a single-piece wheel. **(T-0)**

30.13.5.11. Cracked, broken, bent, or otherwise damaged wheels will not be reworked, welded, brazed, or otherwise heated. **(T-0)**

30.13.5.12. High pressure air will not be used to inflate tires. **(T-1)**

30.13.5.13. Rims will be inspected and maintained IAW individual equipment manufacturer's rim manuals or TO 36-1-191. **(T-1)**

30.13.6. Demounting, Mounting, and Inflating All Types of Tires.

30.13.6.1. Personnel will:

30.13.6.1.1. 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.

30.13.6.1.2. Make sure all tools are in good condition – not damaged, dented, or deformed.

30.13.6.1.3. Remove valve core and exhaust all air from the tire (or tires, in the case of a dual assembly), before demounting. **(T-1)** Probe the valve stem with a wire as a final check to ensure the valve is not obstructed by foreign material. **(T-1) Caution**: Do not stand in front of valve opening, as dirt particles may be blown into eyes.

30.13.6.1.4. Block vehicle so it cannot roll forward or backward after it is lifted. **(T-1)**

30.13.6.1.5. Place large hardwood blocks under the jack. **(T-1)**

30.13.6.1.6. After the load has been raised, it shall be cribbed, blocked, or otherwise secured at once. **(T-0)**

30.13.6.1.7. Check rim diameter to ensure it matches rim diameter molded on tire. **(T-1)**

30.13.6.1.8. Clean and inspect used rim parts. **(T-1)**

30.13.6.1.9. Use new tubes and new flaps in new tires. **(T-1)**

30.13.6.1.10. Inspect inside of tire for loose cords, cuts, penetrating objects, or other damage. Tires that are damaged beyond simple repair will be removed from service. **(T-1)** Remove dirt, debris, and liquids from inside of tire before tube is installed.

30.13.6.1.11. Lubricate with approved rubber lubricant. **(T-1)**

30.13.6.1.12. 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. **(T-0)**

30.13.6.1.13. Center tire properly on rim before inflating. **(T-1)**

30.13.6.1.14. Securely lock wheel down in safety cage or rack before attempting to inflate tire to seat beads. **(T-0)**

30.13.6.1.15. Position the vehicle crane boom in the center of the hub prior to inflation of off-the-road tires in field service work. **(T-1)**

30.13.6.1.16. Check for proper flange and lock ring seating. **(T-1)**

30.13.6.1.17. Adjust air pressure to manufacturer's recommended cold operating pressure after beads have been seated. **(T-1)**

30.13.6.1.18. Inspect valve cores for proper air retention. **(T-1)** Replace damaged or leaky cores. **(T-1)**

30.13.6.2. Personnel will not:

30.13.6.2.1. Work on tire and rim assemblies until they review applicable safety practices and procedures. **(T-1)**

30.13.6.2.2. Loosen lug nuts on dual-wheeled equipment with split or multi-piece rims until all air is exhausted from both tires. **(T-1)** A broken or cracked rim part under pressure may blow apart and seriously injure or kill if lugs are removed before air is exhausted.

30.13.6.2.3. Apply heat or do repair work on an inflated tire, rim, or wheel assembly. **(T-1)** Heat can increase tire air pressure sufficient to burst the tire or rim.

30.13.6.2.4. Re-inflate a tire that has been run flat or seriously under-inflated without demounting that tire and checking tire and tube for damage. **(T-1)**

30.13.6.2.5. Mix rim parts of different manufacturers unless approved by those manufacturers. **(T-1)**

30.13.6.2.6. Rework, weld, heat, or braze rim parts. **(T-1)** Always replace damaged parts with same size, type and make.

30.13.6.2.7. Reuse tubes or flaps that have buckled or creased. **(T-1)**

30.13.6.2.8. Use a tube in a tire larger or smaller than that for which the tube was designed. **(T-1)**

30.13.6.2.9. Inflate beyond recommended bead seating pressure. **(T-1)**

30.13.6.2.10. Stand over tire when inflating. **(T-1)**

30.14. Maintenance Operations.

30.14.1. Body Shops.

30.14.1.1. Wear protective gloves when exposed to jagged edges of mangled fenders, decks and quarter panels. **(T-1)**

30.14.1.2. Wear full protective plastic face shield plus safety glasses or goggles when cutting or grinding glass. **(T-1)** When handling large sheets of glass, gloves will be used for a better grip and to keep hands from being cut. **(T-1)**

30.14.2. Welding in Vehicle Maintenance Shops.

30.14.2.1. General Precautions.

30.14.2.1.1. Inspect all equipment before use. **(T-1)** Equipment with worn, leaky, or burned hoses or damaged cables and connections will not be used.

30.14.2.1.2. Never weld or cut gas tanks, oil barrels, or drums without purging and inerting first. **(T-1)**

30.14.2.1.3. Weld behind flame resistant screens or in booths to protect other employees from flying sparks and flash burns. **(T-1)** Refer to **Chapter 20** for additional guidance.

30.14.2.1.4. Always provide adequate ventilation. **(T-0)** Arrange work so air movement pulls fumes away from the breathing zone. **(T-0)**

30.14.2.1.5. Wear clean, oil free, flame-resistant clothing while welding. **(T-0)** Wear protective gloves and apron (hearing protection may be required for some welding operations). **(T-0)**

30.14.2.1.6. Wear eye protection, as specified in **Chapter 20**. **(T-1)**

30.14.2.1.7. Provide a suitable fire extinguisher in the vicinity of the welding area. **(T-1)** Mount fire extinguishers (if space permits) on portable welding carts used in locations where adequate fire extinguishers are not available. **(T-1)**

30.14.2.1.8. Always mark hot work either with a sign or with chalk on the work itself. **(T-1)**

30.14.2.1.9. Store welding equipment securely when not in use. **(T-1)**

30.14.2.1.10. Have welding tasks evaluated by installation BE to determine the need for (and type of) respiratory protection. **(T-1)**

30.14.2.2. Gas Welding.

30.14.2.2.1. Store cylinders in areas that are isolated, protected, ventilated, dry and removed from any heat source. **(T-1)**

30.14.2.2.2. 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. **(T-1)**

30.14.2.2.3. Keep oxygen cylinders at least 35 feet away from oil, oil pits, and grease. **(T-1)**

30.14.2.2.4. Keep cylinder valve caps in place when cylinders are not connected for use. **(T-1)**

30.14.2.2.5. Shut cylinder valves off tightly when not in use. **(T-1)**

30.14.2.2.6. Do not use acetylene with tank pressure less than 15 psi.

30.14.2.2.7. Always leave the shutoff wrench on the valve stem. **(T-1)**

30.14.2.2.8. Secure all tanks with a chain or fire-resistant strap. **(T-1)**

30.14.2.2.9. Ensure cylinder contents are identified before use. **(T-0)**

30.14.2.3. Electric Arc Welding.

30.14.2.3.1. Carefully spread-out cables while performing work. **(T-1)** Avoid placing cables in walkway areas to prevent tripping hazards. **(T-1)**

30.14.2.3.2. Join ground and electrode cables with connectors designed for that purpose. **(T-1)**

30.14.2.3.3. Do not allow splices in the cable within 10 feet of the electrode holder. **(T-1)**

30.14.2.3.4. 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. **(T-1)**

30.14.2.3.5. Store electrode holders in a safe location away from objects which conduct electricity. **(T-1)**

30.14.3. Mobile Maintenance. Vehicles used routinely for mobile maintenance will 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. **(T-1)** In cold climate regions, efforts will be made to prevent containers of water from freezing.

30.14.4. Air Conditioning Maintenance. Gas and liquid coolants used in automotive air conditioners will be handled with care, especially those stored under pressure. Wear eye and face protection and gloves when servicing or purging these systems. **(T-1)**

30.14.5. Radiator Maintenance.

30.14.5.1. Never open a pressurized radiator while the engine is hot and use appropriate PPE when boiling out radiators. **(T-1)** The cleaning solutions contain caustic chemicals that will burn if splashed on the skin or face. Flush the skin with water if splashed.

30.14.5.2. Wear protective gloves when handling a damaged radiator because it may have jagged metal edges. **(T-1)**

30.14.6. Fuel Tank Repairs.

30.14.6.1. Remove vehicles with leaking fuel tanks from the shop immediately. **(T-1)** Ground the siphon tank and pump out remaining fuel into a safety can. **(T-1)**

30.14.6.2. If the tank requires welding, cutting, or soldering, clean out all fuel and fuel vapors. **(T-1)** 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 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.

30.14.7. Refueler Vehicle Maintenance Areas.

30.14.7.1. 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 will be no smoking within 50 feet of a refueler maintenance building. **(T-1)** Danger signs will be posted in the immediate area and worded as follows: *NO OPEN FLAME OR IGNITION SOURCE BEYOND THIS POINT*. **(T-1)** Refer to **Chapter 18** for additional guidance.

30.14.7.2. Static Grounding.

30.14.7.2.1. Aircraft refuelers will have a serviceable, static ground system. **(T-1)** Refueling equipment in a refueler maintenance facility or undergoing maintenance will be always connected to a serviceable ground, except when the vehicle is in motion. **(T-1)** Refueling maintenance support equipment will be grounded. **(T-1)**

30.14.7.2.2. Storage bins will be grounded if located inside the maintenance bay. **(T-1)**

30.14.7.2.3. Ramp ground rods will have resistance values of 10,000 ohms or less. **(T-1)** 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 will be removed or replaced. **(T-1)** Static ground test data will be maintained by installation CE. **(T-1)**

30.14.7.2.4. Fuel nozzle static grounding will be IAW TO 00-25-172. Only approved 75 amperes ground clips will be used IAW TO 00-25-172. **(T-1)**

30.14.7.2.5. Alligator clips will not be used to ground or bond aircraft and support equipment. Only specified ground wire will be used in the shop or on refueling equipment. **(T-1)** Ground cables will be inspected weekly for broken strands. **(T-1)** Repaired or newly constructed grounding cable assemblies will be checked for continuity. **(T-1)** User will check bonding devices on all aircraft refueling units and associated equipment to ensure proper bonding prior to use. **(T- 1)**

30.14.7.3. The supporting Air Force weather organization, IAW the weather support document, will advise the Fuels Management Flight of adverse or mission-limiting

weather, such as thunderstorms, lightning, strong winds, heavy rain, snow, or freezing precipitation. **(T-1)** All maintenance on fuel systems of fuel servicing vehicles will cease work conducted outside. The supporting Air Force weather organization will advise the Fuels Service Center when the adverse weather advisory is terminated. **(T-1)** Refer to **Chapter 3** for additional information on weather.

30.14.7.4. Personnel will ground themselves prior to entering a refueler maintenance shop. **(T-1)** **(T-1)** Personnel can ground themselves by touching their hand to the bare metal.

30.14.7.5. Certain areas in the refueler vehicle maintenance facility 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. Shut down the operation until the vapors are removed to maintain a safe working environment. **(T-1)**

30.14.7.6. Whenever major maintenance is required to the main tank, all fuel and fuel vapors will be cleaned out from the tank pumping system and filter separator and the tank purged prior to any maintenance. **(T-1)** Cleaning procedures will 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*. **(T-1)** Follow the precautions outlined in the applicable TO of the equipment being serviced and permit-required confined space requirements found in **Chapter 23**. **(T-1)**

30.14.7.7. When fuel filter elements are changed, old filters will be disposed of IAW installation CE regulations. **(T-1)**

30.14.7.8. A minimum of two personnel, one qualified in the task to be performed and the other a safety observer to provide assistance, will be available in the refueling maintenance site whenever repairs are done on a vehicle fuel system. **(T-1)** Permit-required confined space entries will be IAW **Chapter 23** and hazardous energy control procedures will be conducted IAW **Chapter 21**. **(T-0)** 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. A vehicle operator for the type of equipment being repaired may be the second person. Refer to AFI 24-302 for additional guidance.

30.14.7.9. Personnel performing maintenance on fuel trucks will not wear shoes with exposed nails or metal plates due to sparking risk.

30.14.7.10. All tools used in the refueling maintenance shop will be approved for such use. **(T-1)**

30.14.7.11. Axle stands, rated at least 10 tons, will be used for axle support on refuelers. **(T-1)**

30.14.7.12. Hydraulic jacks rated at least 10 tons will be used when lifting refueling vehicles. **(T-1)**

30.14.8. Refueler Maintenance Buildings.

30.14.8.1. An empty refueling vehicle contains fuel vapors that could create a fire or explode with contact by heat sources. Procedures will be developed prior to work in such spaces to eliminate the hazard prior to work start. **(T-1)** Except under conditions listed

below, no other vehicular equipment will be serviced or repaired in refueler maintenance shops when fuel servicing vehicles are present. **(T-1)**

30.14.8.1.1. 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.

30.14.8.1.2. Vehicle(s) containing only JP-4, AV-gas, Mo-gas or other low flashpoint fuels may be serviced or repaired in refueler maintenance shops when no other fuel servicing vehicles are present.

30.14.8.1.2.1. For remote/austere locations, commanders may authorize minor maintenance (e.g., lubrication, oil and filter changes, headlight and tire changes) in facilities not designed for refueler maintenance if the refueler vehicle is used to transport.

30.14.8.1.2.2. Commanders will 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. **(T-1)** Risk assessments will be coordinated with F&ES Flight and the occupational safety office. **(T-1)**

30.14.8.1.3. Because of the large number of fueling vehicles and carts normally assigned, a DAF installation will have a separately sited maintenance and repair facility, unless approved by AFCEC/COSM. **(T-1)** Maintenance and repair facilities will be physically separated from other inhabited structures and any other source of ignition by at least 50 feet. **(T-1)** Air National Guard units are recommended to separate inhabited structures and any other source of ignition by at least 50 feet due to space restrictions and fewer fueling vehicles and carts. Refer to AFI 24-302 and DAFMAN 32-1084 for additional guidance.

30.14.8.2. The refueling maintenance shop should be located near the refueling vehicle parking area to minimize travel distance and help keep refuelers off installation streets.

30.14.8.3. The shop will be located so emergency services have immediate and direct access on paved roads. **(T-1)**

30.14.8.4. Both external and internal earth grounds will be provided for the refuelers, and a lightning protection system provided for the structure. **(T-1)**

30.14.8.5. Separate lockers, washing, and eating areas will be provided for employees. **(T-0)** Adequate PPE for exposure to liquid fuels and vapors will be provided. **(T-0)** Refer to AFI 24-302 and DAFMAN 32-1084 for additional information.

30.14.8.6. The amount of space required for refueler maintenance areas is determined by the number of refueling vehicles assigned. Refer to DAFMAN 32-1084 for specific requirements.

30.14.8.7. Floor drains will always be kept clear of contaminants which have a potential for fire, safety, and health hazards. **(T-1)** Solvents or fuel will not be used to clean floor drains. **(T-1)** Use PPE identified by the installation BE OH Assessment for use when cleaning drains. **(T-1)**

30.14.9. Vehicle Maintenance Repair Pits.

30.14.9.1. Floor markings will be at least six feet from the edge of the pit in colors that contrast with the surrounding area, or places a warning line at least six feet from the edge of the pit, as well as stanchions that are capable of resisting: **(T-0)**

30.14.9.1.1. A force of at least 16 pounds applied horizontally against the stanchion at a height of 30 inches without tipping over. **(T-0)**

30.14.9.1.2. Or places a combination of floor markings and warning lines at least six feet from the edge of the pit. **(T-0)**

30.14.9.1.3. When two mor more pits in a common area are not more than 15 feet apart, the employer may comply by placing contrasting floor markings at least 6 feet from the pit edge around the entire area of the pits. **(T-0)**

30.14.9.1.4. Posts a readily visible caution signs that meet the requirements of **Chapter 17** that states, “Caution – Open Pit.” **(T-0)**

30.14.9.2. Toeboards may be omitted around vehicle repair, service, or assembly pits when the supervisor can demonstrate that a toeboard would prevent access to a vehicle that is over the pit.

30.14.9.3. All pits equipped with steps will have handrails and approved lighting IAW NFPA 70. **(T-1)** Steps will be painted, coated, or made with an approved nonskid material to prevent slippage. **(T-1)**

30.14.9.4. Adequate explosion-proof lighting will be installed in pits or portable explosion-proof extension lights furnished. **(T-1)**

30.14.9.5. Pits will be built with drains equipped with oil or grease traps and will not be connected to sanitary sewers. **(T-1)** Local exhaust will be evaluated by installation BE to determine if it is necessary to remove vapors. **(T-1)** Exhaust fans used in pit ventilation systems will be suitable for use with fuel vapors, e.g., have explosion-proof motors and non-sparking blades IAW NFPA 70. **(T-1)**

30.14.9.6. Pits will be cleaned regularly with soap and water or an approved caustic solution, but not flammable or combustible solvents to prevent fire, safety, and health hazards. **(T-1)** Use PPE identified by the installation BE OH Assessment for use during pit cleaning. **(T-1)**

30.14.9.7. To prevent accumulation of hazardous gases, the vehicle engine will not be operated while a vehicle is positioned over a repair pit, unless required by manufacturer’s instructions or TO. **(T-1)**

Chapter 31

COMPOSITE MATERIALS

31.1. Scope. Composite materials (e.g., fiberglass, carbon fiber, Kevlar) are widely used in DAF 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 will evaluate any operations involving composite materials. **(T-1)** **Paragraph 1.6.**, *Job Hazard Analysis,* and DAFI 90-802 will be consulted when working with composite materials. **(T-1).** For additional information, the OSHA Technical Manual, Section III, Polymer Matrix Materials: Advanced Composites, is available at **https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_1.html.** Composite operations involving confined spaces will follow guidance in **Chapter 23**.

31.2. Specific Responsibilities. Functional managers and supervisors will:

31.2.1. Ensure all personnel who work with or handle composite materials receive training associated with required tasks. **(T-0)**

31.2.2. Ensure employees performing composite repair and fabrication tasks, or handling or using hazardous materials, receive hazard communication training IAW AFI 90-821. **(T-0)**

31.2.3. Ensure SDSs are available for all hazardous materials used in composite work tasks. **(T-0)**

31.2.4. Ensure employees handling and storing flammable or combustible chemicals are trained in fire prevention and protection. **(T-0)** Refer to **Chapter 6** for additional guidance.

31.2.5. Ensure appropriate spill and containment control procedures, and materials are readily available in areas where composite materials are stored, dispensed, or used. **(T-0)**

31.2.6. Provide employees with PPE identified by the installation BE OH Assessment when handling composite materials and chemicals. **(T-0)** Refer to **Chapter 14** or additional guidance.

31.2.7. Coordinate with installation CE to establish procedures for hazardous waste disposal. **(T-1)**

31.3. General Requirements.

31.3.1. 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. Employees will refer to the TO and SDS prior to starting any work when hazardous materials or chemicals are involved or needed for the process. **(T-1) Warning**: Do not exceed manufacturer's maximum batch size or a violent exothermic reaction may result

31.3.2. Training. All personnel who work with composite materials will be trained on the hazardous properties of chemicals and materials used. **(T-0)** Job safety training will include PPE requirements, safe chemical handling procedures, and emergency treatment practices. **(T-1)** This training will be documented IAW DAFI 91-202. **(T-1)**

31.3.3. Hazard Communication. Employees will receive hazard communication training IAW AFI 90-821. **(T-0)**

31.3.4. Eyewash and Emergency Showers. Emergency shower facilities for composite repair shops will be installed IAW **Chapter 9. (T-1)**

31.3.5. Exposure Monitoring. Supervisors will consult installation BE to ensure employees who may be potentially exposed to airborne composite materials are monitored, and appropriate respiratory protection requirements are established IAW AFI 48-137. **(T-0)**

31.3.6. Fire Protection. All facilities and operating areas will have fire protection IAW NFPA. **(T-1)**

31.3.7. Ventilation Requirements. Ventilation for all composite repair and fabrication shops, as well as locations where composites are installed and repaired (e.g., on-aircraft repairs) must be based upon the recommendations provided in the unit's OH Assessment conducted by installation BE and installed IAW the manufacturer's instructions. **(T-1)**

31.3.8. Handling Flammable and Combustible Liquids and Materials. Refer to **Chapter 22** for additional information.

31.3.9. Storage Of Composite Materials. Composite materials, including resins and catalysts, will be stored IAW the manufacturer's instructions and SDSs. **(T-1)** If neither is available, storage will be IAW locally developed guidance prepared in coordination with F&ES Flight, occupational safety office, and installation CE. **(T-1) Note**: Composite materials may be destroyed or damaged by improper storage conditions.

31.3.9.1. Storage Inside Buildings. When the inside storage is incidental and not the primary purpose of the area, comply with **Chapter 22**, NFPA 30, the manufacturer's requirements. **(T-1)**

31.3.9.2. Outside Storage. To minimize the potential for environmental contamination, installation CE will coordinate on the siting of all outside storage areas. **(T-1)** Refer to **Chapter 22** and NFPA 30 for additional guidance.

31.3.10. Electrical Requirements for Flammable Vapor Areas. Facility wiring will be designed, installed and maintained IAW NFPA 70E,and UFC 3-600-01, and any specialized criteria identified to maintain the safety of the operation. **(T-0)**

31.3.11. Powered and Non-powered Equipment and Tools Used Near Flammable and Combustible Materials. Tools and equipment used in composite operations will be purchased, installed, and maintained to ensure they do not create an ignition source to chemicals, chemical byproducts, and finished products of the operation. **(T-1)**

31.4. Specific Applications.

31.4.1. Laboratories. All laboratories will have fire protection appropriate for their fire hazard classification NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals.* Develop chemical hygiene plan IAW AFI 90-821. **(T-0)**

31.4.2. Military Exchanges, Commissaries and Associate Retail Stores. Facilities offering un-reacted composite materials (e.g., auto body fillers, fiberglass repair kits) will ensure the materials are kept in their original containers and that all manufacturer precautions and use information is provided to purchaser at time of sale. **(T-1)** Damaged or leaking packages will be removed from sale and disposed of properly. **(T-0)** Contact installation CE for disposal guidelines. In rooms or areas accessible to the public, storage will be limited to quantities

needed for display and normal merchandising purposes. **(T-1)** For storage of flammable and combustible materials, refer to **Chapter 22** and NFPA 30.

31.5. Hazardous Waste Disposal. Supervisors will coordinate with installation CE to establish a hazardous waste material list for their unit and establish procedures for hazardous waste disposal IAW AFMAN 32-7002. **(T-1)**

31.6. Special Mishap Considerations. Composite material mishaps require special handling. Although burning composites may be extinguished, these materials may continue to smolder and outgas toxic vapors. The F&ES Flight, installation BE and installation CE will establish appropriate measures to handle mishaps involving composite materials. **(T-1)** Special firefighting and debris handling requirements are identified in TO 00-105E-9, *Aerospace Emergency Rescue and Mishap Response Information (Emergency Services)*.

31.7. Use of Composite Materials in New System Acquisition, and System and Process Modifications. New system acquisition or modification of existing systems and processes will be carefully reviewed for fire protection, occupational safety, health, and environmental impact prior to use by the applicable DAF Systems Program Office, Item Manager or Design/Process Engineer, and the technical data developing organization. **(T-1)** When composite handling/repair/fabrication processes are turned over to a contractor, the contracting officer will ensure associated DAF fire, safety, health, and environmental data is provided to the contractor. **(T-1)**

Chapter 32

PRECISION MEASUREMENT EQUIPMENT LABORATORY

32.1. Scope. This chapter addresses the hazards and safety requirements associated with PMEL operations. Refer to DAFMAN 21-113, *Air Force Metrology and Calibration Program Management,* for additional information and guidance on the Air Force's Metrology and Calibration program requirements. **Note**: Due to the inherent differences between Communication-Electronic maintenance and PMEL operations, guidance in **Chapter 28** does not apply to PMEL operations.

32.1.1. Housekeeping. A high standard of housekeeping is essential to safe operations in laboratories. Dry floors are essential to physical safety. Liquid spills on floors will be immediately cleaned and dried to minimize the possibility of slipping and falling. **(T-0)** In addition, wet floors provide a conductive surface which may cause electrical shock, injury, or death. All work and storage areas will be kept clean and free of unnecessary obstructions. **(T-0)** Equipment and materials will be stored in a safe and orderly manner. **(T-1)** Refer to **Chapter 2** for additional guidance on housekeeping.

32.1.2. Supervisor Responsibilities. Supervisors will:

32.1.2.1. Trained personnel on the location, selection and use of fire extinguishers, alarm systems, main power switches, and evacuation procedures. **(T-0)**

32.1.2.2. Provide CPR training for employees required to perform work on energized high voltage electric circuits. **(T-0)** Refer to **Chapter 1** for additional guidance.

32.1.2.3. Receive proper ionizing and non-ionizing radiation safety training for personnel performing maintenance on equipment from the IRSO. **(T-1)**

32.1.2.4. Ensure fire extinguishers are properly mounted, readily accessible, in a serviceable condition, and clearly visible IAW **Chapter 6**. **(T-0)**

32.1.2.5. Ensure all exits are clearly identified, posted with signs, doors unlocked, easily accessible and clear paths of egress are provided IAW **Chapter 6**. **(T-0)**

32.1.2.6. Ensure all new chemicals, machines and processes are evaluated by the occupational safety office, F&ES Flight, installation CE, and installation BE prior to introduction into the work area. **(T-0)** Once approved, all personnel will be trained prior to using the new chemicals, machines, or processes. **(T-0)** Document training for personnel. **(T-1)**

32.1.2.7. Comply with housekeeping requirements IAW **Chapter 2**.

32.2. Hazards. Personnel engaged in PMEL operations are exposed to several hazards, including exposure to electrical and electromagnetic energy, hazardous chemicals/materials, and flammable and combustible liquids and gases. 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 adhering to proper work procedures, engineering controls and facility design, and appropriate PPE and clothing.

32.2.1. Electrical Hazards. All sources of electrical energy can be hazardous, personal injury from electric shock and arcing may cause severe or fatal injuries. Safe electrical work practices,

safe equipment, and approved grounding procedures are essential to prevent electrical mishaps. Personnel working on, with or near energized electrical circuits or equipment will adhere to guidance in Chapters 8 and 21. **(T-1)**

32.2.2. Radiation Hazards. Hazardous radiation in PMEL operations may be classified as either ionizing or non-ionizing radiation.

32.2.2.1. Ionizing Radiation. 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. Refer to 29 CFR § 1910.1096, *Ionizing Radiation,* and AFMAN 48-148 for guidance on ionizing radiation hazards and DAFMAN 48-125 for guidance on use of ionizing radiation detection devices.

32.2.2.2. Non-ionizing Radiation. Refer to AFI 48-109 and 29 CFR § 1910.97, *Nonionizing Radiation,* for guidance on management of hazards associated with non-ionizing radiation. Employees 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. **(T-0)** All PMEL employees will be made aware of this requirement. **(T-1)** If there are questions, refer the employee to their medical provider for assessment.

32.2.2.2.1. 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, e.g., binoculars, telescopes, 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 AFI 48-139 for additional guidance.

32.2.2.2.2. Radio Frequency Radiation. Radio frequency radiation produces heat in body tissues. Absorption by specific body organs depends upon the frequency and intensity of the radio frequency radiation. It is possible for a person to absorb damaging amounts of radio frequency radiation in deep tissue and organs with little or no sensation of skin heating. Refer to AFI 48-109 for additional guidance.

32.2.3. Chemical Hazards. PMEL operations use and may expose personnel to hazardous chemicals, which is defined as a chemical that poses a physical or health hazard. This definition applies to most of the chemicals used in PMEL operations IAW DAFMAN 48-146.

32.2.4. Compressed Oil and Gas Hazards. Some testing and calibrating operations require use of compressed oil at pressures of 30,000 psi. An oil leak above 4,000 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.

32.2.4.1. When a TO calls for a safety shield, the safety shield will be impact-rated and 3/16-inch polycarbonate material at a minimum. **(T-0)** The safety shield will either be weighted or secured at the bottom to prevent tipping over when exposed to pressurized materials. **(T-0)**

32.2.4.2. The safety shield will be placed between the technician and Item Under Test (IUT) when pressure is applied to the IUT. **(T-0)**

32.2.4.3. If personnel are directly exposed to the rear of the IUT under pressure, a safety shield will be placed behind the IUT to protect from potential rear facing ruptures. **(T-0)**

32.2.4.4. If a safety shield placement is not feasible due to the location of the IUT, then face and eye protection will be used IAW **Chapter 14. (T-0) Warning**: Injected oil may be life threatening and require immediate medical treatment. Items under pressure may rupture with the potential to cause serious injury if over pressurized.

32.2.5. Fire Hazards. Flammable and combustible liquids will be handled, stored, and used IAW Chapters **22** and **6**. **(T-0)**

32.2.6. Laser Eye Protection. Appropriate laser eye protection will be worn when working with laser equipment. Consult the Laser Safety Officer and the unit's OH Assessment provided by installation BE for the type of laser eye protection required. **(T-1)** Lasers will be used in a controlled area and protection provided by required warning devices. **(T-0)** Refer to AFI 48-139 for additional guidance.

32.2.7. Respiratory Protection. Inhalation of toxic levels of hazardous materials may cause adverse health effects. These exposures may be short-term or long-term (chronic), 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 will protect the wearer from toxic levels of airborne chemicals. **(T-0)** Refer to the unit's OH Assessment provided by installation BE for respiratory protection requirements IAW Chapter **14** and **29** CFR § 1910.134.

32.3. Ventilation Systems. PMEL cleaning and work areas must have appropriate ventilation. **(T-0)** Ventilation at workstations will continue for a sufficient time after job completion to minimize residual vapors and provide adequate makeup air. **(T-0)** Installation BE will identify ventilation requirements, to include periodic testing IAW ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, DAFMAN 48-146, and FC 4-218-01F, *Air Force Criteria for Precision Measurement Equipment Laboratory Design and Construction*. **(T-1)**

32.4. Electrical Safety for PMEL Operations. Refer to Chapters **8** and **21** for additional guidance.

32.4.1. Laboratory Floors. The floor covering of calibration/repair areas will be as specified in FC 4-218-01F. **(T-0)** Floor coverings that are damaged or do not meet specified requirements, will be repaired or replaced. **(T-0)** Insulated mats or suitable substitutes are required when personnel are exposed to energized high voltage circuits. **(T-0)** Use TO 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application,* and TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance, and Test of Electrical Equipment,* for instructions on control, use, testing, inspection, and marking of insulating matting in addition to any manufacturer guidance. **(T-0)** Insulating matting must be permanently marked per 29 CFR § 1910.137. **(T-0)**

32.4.2. Equipment Grounding. Use the manufacturer's instructions, 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 guidance. **(T-0)**

32.4.3. Facility Ground. The facility ground will be marked at its connection to the ground buss bar. **(T-1)** The facility custodian will visually inspect the electrical and grounding systems monthly for security and damage. **(T-1)** After repairs, the facility ground will be tested for continuity and polarity by a qualified electrician. **(T-1)** Refer to AFMAN 32-1065 for additional guidance.

32.4.4. Buss bars will be clean, free of corrosion and connections periodically checked for tightness. **(T-1)**

32.4.5. Equipment Electrical Safety Devices.

32.4.5.1. Interlocks will not be disabled during maintenance or adjustments unless prescribed by the manufacturer's instructions or applicable TOs. **(T-1)** During these periods, a sign stating “Danger Interlocks Disabled” or other suitable commercially available substitute will be placed on the equipment. **(T-1)** Interlocks will not be permanently disabled or bypassed. **(T-1)** Refer to Chapters **17** and **21**, and **29** CFR § 1910.306, *Specific Purpose Equipment and Installations*, for additional information on hazardous energy control procedures and requirements.

32.4.5.2. Only qualified technicians will perform repair work on equipment with defective interlocks. **(T-1)** Refer to 29 CFR §§ 1910.303, 1910.305 and 1910.306 for additional guidance regarding interlocks.

32.4.5.3. When personnel are exposed to energized high voltage circuits, e.g., greater than 600 volts, safety observers trained in CPR will be present, unless the area supervisor determines the risk of the operation does not warrant a safety observer. **(T-0)** Personnel will follow guidance in UFC 3-560-01 when an arc flash hazard exists. **(T-0)**

32.4.6. Fuses and Circuit Breakers. Use NFPA 70 for circuit breakers/fuse box identification requirements. **(T-1)**

32.4.6.1. Circuit breakers or fuses will be installed in all electrical circuits to interrupt the current flow when it exceeds the current carrying capacity of the conductor and/or circuit. **(T-0)** Do not bypass circuit breakers and fuses. **(T-0)** Refer to 29 CFR § 1910.306 for additional guidance.

32.4.6.2. Equipment fuses will always be replaced by fuses of the size and type required by the TO or manufacturer's instructions. **(T-1)** Use insulated fuse pullers to remove and replace cartridge fuses. **(T-1)** Do not use wire, foil, solder, or other conductive materials 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. Refer to 29 CFR § 1910.306 for additional guidance.

32.4.7. Grounding Sticks. A grounding stick will be available for use at electronic workstations where residual voltages may be encountered during maintenance on de-energized equipment. **(T-1)**

32.4.8. Adjustments and Testing of Equipment. Electrical power will be disconnected before technicians perform adjustments or repairs not involving alignment of mechanical/electrical components. **(T-0)** Adjustments with power on will only be accomplished when required by

applicable TOs or manufacturer's instructions. **(T-1)** Technicians performing the adjustment/alignment will use insulated tools to minimize the possibility of shock or damage to equipment components. **(T-1)** Refer to **Chapter 21** for proper hazardous energy control procedures.

32.4.9. Electrical Safety Boards. Refer to **Chapter 8** for required items included in an emergency equipment kit or board.

32.5. Radioactive Material Safety.

32.5.1. Radioactive material will be handled in a manner that results in as low as reasonably achievable (ALARA) exposures to personnel. **(T-1)** The IRSO and/or installation BE will prescribe special procedures and precautionary measures as necessary. **(T-1)** In overseas areas, disposal procedures will be coordinated with the IRSO and installation BE. **(T-1)** Refer to AFMAN 40-201 for additional guidance.

32.5.2. Personnel will not handle or expose a radioactive source except as required in the performance of duty. **(T-1)** Personnel using or exposed to radioisotopes will receive formal training, followed by continuing OJT. **(T-1)** No one will be authorized to use, handle, or access any area with an exposed or open ionizing radiation source without the employee and task being evaluated by the RSO for possible entry into the US Air Force Dosimetry Program and placed on the dosimetry program. **(T-1)** Refer to DAFMAN 48-125 for additional guidance.

32.5.3. In restricted areas where radioactive material is used or stored, appropriate placards will 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. **(T-0)** Obstacles, such as rope, barricades, etc., will be used to discourage unauthorized entry into controlled areas. **(T-1)** Individual containers of radioactive material within the area will be appropriately identified. **(T-1)**

32.5.4. Pregnant military personnel must report to PH, and civilian employees will report to PH, who will, in coordination with installation BE and the Primary Care Manager, document health risks and preventive actions. **(T-1)** For military personnel, an AF Form 469, *Duty Limiting Condition Report*, will be completed and sent to the supervisor. **(T-1)**

32.5.5. Eating or drinking in any area in which a radiation ingestion hazard may exist is strictly forbidden. **(T-0)** Personnel working with radioactive materials will wash their hands and face before eating or drinking and upon leaving a contaminated area. **(T-0)**

32.5.6. Regardless of radiation intensity, radioactive items used in PMEL operations will not be carried in pockets or clothing of personnel. **(T-1)**

32.5.7. In addition to placards, positive measures, such as locked or guarded gates or doors, will be established to prevent unauthorized entry into high radiation areas IAW AFMAN 48-148. **(T-1)**

32.5.8. When containers of radioactive materials are broken or damaged, the area will be evacuated of all personnel and implement the emergency response plan IAW DAFI 10-2501, *Emergency Management Program.* **(T-1)** Personnel essential to evaluating the condition of the material, recovery of the radioisotope, or decontamination of that area will be authorized access. **(T-1)** The PMEL supervisor and IRSO will be notified of the situation. **(T-1)** A survey of the area will be conducted to determine the extent of the radiological hazard. **(T-1)** Personnel

who may have been exposed will be monitored to determine the extent of medical action required. **(T-1)** The IRSO will direct the decontamination or recovery operation. **(T-1)** Broken or damaged items will be properly packaged and disposed of. **(T-1)** Refer to AFMAN 40-201, *Radioactive Materials (RAM) Management,* for additional disposal and handling instructions. **(T-1)**

32.6. Equipment/Component Cleaning.

32.6.1. Vacuuming using a nonmetallic wand and suction nozzle is the preferred method for cleaning electronic equipment. When using compressed air, five psi is adequate for equipment cleaning; do not exceed 30 psi. **(T-0)** Refer to TO 00-25-234 for additional guidance.

32.6.2. Only approved and authorized solvents will be used with adequate ventilation. **(T-0)** Consult installation BE if the characteristics of a solvent are in question and request a HRA if not previously assessed during the unit's OH Assessment. **(T-1)** Required PPE will be worn. **(T-0)** Refer to **Chapter 14** for additional PPE requirements when working around solvents.

32.6.3. Ultrasonic Cleaning. When using ultrasound-cleaning equipment, employees will follow the manufacturer's instructions for parts and equipment cleaning. **(T-1)** Refer to TO 00-25-234 for additional guidance.

32.7. Tools and Equipment.

32.7.1. Insulated tools will be used when performing work on energized equipment. **(T-1)** Placing rubber grips or tape on un-insulated tools does not make them acceptable insulated tools. Wooden handle tools will not be used on energized equipment. **(T-1)**

32.7.2. Only wood or fiberglass ladders are acceptable for work on or near electrical equipment. Refer to **Chapter 7** for additional guidance on portable ladders.

32.7.3. Ground wrist straps will be disconnected when personnel are exposed to or working on energized electrical circuits. **(T-1)**

32.7.4. Industrial equipment such as floor hoists, cranes, drill presses, grinders, and polishers may pose hazards to technicians. Consult applicable maintenance, commercial data, **Chapter 11**, and TO 34-1-3 for proper operation and maintenance of such equipment.

32.7.5. Radar and Microwave Equipment. Radar and microwave equipment are sources of radio frequency radiation. Personnel will be instructed on radio frequency radiation hazards prior to working on this equipment and will not be exposed to radio frequency radiation levels above permissible exposure limits. **(T-0)** Caution will 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. **(T-1)** A radio frequency radiation warning sign will be posted in areas where access to power density levels exceed the permissible exposure limit. **(T-1)**

32.7.6. Hydraulic and Pneumatic Pressure Systems. TO 00-25-223, *Integrated Pressure Systems and Components (Portable and Installed)*, provides safe operating procedures for this equipment and will be followed when using this equipment. **(T-1)**

32.7.7. Calibration/Repair of Fluid Analysis Equipment. Exposure to acids, electric current, and petroleum distillates may occur when performing oil analysis operations and maintenance. Employees will wear appropriate PPE when using this equipment and associated chemicals. **(T-1)**

32.7.8. Calibration/Repair of Radiation Measuring Equipment. Personnel will follow AFI 48-109, AFI 48-139, and AFMAN 40-201 when calibrating or repairing radiation test, measuring and diagnostic equipment. **(T-1)**

Chapter 33

PROCESS SAFETY MANAGEMENT (PSM) OF HIGHLY HAZARDOUS CHEMICALS

33.1. Scope. The DAF implements 29 CFR § 1910.119, *Process Safety Management of Highly Hazardous Chemicals,* requirements to prevent or minimize consequences of catastrophic releases of toxic, reactive, flammable or explosive chemicals. The regulations found on 29 CFR § 1910.119 will be complied with for program implementation and application. **(T-0)** PSM may also apply to explosives and pyrotechnics. Refer to 29 CFR § 1910.119 and Mil-STD-882E for additional guidance.

33.2. OSHA Regulation. 29 CFR § 1910.119, Appendix A, *List of Highly Hazardous Chemicals, Toxics and Reactives,* is the mandatory appendix under PSM that contains a list of chemicals known to be toxic, reactive, flammable, and/or explosive. These chemicals, whether used in a mixture or a byproduct of a chemical process and/or reaction have the potential for a catastrophic event at or above the Appendix threshold quantities. **Note:** 29 CFR § 1910.119, Appendix A will be referred to as "Appendix A."

33.3. Responsibilities.

33.3.1. Commanders and/or functional managers of organizations that own chemicals above the Appendix A thresholds will:

33.3.1.1. Identify an individual to serve as the unit's PSM Program Manager. **(T-1)** This must be an employee with expertise in engineering and process operations that, alone or as a team lead, has the specific experience and knowledge of the process being evaluated and knowledgeable of the specific process hazard analysis (PHA) methodology used. **(T-0)** The PSM Program Manager will lead the PSM Program Team in conducting the PHA, developing operating procedures, development of training, and any other requirements necessary to comply with 29 CFR § 1910.119. **(T-1)** IAW 29 CFR § 1910.119, the PSM Program Manager will:

33.3.1.1.1. Identify the designated organizational representative(s) and PSM Program Manager(s) to the Hazardous Materials Management Process (HMMP) Team in writing. **(T-1)**

33.3.1.1.2. Maintain oversight of the organization's program and ensure compliance. **(T-0)**

33.3.1.2. Ensure the organization establishes, documents, and maintains a PSM Program IAW 29 CFR § 1910.119. **(T-0)**

33.3.1.3. Support the organization in establishing and maintaining the PSM program. **(T-1)**

33.3.1.4. Ensure the PSM Program Manager and organizational process team members, prior to PSM operations, receive training IAW 29 CFR § 1910.119, initially and refresher training every three years. **(T-0)**

33.3.1.5. Employee training will be documented with the name of employee, date of training, and means used to verify the employee understands the training. **(T-0)**

33.3.1.6. Ensure an initial PHA is completed IAW 29 CFR § 1910.119(e). **(T-0)** At least every five years or when changes occur, the PHA will be updated and certified for accuracy. **(T-0)** These PHAs may be performed by internal staff members, contractors or a combination of both, who meet 29 CFR § 1910.119(g), *Training Requirements*.

33.3.1.7. Maintain all documentation developed in support of implementing the PSM program for program assessment by F&ES Flight, installation CE, installation BE, and occupational safety or appropriate federal agencies. **(T-1)**

33.3.2. Tenant organizations will notify host occupational safety for assistance in contacting the appropriate agencies to assist in determining if a PSM program is required. **(T-1)**

33.3.3. The Occupational Safety office will:

33.3.3.1. Assign safety personnel to assist process owners with coordinating PSM procedures with appropriate agencies. **(T-1)**

33.3.3.2. Assign the OSM to maintain written certification of PSM compliance with 29 CFR § 1910.119(o)(1) for Higher Headquarter, OSHA or other regulatory inspection. **(T-0)**

33.3.3.3. Assess installation operations and advise MAJCOM/FLDCOM of the number and type of operations that fall under the PSM program annually or when changes occur. **(T-1)**

33.3.4. Installation BE will assist organizations with PSM programs to ensure HAZCOM requirements are met. **(T-1)**

33.3.5. F&ES Flight will be involved with PSM program planning to ensure adequate emergency response is planned into the process. **(T-1)**

33.3.6. Installation CE will be involved with PSM program planning to ensure adequate compliance with Environmental Protection Agency (EPA) regulations. **(T-0)**

33.3.7. Installation Emergency Management will support the PSM Team to ensure emergency actions from catastrophic events are incorporated into the installation Emergency Management Plan 10-2. **(T-1)**

33.3.8. Other installation agencies will support, as required. **(T-1)**

33.3.9. PSM Program Team.

33.3.9.1. The PSM Program Team is a cross functional team (CFT) where representatives from multiple installation organizations brought together to assist the affected organization evaluate the process and identify hazards under evaluation. The team includes installation BE and CE, F&ES Flight, occupational safety, employees with expertise in engineering and process operations, employee(s) who have experience and knowledge specific to the process being evaluated and the PSM Program Manager.

33.3.9.2. The PSM Program Team will meet to identify hazards in the chemical process and facilities, identify controls applicable to the hazards, and coordinate emergency response actions. **(T-1)**

33.4. Chemical Process and Storage Review. Certification of PSM Program compliance will be conducted every three years or when new chemicals, increased quantities of chemicals, or processes that contain chemicals listed in Appendix A are introduced to the installation. **(T-0)**

33.4.1. Occupational safety, in coordination with the HMMP team will conduct and certify an assessment of the installation's chemical quantities on-hand of those chemicals listed in Appendix A and their location on the installation. **(T-0)**

33.4.2. When chemicals on the installation do not exceed the threshold quantities listed in Appendix A, the occupational safety office will maintain written certification that Appendix A threshold quantities were not exceeded and a PSM program is not required. **(T-0)**

33.4.3. If the chemicals on the installation do exceed the threshold quantities listed in Appendix A:

33.4.3.1. The occupational safety office, in consultation with the HMMP Team, should evaluate all locations containing the Appendix A chemicals for proximity to one another for exceedance of the threshold amounts.

33.4.3.1.1. If there is no possible way for chemicals at the sites to interact with one another or initiate unintentional release of material and the quantity on-hand does not exceed the threshold quantity, then a PSM program may not be required. Ensure a copy of OSHA-required PSM documentation listed in **paragraph 33.4.2** is maintained in the occupational safety office for higher headquarter or other regulatory agency review, e.g., OSHA, EPA. **(T-0)**

33.4.3.1.2. Chemicals at sites that exceed threshold quantities in Appendix A or are in close proximity to one another where chemicals could interact to exacerbate unintentional release or pose hazards to personnel nearby, a PSM program is required. **(T-0)** The occupational safety office will advise the installation commander and affected organization commander of the exceedance and that a formal PSM program is required. **(T-0)**

33.4.3.2. The organization with the exceedance has responsibility for establishing a PSM program IAW 29 CFR § 1910.119. **(T-0)**

33.5. Training. It is very rare for installations to have an Appendix 1 exceedance that drives the need for a PSM program. PSM training will be provided to all personnel who may be subject to the requirement for an organizational PSM program. **(T-1)** Training will focus on making employees knowledgeable of basic PSM requirements, principles, how to recognize process hazards (e.g., chemical releases, fires, explosions), and know their role in preventing incidents. **(T-0)**

33.5.1. Safety Office Personnel. Safety personnel will be familiar with 29 CFR § 1910.119 and this chapter. **(T-0)** Personnel need an awareness level of understanding of the PSM elements; hazard awareness, to include chemical properties, reactivity, toxicity and physical hazards; and emergency response, including evacuation procedures, spill containment and communication protocols. Awareness training will be conducted upon initial assignment and as needed, thereafter, to be able to identify program requirements. **(T-2)**

33.5.2. PSM Team Lead. When a PSM program is required, the PSM team lead is the organizational focal point for managing the program whether the analysis is performed "in-house" or contracted out. The PSM lead will be knowledgeable of 29 CFR § 1910.119 requirements and this chapter when fulfilling duties as described above. **(T-0)** When filling

this role, the PSM team leader will receive in-depth PSM training, which is commercially available. **(T-1)** Training will cover the following items:

33.5.2.1. Understanding chemical hazards and risks. **(T-1)**

33.5.2.2. Operating procedures and safe work practices. **(T-1)**

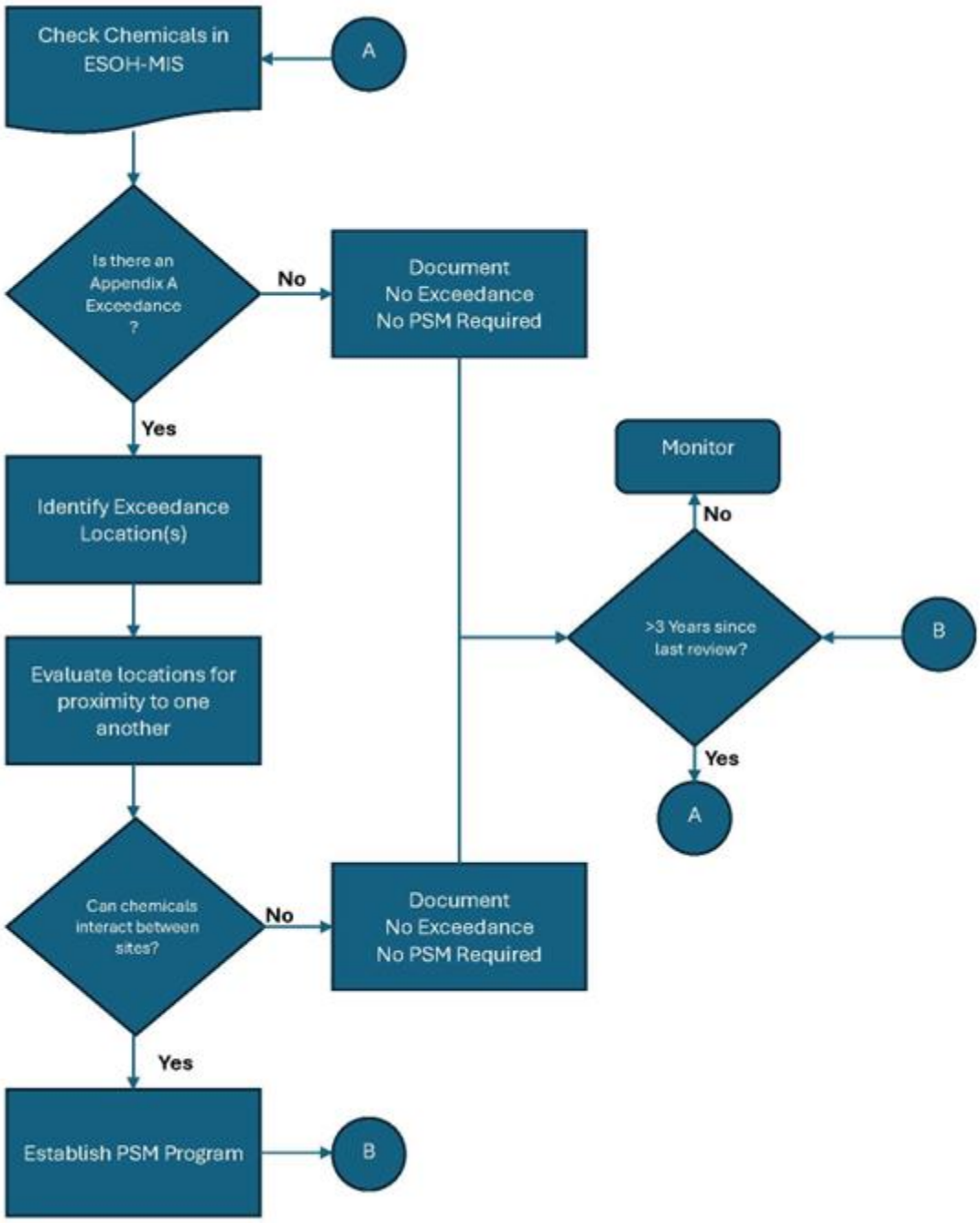
33.5.2.3. Equipment integrity and reliability. **(T-1)**

33.5.2.4. Management of change. **(T-1)**

33.5.3. Process Employees (Operations, Maintenance and Engineering). Each employee involved in operating a process will be trained in an overview of the process and in the operating procedures as specified in 29 CFR § 1910.119(f). **(T-0)** The training will include emphasis on the specific safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks. **(T-0)**

33.5.4. HMMP Team. HMMP team personnel will be familiar with 29 CFR § 1910.119 and this chapter. **(T-0)** They need functional knowledge of report generation within the EESOH-MIS system and an awareness level of understanding of the PSM elements.

Table 33.1. Process Safety Management (PSM) Decision Flow Chart.



Chapter 34

ADDITIVE MANUFACTURING SAFETY

34.1. Scope.

34.1.1. This chapter covers the safety requirements when using additive manufacturing equipment. Additive manufacturing (often called 3D printing) is used to make prototype parts and production parts quickly or in place of parts manufactured using conventional means. Each type of part requires different materials and additive manufacturing processes to meet specifications for the intended purpose it will be used.

34.1.2. Additive manufacturing has many safety and health hazards that must be addressed, such as airborne nano particles, chemical vapors, skin irritants, burns, mechanical motion, and lasers (not an all-inclusive list). Refer to International Organization of Standardization (ISO) 17296-2, *Additive Manufacturing – General Principles – Part 2 Overview of Process Categories and Feedstock,* for additional information.

34.2. Responsibilities.

34.2.1. Commanders. Commanders must ensure that installation BE and occupational safety are notified when additive manufacturing equipment will be purchased to ensure proper controls are put in place. **(T-1)**

34.2.2. Supervisors. Supervisors will train employees IAW **paragraph 34.6**. **(T-1)**

34.3. Types of Additive Manufacturing. There are seven commonly used types of additive manufacturing. This list is not all-inclusive.

34.3.1. Material Extrusion. Material extrusion uses plastic or ceramic filaments or pastes that are heated and layered to make a part. Parts are heated or a chemical reaction is used to bind the parts together. Secondary processing requires removal of support structures. **Note:** This is a form of additive manufacturing, which is well-known for being used significantly in hobby 3D printing.

34.3.2. Powder Bed Infusion. Powder bed infusion uses metal, ceramic, or plastic powder heated with a laser or electron beam to melt the powder in selective locations to build a part. The process may also use binders and fillers to build a part. Secondary processing may include removal of loose powder or any support material. Additionally, a variety of operations are conducted to improve the finishing, accuracy of the part and material properties.

34.3.3. Vat Photopolymerization. Vat photopolymerization uses a liquid resin and an ultraviolet laser to cure the resin selectively to make a part. This process has secondary processing to finish curing the material, remove support material, and clean the part using chemicals.

34.3.4. Material Jetting. Material jetting selectively places build material and uses chemical reaction bonding or solidified melted material activated by a radiation light source to build a part. Common materials used are liquid polymers or wax with or without fillers. Secondary processing may include support material removal and further light exposure to finalize curing of the part.

34.3.5. Binder Jetting. Binder jetting uses powder, powder blends, or particulate materials, such as metal, ceramic, plastic, or sand with a liquid adhesive to create a chemical reaction to make the parts. Secondary processing would include removal of loose powder and adding a suitable liquid material to further complete the part.

34.3.6. Sheet Lamination. Sheet lamination uses sheets of paper, metal foil, polymers, or composites of metal or ceramic powder held together with a binder to layer on top of each other to make a part. Each layer is bound to the next using thermal or chemical reaction bonding or ultrasound. Secondary processing includes removal of waste material, and possibly sintering, infiltration, heat treatment, sanding, or machining to improve the finish.

34.3.7. Directed Energy Deposition. Directed energy deposition uses heat to melt materials as they are deposited to fuse into a part. Materials used are a filament or paste of plastics and ceramics. Secondary processing consists of removal of support structures.

34.4. Categories of Part Processing. There are two categories of processes when making parts:

34.4.1. Single-step Process. This is completed when the part is finished printing and no additional processing is required to complete the part. Essentially, the part is removed from the machine and used as is.

34.4.2. Multi-step Process. The part requires multiple operations to achieve the final result. Other processes include use of chemicals to clean the part, increase stability of the part, improve the part finish, etc.

34.5. Hazards.

34.5.1. Additive manufacturing processes have numerous hazards that can differ depending on the process and materials in use. Supervisors must evaluate how to address these hazards from receipt and storage of materials used for parts, pre-printing cleaning and set up, the manufacturing process itself, clearing malfunctions, and the hazards from post processing and equipment cleaning. **(T-1)** SDSs for materials used in this process will be maintained and referred to when evaluating controls to protect personnel. **(T-1)** Prior to beginning an additive manufacturing process, contact installation BE for a HRA and occupational safety for evaluation. **(T-1)** Common hazards include (this is not an all-inclusive list):

34.5.1.1. Inhalation. Inhalation hazards include nanoparticles, fumes and volatile organic compounds (VOCs) from the heating of materials and those materials in powdered form. Exposure to these hazards may require ventilation or respiratory protection when working around processes.

34.5.1.2. Skin exposure. Resins, powders, solvents, binders, ultraviolet lights, and lasers can have significant effects on exposed skin. Wear appropriate hand protection to prevent exposure when working with an additive manufacturing process. **(T-1)**

34.5.1.3. Laser exposure. Lasers are used by some processes to adhere material together. Ensure proper guarding is in place and wear appropriate eye protection as identified by the installation BE. **(T-1)**

34.5.1.4. Burns. These processes heat materials to temperatures over 150^{o} F where touching these heated parts will cause burns to hands. Employees will wait to conduct maintenance on equipment until the machine has cooled down or use approved hand protection. **(T-1)**

34.5.1.5. Chemical Exposure. Processes use a variety of chemicals as part of machine maintenance, the process itself, or to finish the part. Many of these chemicals are combustible or flammable, refer to **Chapter 22** for additional guidance. Refer to the SDSs on how to properly store, handle, and use the chemicals. **(T-1)** Contact installation BE to assist with appropriate controls, such as ventilation and PPE, including by not limited to eye protection, respiratory protection, and chemical gloves.

34.5.1.6. Moving parts. These machines work in pre-programmed paths and can catch fingers, hair, and loose clothing that comes into contact with moving parts and injuring employees. Ensure machines are strategically placed to minimize inadvertent contact with moving parts and maintain manufacturer guarding when provided. **(T-1)**

34.5.1.7. Electrical Exposure. Equipment that is damaged, malfunctioned, or dismantled for maintenance or servicing will be deenergized to protect against electrical shock. **(T-1)** Refer to **Chapter 21** for hazardous energy control requirements.

34.5.1.8. Noise Hazards. Noise hazards can be created with the operation of the equipment. Some individual machines or multiple machines in one location may reach a level of hazardous noise and must be evaluated by installation BE to determine whether hearing protection will be needed. **(T-0)** Refer to AFI 48-127 for additional information.

34.5.2. Contamination of materials and chemicals used in additive manufacturing processes can create a secondary risk to family members at home when clothing is not changed or properly decontaminated prior to leaving the workplace. Seek guidance from the installation BE whether this may be a concern for the processes used in the work center. **(T-2)**

34.5.3. Evaluate set up to protect against fire hazards, consult F&ES Flight to ensure appropriate controls.

34.6. Exposure Controls. Each hazard must be evaluated and a control put in place to protect employees. **(T-1)** Contact the installation BE and occupational safety office for assistance and follow the manufacturer's documentation. The following are possible controls to implement when using additive manufacturing equipment (this is not an all-inclusive list):

34.6.1. Placement. Placing the equipment in a dedicated room not constantly occupied by employees ensures that they are not continually exposed to the hazards of the equipment like fumes, nanoparticles, noise, etc.

34.6.2. Ventilation. Providing adequate ventilation and exhaust to the machines minimizes employee exposure to fumes and particles, reducing the need for PPE.

34.6.3. Guarding. Placing the machines in well-designed enclosures aids in ventilating fumes out of the room and further reduces employee exposure. Some machines come with their own designed enclosure that are typically not sealed when closed and do not reduce exposure. Contact installation BE to assist with determining best method. Enclosures also assist with preventing employee contact with heated or moving parts.

34.6.4. PPE. PPE needed for the machines used in the work center are based on the materials used during operation and chemicals used for cleaning and post processing of parts. Contact installation BE for assistance on identifying PPE to use. Common PPE would include N95 respirator, chemical resistant gloves, and eye protection to protect against splashes.

34.6.5. Work Practices. Work practices that will help in protecting employees could be requiring machine shutdown and cooldown before removing parts or conducting service or maintenance, use of hazardous energy control when servicing or maintaining equipment (reference **Chapter 21**), and/or storage requirements for materials used in the printing process and the post processing of parts. Many chemicals used in cleaning and post processing are flammable.

34.7. Training. Employees will be trained prior to working with additive manufacturing equipment. **(T-1)** Training will include:

34.7.1. Operation of Equipment. **(T-1)** Employees will be trained in inspection, operation, and servicing of equipment. **(T-1)**

34.7.2. HAZCOM. **(T-1)** Employees will be trained on the HAZCOM requirements when dealing with chemicals used in the printing and finishing process. **(T-1)**

34.7.3. PPE. Employees will be trained on the PPE to be used in the printing and finishing process IAW **Chapter 14**. **(T-1)**

34.7.4. Training will be documented as described in DAFI 91-202. **(T-1)**

34.7.5. Supervisors will follow machine operator requirements as listed in TO 34A-1-1, *Additive Manufacturing Qualification of Technicians, Machines and Facilities.*

34.7.6. Supervisors will contact the AFRSO/AMPO Additive Manufacturing Data Exchange at the following websites: **AdditiveManufacturingDataExchange@groups.af.mil** or website: **https://usaf.dps.mil/teams/AFRSOAdditiveManufacturingDataExchange,** for required qualification training for additive manufacturing.

OTIS C. JONES
Brigadier General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

10 USC § 1073c, *Administration of Defense Health Agency and Military Medical Treatment Facilities*

15 U.S.C. Chapter 53, *Toxic Substances Control Act*

29 U.S.C. Chapter 15, *Occupational Safety and Health Act*

42 U.S.C. Chapter 85, *Air Pollution Prevention and Control*

10 CFR § Part 20, *Standards for Protection Against Radiation*

21 CFR § Part 1020.30, *Diagnostic X-ray Systems and Their Major Components*

29 CFR § 1910, *General Industry, Occupational Safety and Health Standards*

29 CFR § 1926, *Safety and Health Regulations for Construction*

29 CFR Chapter XVII, *Occupational Safety and Health Administration (OSHA), Department of Labor*

33 CFR § Part 156, Subpart A, *Oil and Hazardous Material Transfer Operations,* Section 156.120, *Requirements for Transfer*

49 CFR § 180.209, *Requirements for Requalification of Specification Cylinders*

OSHA 3421, *Servicing Multi-Piece and Single-Piece Rim Wheels,* 2014

OSHA's Enforcement Memorandum, *Enforcement Inspection Guidance for Tree Care and Tree Removal Operations,* 30 June 2021

DoDI 1322.24, *Medical Readiness Training,* 16 March 2018

DoDI 4000.19, *Support Agreements,* 16 December 2020

DoDI 5400.11, *DoD Privacy and Civil Liberties Programs,* 29 January 2019

DoDI 6055.01, *DoD Safety and Occupational Health (SOH) Program,* 14 October 2014

DoDI 6055.12, *Hearing Conservation Program (HCP),* 14 August 2019

DoDM 3150.02, *DoD Nuclear Weapon System Safety Program Manual,* 31 January 2014

DoDM 4160.21, Volume 1, *Defense Materiel Disposition: Disposal Guidance and Procedures,* 22 October 2015

DESR 6055.09_DAFMAN 91-201, *Explosives Safety Standards,* 28 May 2020

AFJMAN 23-210, *Joint Service Manual (JSM) for Storage and Materials Handling,* 12 April 1994

DAFPD 91-2, *Safety Programs,* 25 June 2024

DAFI 10-2501, *Emergency Management Program,* 16 October 2023

DAFI 13-213, *Airfield Driving,* 4 February 2020

DAFI 15-129, *Air and Space Weather Operations,* 19 November 2025

DAFI 21-101, *Aircraft and Equipment Maintenance Management,* 20 December 2023

DAFI 23-201, *Fuels Management,* 23 August 2023

DAFI 24-301, *Ground Transportation,* 9 January 2026

DAFI 24-605V2, *Air Transportation Operations,* 30 January 2025

DAFI 32-9005, *Real Property Accountability,* 14 September 2022

DAFI 48-145, *Occupational and Environmental Health Program,* 22 September 2022

DAFI 48-151, *Thermal Stress Program,* 2 May 2022

DAFI 90-160, *Publications and Forms Management,* 14 April 2022

DAFI 90-802, *Risk Management,* 20 January 2026

DAFI 91-202, *The Department of the Air Force (DAF) Mishap Prevention Program,* 12 March 2020

DAFI 91-204, *Safety Investigations and Reports,* 10 March 2021

AFI 10-217, *Management of Air Force Operational Training and Undergraduate Aircrew Training Systems,* 22 December 2023

AFI 24-302, *Vehicle Management,* 21 February 2020

AFI 25-201, *Intra-Service, Intra-Agency, and Inter-Agency Support Agreements Procedures,* 18 October 2013

AFI 31-218, *Motor Vehicle Traffic Supervision,* 22 May 2006

AFI 32-1001, *Civil Engineer Operations,* 4 October 2019

AFI 32-1023, *Designing and Constructing Military Construction Projects,* 23 December 2020

AFI 32-2001, *Fire and Emergency Services (F&ES) Program,* 28 July 2022

AFI 33-322, *Records Management and Information Governance Program,* 23 March 2020

AFI 44-108, *Infection Prevention and Control Program,* 5 June 2019

AFI 44-177, *Public Access Defibrillator Program,* 5 June 2014

AFI 48-109, *Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program,* 1 August 2014

AFI 48-127, *Occupational Noise and Hearing Conservation Program,* 26 February 2016

AFI 48-137, *Respiratory Protection Program,* 12 September 2018

AFI 48-139, *Laser and Optical Radiation Protection Program,* 30 September 2014

AFI 90-821, *Hazard Communication (HAZCOM) Program,* 13 May 2019

DAFMAN 21-113, *Air Force Metrology and Calibration Program Management,* 27 December 2023

DAFMAN 32-1067, *Water and Fuel Systems,*3 August 2020

DAFMAN 32-1084, *Standard Facility Requirements,* 15 January 2020

DAFMAN 32-7002, *Environmental Compliance and Pollution Prevention,* 11 June 2025

DAFMAN 48-125, *Personnel Ionizing Radiation Dosimetry,* 27 October 2020

DAFMAN 48-146, *Occupational Health Program Management,* 1 December 2022

DAFMAN 65-605, Volume 1, *Budget Guidance and Technical Procedures,* 31 March 2021

DAFMAN 90-161, *Publishing Processes and Procedures,* 18 October 2023

DAFMAN 91-118, *Safety Design Criteria for Nuclear Weapon Systems,* 13 March 2020

DAFMAN 91-224, *Ground Safety Investigation and Reports,* 21 January 2022

AFMAN 11-218, *Aircraft Operations and Movement on the Ground,* 5 April 2019

AFMAN 24-604, *Preparing Hazardous Materials for Military Air Shipments,* 9 October 2020

AFMAN 32-1040, *Civil Engineer Airfield Infrastructure Systems,*23 August 2019

AFMAN 32-1065, *Grounding and Electrical Systems,* 17 July 2020

AFMAN 32-1068, *Heating Systems and Unfired Pressure Vessels,* 16 June 2020

AFMAN 40-201, *Radioactive Materials (RAM) Management,* 29 March 2019

AFMAN 48-148, *Ionizing Radiation Protection,* 20 July 2020

DAFPAM 90-803, *Risk Management (RM) Guidelines and Tools,* 23 March 2022

DLAI 4145.25, *Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders,* 16 June 2000

DHA 6000.03, *Life Support Training Certification Requirements and Guidance,* 6 May 2021

TO 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures,* 6 September 2019

TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding,* 12 July 2023

TO 00-25-223, *Integrated Pressure Systems and Components (Portable and Installed),* 11 January 2017

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,* 22 September 2013

TO 00-25-245, *Operations Instruction – Testing and Inspection Procedures for Personnel Safety and Rescue Equipment,* 21 October 2020

TO 00-25-252, *Intermediate and Depot Level Maintenance Instructions – Aeronautical Equipment Welding,* 1 September 2009

TO 00-105E-9, *Aerospace Emergency Rescue and Mishap Response Information (Emergency Services),* 1 February 2006

TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells,* 1 February 2019

TO 1-1-8, *Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment,* 8 June 2022

TO 4T-1-3, *Inspection, Maintenance Instruction – Storage and Disposition of Aircraft Tires and Inner Tubes,* 19 January 2023

TO 11A-1-33, *Handling and Maintenance of Explosives Loaded Aircraft,* 23 September 2020

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

TO 31R-10-5, *Air Force Comm Commands (E-I Standards) – Antenna Systems, Maintenance, Repair and Testing*

TO 31W3-10-12, *Outside Plant Cable Placement,* 30 October 2004

TO 31W3-10-16, *Outside Plant Cable Pressurization,* 15 July 2009

TO 32-1-2, *Use of Hand Tools (International Business Machines)*

TO 32-1-101, *Use and Care of Hand Tools and Measuring Tools,* 19 August 2023

TO 33-1-37-1, *Joint Oil Analysis Program Manual,* 15 September 2014

TO 33B-1-1, *Nondestructive Inspection Methods, Basic Theory,*

15 October 2016

TO 33B-1-2, *Nondestructive Inspection General Procedures and Process Controls,* 15 September 2015

TO 34A-1-1, *Additive Manufacturing Qualification of Technicians, Machines and Facilities,* 30 July 2025

TO 34-1-3, *Inspection and Maintenance – Machinery and Shop Equipment,* 23 August 2019

TO 35-1-3, *Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE),* 26 April 2014

TO 35E8-2-5-1, *Operation and Maintenance Aircraft Arresting System Mod BAK-12/E32A,* 21 January 2015

TO 36-1-191, *Technical and Managerial Reference for Motor Vehicle Maintenanc*e, 17 November 2023

TO 36M-1-141, *Operator and Operation Instruction—Material Handling Equipment System Components of 463L,* 9 June 2000

TO 36M2-3-35-11, *Operation and Operator Maintenance Instructions, Truck, Aircraft Cargo Loading/Unloading 60,000 Pound Capacity,* 31 January 2014

TO 36M2-3-45-1, *Halvorsen 25K Aircraft Cargo Loaders,* 14 March 2015

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,* 14 May 1985

TO 37-1-1, *General Operation and Inspection of Installed Fuel Storage and Dispensing Systems*, 21 December 2023

TO 37A-1-101, *General Instructions – USAF Fuel, Water, and Lubricant Dispensing Equipment,* 1 August 2012

TO 42B-1-1, *Quality Control of Fuels,* 5 February 2024

TO 42B1-1-14, *Fuels for USAF Aircraft,* 23 July 2012

TO 42B5-1-2, *Gas Cylinders (Storage Type) Use, Handling, and Maintenance,* 16 August 2010

TO 42B6-1-1, *Quality Control of Aviators Breathing Oxygen and Aviators Gaseous Breathing Oxygen,* 6 March 2012

TO 42B7-3-1-1, *Quality Control of Nitrogen,* 25 April 2011

TO 42C-1-2, *Anti-icing, Deicing and Defrosting of Parked Aircraft,* 15 April 2016

US Army Corps of Engineers Manual (EM) 385-1-1, *Safety and Health Requirements Manual,* 30 November 2014

MIL-PRF-680C, *Performance Specification: Degreasing Solvent,* 25 March 2010

MIL-STD-101C, *DoD Standard Practice: Color Code for Pipelines and for Compressed Gas Cylinders,* 26 August 2014

MIL-STD-161, *DoD Standard Practice: Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels,* 4 September 2015

MIL-STD-882, *DoD Standard Practice: System Safety,* 11 May 2012

MIL-STD-1411, *DoD Standard Practice: Inspection and Maintenance of Compressed Gas Cylinders,* 5 March 2020

MIL-STD-1472, *DoD Design Criteria Standard: Human Engineering,* 15 September 2020

American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation; A Manual of Recommended Practice,* April 2023

National Institute for Occupational Safety and Health (NIOSH) *Pocket Guide to Chemical Hazards*

ANSI A300, *Tree Care Operations – Tree, Shrub and Other Woody Plant Maintenance – Standard Practice*

ANSI B56.1, *Safety Standard for Low, High Lift Trucks,* 2020

ANSI B71.1, *Consumer Turf Care Equipment – Pedestrian-Controlled Mowers Ride-On Mowers – Safety Specifications*, 24 January 2017

ANSI/ASHRAE 62.1, *Ventilation for Acceptable Indoor Air Quality,* 21 December 2022

ANSI/ASSP A10.9, *Safety Requirements for Concrete and Masonry Work,* 3 May 2018

ANSI/ASSP A1264.2, *Standard for the Provision of Slip Resistance on Walking/Working Surface,* 19 December 2012

ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel and Accessories,* 2 November 2020

ANSI/ISEA Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices,* 20 April 2020

ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection,* 29 June 2016

ANSI/ISEA Z358.1, *Emergency Eyewash and Shower Equipment,* 1 January 2014

ANSI/OPEI B71.4., *Commercial Turf Care Equipment - Safety Specifications,* 24 April 2017

ANSI/SAIA A92.2, *Vehicle-Mounted Elevating and Rotating Aerial Device,* 2021

ASME *Boiler and Pressure Vessel Code,* 1 July 2019

ASME A13.1, *Scheme for the Identification of Piping Systems,* 6 December 2023

ASME A17.1, *Safety Code for Elevators and Escalators,* 12 October 2023

ASME A17.2, *Guide for Inspection of Elevators, Escalators and Moving-Walkways,* 27 June 2024ASME B20.1, *Safety Standard for Conveyors and Related Equipment,* 2021

ASME B30.2, *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist),* 25 October 2022

ASME B30.5, *Mobile and Locomotive Cranes,* 2021

ASME B30.7, *Winches,* 2021

ASME B30.9, *Slings,* 2021

ASME B30.10, *Hooks,* 2019

ASME B30.11, *Monorails and Underhung Cranes,* 2010

ASME B30.16, *Overhead Underhung and Stationary Hoists,* 2022

ASME B30.17, *Cranes and Monorails (With Underhung Trolley or Bridge),* 2021

ASME B30.19, *Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings,* 2016

ASME B30.21, *Lever Hoists,* 30 May 2014

ASME B30.23, *Personnel Lifting Systems,* 2023

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* 1 July 2019

ASTM E119, *Standard Test Methods for Fire Tests of Burning Construction and Materials,* 1 November 2018

ASTM F2412, *Standard Test Methods for Foot Protection,* 1 August 2018

ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear,* 1 August 2018

CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders,* 1 June 2013

CGA C-13, *Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders,* 1 January 2018

CMAA 70, *Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes,* 2020

CMAA 74, *Specification for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist,* 2020

CMAA Specification 78, *Standards and Guidelines for Professional Services Performed on Overhead and Traveling Cranes and Associated Hoisting Equipment,* 2014

ISO 17296-2, *Additive Manufacturing – General Principles – Part 2 Overview of Process Categories and Feedstock,* 15 January 2015

FC 3-260-18F, *Air Force Aircraft Arresting Systems (AAS), Installation, Operation, and Maintenance,* 28 October 2015

FC 4-218-01F, *Air Force Criteria for Precision Measurement Equipment Laboratory Design and Construction*, 28 October 2015

NFPA 1, *Fire Code*

NFPA 10, *Standard for Portable Fire Extinguishers*

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 13, *Standard for the Installation of Sprinkler Systems*

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*

NFPA 30, *Flammable and Combustible Liquids Code*

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*

NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting and Other Hot Work*

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*

NFPA 70, *National Electrical Code,* including applicable Articles

NFPA 70E, *Standard for Electrical Safety in the Workplace,* including applicable Articles

NFPA 72, *National Fire Alarm and Signaling Code*

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*

NFPA 86, *Standard for Ovens and Furnaces*

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*

NFPA 99, *Health Care Facilities Code*

NFPA 101, *Life Safety Code*

NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials*

NFPA 326, *Safeguarding of Tanks and Containers for Entry, Cleaning or Repair*

NFPA 400, *Hazardous Materials Code*

NFPA 409, *Standard on Aircraft Hangars*

NFPA 410, *Standard on Aircraft Maintenance*

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*

NFPA 1006, *Standard for Technical Rescue Personnel Professional Qualifications*

NFPA 1670, *Standard for Operations and Training for Technical Search and Rescue Incidents*

NFPA 1914, *Standard for Testing Fire Department Aerial Devices*

NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*

NFPA 1932, *Standard on Use, Maintenance and Service Testing of In-Service Fire Department Ground Ladders*

UFC 3-120-01, *Design: Sign Standards,* 1 March 2014

UFC 3-410-04, *Industrial Ventilation,* 13 December 2017

UFC 3-420.01, *Plumbing Systems,* 1 April 2021

UFC 3-460-01, *Design: Petroleum Fuel Facilities,* 16 July 2019

UFC 3-460-03, *Petroleum Fuel Systems Maintenance,* 10 November 2017

UFC 3-490-06, *Elevators,* 8 June 2018

UFC 3-520-01, *Interior Electrical Systems,* 6 October 2015

UFC 3-520-05, *Stationary and Mission Batteries,* 1 May 2015

UFC 3-560-01, *Operation and Maintenance: Electrical Safety,* 24 July 2017

UFC 3-600-01, *Fire Protection Engineering for Facilities,* 8 August 2016

UFC 3-601-02, *Fire Protection Systems Inspection, Testing, and Maintenance,* 7 October 2021

UFC 4-211-01, *Aircraft Maintenance Hangars,* 13 April 2017

UFC 4-310-03, *DoD Fuels Laboratory Standards,* 12 August 2020

Underwriters Laboratories (UL) 94, *Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances,* 8 July 2015

Prescribed Forms

AF Form 979, *Danger Tag*

AF Form 980, *Caution Tag*

AF Form 981, *Out of Order Tag*

AF Form 982, *Danger Tag: Do Not Start*

AF Form 983, *Danger – Equipment Lockout Tag*

DAF Form 592, *Hot Work Permit*

DAF Form 1024, *Confined Space Entry Permit*

Adopted Forms

AF Form 469, *Duty Limiting Condition Report*

AF Form 483, *Certificate of Competency*

DAF Form 55, *Employee Safety and Health Record*

DAF Form 103, *Base Civil Engineering Work Clearance Request*

DAF Form 623, *Individual Training Record Folder*

DAF Form 679, *Department of the Air Force Publication Compliance Item Waiver Request/Approval*

DAF Form 847, *Recommendation for Change of Product*

DAF Form 1098, *Special Task Certification and Recurring Training*

DAF Form 1118, *Notice of Hazard*

DD Form 1574, *Serviceable Tag – Material*

DD Form 1577-2, *Unserviceable (Reparable) – Tag Materiel*

AF Form 1800, *Operator's Inspection Guide and Trouble Report*

AFTO Form 95, *Significant Historical Data*

AFTO Form 244, *Industrial/Support Equipment Record*

AFTO Form 492, *MX Warning Tag*

Abbreviations and Acronyms

AAFES—Army and Air Force Exchange Service

ACGIH—American Conference of Governmental Industrial Hygienists

ADA—Americans with Disabilities Act

AFCEC—Air Force Civil Engineer Center

AFI—Air Force Instruction

AFIMS—Air Force Incident Management System

AFJMAN—Air Force Joint Manual

AFMAN—Air Force Manual

AFMC—Air Force Materiel Command

AFOSH—Air Force Occupational Safety and Health

AFPD—Air Force Policy Directive

AFR—Air Force Reserve

AFSEC—Air Force Safety Center

AFTO—Air Force Technical Order

AFVA—Air Force Visual Aid

AGE—Aerospace Ground Equipment

ALC—Air Logistics Center

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

ASSP—American Society of Safety Professionals

ASTM—American Society of Testing and Materials

AVGAS—Aviation Gasoline

BAK—Barrier Arresting System

BE—Bioenvironmental Engineering

BEE—Bioenvironmental Engineer

C—Celsius—CBT—Computer-based Training

CE—Civil Engineer or Civil Engineering

CFR—Code of Federal Regulation

CFT—Combined Functional Team

CG—Center of Gravity

CGA—Compressed Gas Association

CH4—Methane

cm—Centimeter

CMAA—Crane Manufacturer’s Association of America

CO—Carbon Monoxide

CO2—Carbon Dioxide

CONUS—Continental United States

CPR—Cardiopulmonary Resuscitation

CSPT—Confined Space Program Team

C2H6—Ethane

DAF—Department of the Air Force

DAFI—Department of the Air Force Instruction

DAFMAN—Department of the Air Force Manual

DAFPD—Department of the Air Force Policy Directive

dBA—Decibels-A-Weighted

DESR—Defense Explosive Safety Regulation

DFPE—Designated Fire Protection Engineer

DLAI—Defense Logistics Agency Instruction

DoD—Department of Defense

DoDI—Department of Defense Instruction

DoDM—Department of Defense Manual

DoL—Department of Labor

DOT—Department of Transportation

DRU—Direct Reporting Unit

E-I—Engineering/Installation

EM—Engineers Manual

EMFR—Electromagnetic Field Radiation

EPA—Environmental Protection Agency

ETL—Engineering Technical Letter

F—Fahrenheit—FAR—Federal Acquisition Regulation

F&ES—Fire & Emergency Services

FEMA—Federal Emergency Management Agency

FLDCOM—Field Command

FOA—Field Operating Agency

FOD—Foreign Object Damage

GFCI—Ground Fault Circuit Interrupter

HAF—Headquarters Air Force

HAFMD—Headquarters Air Force Mission Directive

HAZCOM—Hazard Communication

HAZMAT—Hazardous Material

HCP—Hearing Conservation Program

HMMP—Hazardous Material Management Process

HMMWV—High Mobility Multipurpose Wheeled Vehicle

HQ—Headquarters

HVAC—Heating, Ventilation and Air Conditioning

HRA—Health Risk Assessment

IDLH—Immediately Dangerous to Life or Health

IAW—In Accordance With

IRSO—Installation Radiation Safety Officer

ISEA—International Safety Equipment Association

ITSDF—Industrial Truck Standards Development Institute Foundation

IUT—Item Under Test

JHA—Job Hazard Analysis

JP—Jet Petroleum

JSM—Joint Service Manual

JSTO—Job Safety Training Outline

kN—Kilonewton

kV—Kilovolt

kW—Kilowatt

LEL—Lower Explosive Limit

LFL—Lower Flammable Limit

LH2—Liquid Hydrogen

LN2—Liquid Nitrogen

LNG—Liquefied Natural Gas

LOI—Letter of Interpretation

LOTO—Lockout/Tagout

LOX—Liquid Oxygen

MAJCOM—Major Command

MDS—Mission Design Series

MEP—Master Entry Plan

MHE—Material Handling Equipment

MIL-PRF—Military Performance Specification

MIL-STD—Military Standard

MPH—Miles Per Hour

MTF—Military Treatment Facility

MX—Maintenance

MXG/CC—Maintenance Group Commander

N—Newton

NAF—Numbered Air Force

NATO—North Atlantic Treaty Organization

NDI—Non-Destructive Inspection

NFPA—National Fire Protection Association

NIOSH—National Institute for Occupational Safety and Health

NRTL—Nationally Recognized Testing Laboratory

NSC—National Safety Council

O&M—Operation and Maintenance

OEL—Occupational Exposure Limit

OH—Occupational Health

OI—Operating Instruction

OJT—On-The-Job Training

OPEI—Outdoor Power Equipment Institute

OPR—Office of Primary Responsibility

OSH—Occupational Safety and Health

OSHA—Occupational Safety and Health Administration

OSM—Occupational Safety Manager

PAD—Public Access Defibrillator

PFAS—Personal Fall Arrest System

PH—Public Health

PHA—Process Hazard Analysis

PMEL—Precision Measurement Equipment Laboratory

POL—Petroleum/Oil/Lubricant

PPE—Personal Protective Equipment

PSI—Pounds per Square Inch

PSIA—Pounds per Square Inch Absolute

PSIG—Pounds per Square Inch Guage

PSM—Process Safety Management

RAC—Risk Assessment Code

RAM—Radioactive Materials Management

RM—Risk Management

ROPS—Rollover Protection Structure

RPIE—Real Property Installed Equipment

SAE—Society of Automotive Engineers

SAIA—Scaffold and Access Industry Association

SDS—Safety Data Sheet

SE—Support Equipment

SEG—Occupational Safety

SOH—Safety and Occupational Health

SORNs—System of Records Notices

SSEA—System Safety Engineering Analysis

TCCC—Tactical Combat Casualty Care

TMDE—Testing, Measurement, Diagnostic and Evaluation

TO—Technical Order

UFC—Unified Facilities Criteria

UL—Underwriters Laboratories

US—United States

USAF—United States Air Force

USC—United States Code

USSF—United States Space Force

Office Symbols

AF/SE—Air Force Chief of Safety

AFSEC/SEG—Air Force Safety Center/Occupational Safety Division

Terms

Abrasive Wheel—A cutting tool made of abrasive grains held together by organic or inorganic bonding materials.

Air Force Occupational Safety and Health (AFOSH)—An overarching term for the Air Force Occupational Safety and Health Program.

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, pushbutton, toggle switch, foot pedal, hand lever or a handset timer.

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.

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.

Approved—Listed and approved by the Nationally Recognized Testing Laboratory (NRTL), 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.

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 Employee—An employee approved or assigned by the employer to perform a specific type of duty or duties, or to be at a specific location(s) at the jobsite. **Example:** An employee who locks or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment.

Bearer—A horizontal part of a scaffold on which the platform rests and which may be held in place by ledgers.

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 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 (Crane)—A member, fixed or telescoping, hinged to the rotating superstructure and used to support the hoisting tackle.

Brace—A tie that holds one scaffold part in a fixed place with respect to another part.

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.

(1) *Brake, Drag.* A brake that provides retarding force without external control.
(2) *Brake, Holding.* A brake that automatically prevents motion when power is off.
(3) *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, foot walks and drive mechanism that carries the trolley or trolleys.

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 types of buddy systems. One involves both personnel subjected to the sane 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.

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.

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.

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).

Catwalk—A passageway for persons, elevated above the floor or ground level, such as a foot walk along shafting or a walkway between buildings.

Chain—A series of links pivotally joined together for conveying or transmitting motion or power. General classes of chain are detachable, pintle, combination, roller, rivet less, coil, inverted tooth, and bar link chains.

(1) *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.

(2) *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 employee 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.

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.

Coating—An elastomer or other suitable material used to impart physical, electrical, or other desired properties when applied to a sling or sling component.

Combustible Liquid—A liquid having a flashpoint at or above 100o F (37.80º C). Combustible liquids will be divided into two classes as follows:

(1) ——Class II liquids have a flashpoint at or above 100º F (37.8º C) and below 140º F (60º C), except any mixture having components with flashpoints of 200º F (93.3º C) or higher, the volume of which makes up 99 percent or more of the total volume of the mixture.

(2) ——Class III liquids have flash points at or above 140º F (60º C) and are subdivided into two subclasses:

(a) ——Class IIIA liquids have flashpoints at or above 140º F (60º C) and below 200º F (93.3º C), except any mixture having components with flashpoints of 200º F (93.3º C) or higher, the total volume of which makes up 99 percent or more of the total volume of the mixture.

(b) ——Class IIIB liquids have flashpoints at or above 200º F (93.3º C).

Competent Person—A person who is capable of identifying existing and predictable hazards in any personal fall protection system or any component of it, as well as in their application and uses with related equipment, who has authorization to take prompt, corrective action to eliminate the identified hazards and is designated, in writing, by the commander.

Compressed Gas—Any gas or mixture of gasses in a container having a pressure exceeding 40 psia at 70º F (21.1º C), or a pressure exceeding 104 psia at 130º F (54.4º C), or any liquid having an absolute vapor pressure exceeding 40 psia at 100º F (37.8º C).

Conductor—A substance or device that readily conducts heat, electricity, sound, etc. Definitions of specific conductors follow:

(1) *Conductors, Bridge.* The electrical conductors located along the bridge structure of a crane to provide power to the trolley.
(2) *Conductors, Enclosed.* Bar or wire used to transmit electricity, enclosed to minimize the possibility of accidental contact with the conductor.
(3) *Conductors, Open.* Bar or wire not enclosed, used to transmit electrical current and provide power (frequently used with the crane or monorail carrier).

(4) *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 an employee 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—A group of professionals, consisting of representatives from the Occupational Safety office, F&ES Flight, and installation BE, working together for the purposes of organizing and controlling the confined space program. Commanders, functional managers, or their representatives are members of the team when their organizations are involved.

Construction Work—Work on or for construction, alteration, and/or repair, including painting and decorating. See also **https://www.osha.gov/laws-regs/standardinterpretations/2003-11-18**.

Control—The system governing the starting, stopping, direction of motion, acceleration, speed, retardation, and function of the moving member in a predetermined manner.

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.

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.

Corrosive—Any substance that burns, injuriously irritates, or destructively attacks metal, organic tissues, or other materials.

Counterweight—A weight used to balance or counter a load. Examples are:

(1) Additional weight attached to the rear of the forklift to provide better weight distribution.
(2) 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.

(1) ***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.

(2) ***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.

(3) ***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.

(4) ***Crane, Gantry***—A crane similar to an overhead crane except the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.

(5) ***Crane, Overhead***—A crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed runway structure.

(6) ***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).

(7) ***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.

(8) ***Crane, Underhung***—A traveling bridge on two 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.

(9) ***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. DAF 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:

(1) **——**Personnel injury or significant adverse health impact.

(2) **——**Damage resulting in serious economic consequences (non-availability of necessary funds to repair or replace the item).

(3) **——**Damage resulting in unacceptable delay to schedule (mission impairment) or other destructive programmatic impact, e.g., loss of vital data.

(4) **——**Undetectable damage that would jeopardize future operations or safety of a facility.

(5) **——**Damage that may occur without exceptional care in handling because of close-tolerance installation, high susceptibility to damage or other unusual characteristic.

(6) **——**Damage that would result in significant release of hazardous materials.

(7) **——**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 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^{o} C (-256^{o} F) and is used as a refrigerant. As used in this publication, 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 publication 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 an employee during fall arrest.

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.

Department of the Air Force Military Personnel—These are DAF personnel on Regular Air Force status with the DAF or ANG (under the provisions of either Title 10 or 32) and AFR personnel on military duty status (on active duty, on active duty for training, or inactive duty for training), which includes Air Force Academy cadets and Reserve Officer Training Corps cadets engaged in directed training activities. Includes members of other US military services serving on extended Regular Air Force status with the DAF or foreign-national military personnel assigned to the DAF.

Department of Defense Civilian Personnel—Includes Senior Executive Service (SES), General Schedule (GS), Defense Civilian Intelligence Personnel System (DCIPS) and federal wage system employees, including ANG and AFR technicians, unless in military duty status. Includes non-appropriated fund employees who are not military personnel working part time; Corps of Engineers Civil Works employees; Youth Opportunity Program and student assistance program employees; Direct-Hire Foreign-national civilians employed by the Air Force (Air Force Foreign Nationals) and Army-Air Force Exchange Service employees.

Department of Defense Military Personnel—These are non-DAF military personnel assigned to an DAF-led joint base.

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 employees, materials, equipment, and platform.

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 closed in-line valves and locking or tagging open to the outside atmosphere a drain or bleed in the line between the two 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.

Emergency Shower—A unit that cascades water over an employee's entire body to remove hazardous chemicals splashed or sprayed on the employee.

Emergency Shower and Eyewash—A unit combining a shower with an eye and face wash, or eyewash with a drench hose, or both.

Employee—For the purpose of this publication, the term Employee applies to all personal services contractors, DoD civilian personnel, DoD military personnel and DAF military personnel, including Space Force personnel.

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.

Energy (Shock)—A component of whose primary function is to dissipate energy and limit deceleration forces which the system imposes on the body during fall arrest.

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 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.

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 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.

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.

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. Also known as Bump Test.

Fire Protection—Sprinkler systems and other firefighting or fire protection equipment or systems.

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 will be capable of supporting a minimum deadweight of 5,000 pounds (per person).

Fixed Ladder—means a ladder with rails or individual rungs that is permanently attached to a structure, building, or equipment. Fixed ladders include individual-rung ladders, but not ship stairs, step bolts, or manhole steps.

Flammable Liquid—A liquid having a flashpoint below 100º F (37.80º C) closed cup test and having a vapor pressure not exceeding 40 pounds psi at 100º F (37.80º C). Flammable liquids are categorized as Class 1 liquids and are further subdivided as follows:

(1)—Class 1A have a flashpoint below 73º F (22.8º C) and boiling points below 100º F (37.8º C).

(2) —Class 1B have flashpoints below 73º F (22.8º C) and boiling points at or above 100º F (37.8º C).

(3)—Class 1C have flashpoints at or above 73º F (22.8º C) and below 100º F (37.8º 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. **Flightline—**Any area or facility including aprons, hardstands, and ramps on or in which aircraft may be parked, stored, service or maintained.

Flightline 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. **Note**: 150-pound flightline fire extinguisher programs are maintained under the Aircraft Maintenance Squadrons or Generation Squadrons.

Floor—The interior walking surface upon which machinery, aisles and passageways are located. This does not include platforms, walkways, or catwalks.

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.

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, FLDCOM, 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.

Goggles—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.

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.

Hand-Held Drench Hose—A flexible hose connected to a water supply and used to irrigate and flush eyes, face, and body areas.

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.

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 exposure limit (OEL), which is capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to its health effects.

Hazardous Energy Control 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 will be isolated from the energy source and rendered inoperative.

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 employees 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.

Health Risk Assessment (HRA)—Application of professional judgment (full qualified BE officer, civilian industrial hygienist, or BE Craftsman (4b071) based on qualitative and quantitative information, such as exposure measurements and estimates, mathematical modeling, and/or observations of work practices to identify and assess chemical, physical, and biological health hazards.

Hierarchy of Controls—The means of protecting employees from hazards in order from most effective to least effective.

(1) ***Elimination.*** —The process of physically removing the hazard.

(2) ***Substitution.*** —Replacing the hazard, such as toxic chemical, with one that is less hazardous or is not hazardous at all.

(3) ***Engineering Controls.***—Isolate the people from the hazard.

(4) ***Administrative Controls.*** —Change the way employees work, such as limiting their exposure to noise or heat through job rotation.

(5) ***Personal Protective Equipment (PPE).***—Protect the employee with PPE.

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.

(1) ***Basket Hitch.***—A sling configuration where the sling is passed under the load and has both ends, eyes or handles on the hook or single master link.

(2) ***Choker Hitch.***—A sling configuration with one end of the sling passing under the load and through a handle or eye on the other end of the sling. Used for turning an object.

(3) ***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.

Hot Work Permit (DAF Form 592)—The written authorization to perform "hot work" operations such as welding, cutting, burning, or heating that could provide a source of ignition.

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 an employee's ability to escape unaided from a permit-required confined 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.

Insulated Aerial Device—An aerial device designed for work near energized electrical lines and apparatus.

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.

Isolation—Positively preventing any unwanted form of energy (or other agent with a serious potential for hazard) from contacting an employee or operation through the use of blanking, double block and bleed or LOTO.

Job Hazard Analysis (JHA)—A technique or procedure used by supervisors and employees that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the employee, the task, the tools, and the work environment. Ideally, after you identify uncontrolled hazards, you will take steps to eliminate or reduce them to an acceptable risk level. Specific documentation is required. The prescribing directives for conducting JHAs are DAFI 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—means a device with rungs, steps, or cleats used to gain access to a different elevation.

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.

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).

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.

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.

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.

Lower Explosive Limit—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).

Master Entry Plan—A written document, which must be reviewed annually by the Confined Space Program Team, that authorizes entry supervisors to issue entry permits. This document defines acceptable entry conditions for routine recurring entries into like spaces.

Maximum Intended Load—The total weight of all loads including the weight of employees, 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)—Uniquely military equipment, systems, operations, or workplaces are excluded from the federal regulatory standards distributed by OSHA. However, the DoD Components must apply OSHA and other regulatory safety and health standards to uniquely military equipment, systems, operations, or workplaces, in whole or in part, as practicable. When military design, specifications, or deployment requirements render compliance with existing SOH standards infeasible or inappropriate, or when no standard exists for such military application, the DoD Components must apply risk management procedures. The results of the risk management decision must be communicated to all affected personnel.

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.

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, e.g., 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 DAF.

Nationally Recognized Testing Laboratory (NRTL)—Private-sector organizations that OSHA has recognized as meeting the legal requirements in 29 CFR 1910.7 to perform testing and certification of products using consensus-based test standards. These requirements are:

(1) ——The capability to test and evaluate equipment for conformance with appropriate test standards.

(2) ——Adequate controls for eh identification of certified products, conducting follow-up inspections of actual production.

(3) ——Complete independence from users, e.g., employers subject to the tested equipment requirements, and from any manufacturers or vendors of the certified products.

(4) ——Effective procedures for producing its findings and for handling complaints and disputes. An organization must have the necessary capability both as a product safety testing laboratory and as a product certification body to receive OSHA recognition as an NRTL. For a current list of OHSA-approved NRTLs, visit **https://www.osha.gov/dts/otpca/nrtl/nrtllist.html**.

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.

Notice of Hazard (DAF Form 1118)—A written warning of a condition, procedure or practice that constitutes an occupational hazard.

Nuclear—Certified Equipment—Hoists and related lifting equipment approved 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 Master Nuclear Certification List (**https://members.lcmp.af.mil/MNCL/mncl**).

Occupational Exposure Limit (OEL)—The most appropriate limit adopted from established recognized standards including, but not limited to, those in AFIs and AFOSH Standards, the latest edition of the TLV® Booklet published annually by the American Conference of Governmental Industrial Hygienists, and 29 CFR § 1910.1000 Tables Z-1, Z-2, and Z-3. Occupational and environmental exposure limits are limits of exposure established to protect personnel from hazardous occupational and environmental health threat exposures. Occupational and environmental exposure limits apply to occupational and environmental health threat exposures for individuals and/or similarly exposed groups of individuals.

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.

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.

Pawl (Dog)—A device for positively holding the mechanism, drum, etc., against undesired rotation.

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 employees 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 (e.g., liquid to gas, solid to liquid, etc.).

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.

Platform—A walking or working surface elevated above the surrounding floor or ground (such as a balcony or landing) or personnel carrying device (basket or bucket), which is a component of a mobile unit.

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.
Portable Ladder—means a ladder that can readily be moved or carried and usually consists of side rails joined at intervals by steps, rungs, or cleats.

Powder-Actuated Tools—Tools, such as ram sets, where cartridge-type explosives are the source of power.

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.

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.

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.

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.

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).

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.

Remote Location—Emergency care that is more than three to four minutes from the workplace.

Rescue Team—A group of two or more personnel typically designated and trained by an organization to perform rescues from confined spaces within that organization.

Retrieval Line—A line or rope secured at one end to an employee's full harness or wristlets, with the other end secured to a lifting or other retrieval device. The retrieval line will be used to remove an unconscious entrant from a confined space.

Riser—The upright part of a step at the back of a lower tread and near the leading edge of the next higher tread.

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 Data Sheet (SDS)—Electronic, written, or printed information on hazardous material prepared IAW 29 CFR § 1910.1200, Hazard Communication.

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—An employee trained in CPR and qualified to operate the equipment in use. Responsible for placing equipment in safe/neutral mode and administered 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 employees and materials or both. Also, known as Scaffold Tower.

Sectional Ladder—A non-self-supporting portable ladder, nonadjustable in length, consisting of two or more sections constructed so it functions as a single ladder. Its size is designated by the overall length of the assembled sections.

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 employee movement and that, after onset of a fall, automatically locks the drum and arrests the fall.

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.

Sheave—A grooved wheel or pulley used with a rope to change direction and point of application of a pulling force.

(1) ***Sheave, Non—running.*** A sheave used to equalize tension in two parts of the rope. Because of its slight movement, it is not termed a running sheave.

(2) ***Sheave, Running.***—A sheave that rotates as the load block is raised or lowered.

Should—Indicates a preferred method of accomplishment.

Side Shield—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.

Snagging—Grinding that removes relatively large amounts of material without regard to close tolerances or surface finish requirements.

Spectacle, Safety—A device patterned after conventional type spectacle eyewear but of more substantial construction. They may be equipped with side shields. 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.

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.

Stepladder—means a self-supporting, portable ladder that has a fixed height, flat steps, and a hinged back.

Stepstool—means a self-supporting, portable ladder that has flat steps and side rails. For purposes of the final rule, stepstool includes only those ladders that have a fixed height, do not have a pail shelf, and do not exceed 32 inches in overall height to the top cap, although side rails may extend above the top cap. A stepstool is designed so an employee can climb and stand on all the steps and the top cap.

Stroboscopic Effect—The potential for fluorescent lighting to create the appearance that moving, rotating, or vibrating objects are stationary.

Stripper—A device that aids the load chain in leaving the load sprocket.

Swing—Rotation of the crane or other machine superstructure for movement of loads in a horizontal direction about the axis of rotation. 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.

System Safety Engineering Analysis (SSEA)—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.

Test load—The specific load applied in performance of the load test.

Tread—The horizontal part of a step. 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.

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.

Unit Occupational Health (OH) Assessment—Unit OH Assessments enhance overall mission effectiveness by protecting DAF personnel from OH hazards and risks and provide a framework to communicate control options, mitigation actions, and follow-up monitoring with stakeholders. Unit OH Assessments encompass several different types of assessments, including unit comprehensive HRAs, high-risk process HRAs, and specific WMP tasks.

Will—Indicates a mandatory requirement.

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 employees and their materials, made up of the necessary vertical, horizontal, and diagonal braces, guardrails, and ladder for access to the work platform.

Attachment 2

SAFETY INSTRUCTIONS TO BE POSTED IN ALL FUELS LABORATORIES

A2.1. Hazards.

A2.1.1. Body contact with fuel can cause skin or eye irritation.

A2.1.2. Swallowing fuels may cause poisoning.

A2.1.3. Inhaling vapors may cause dizziness. Danger: In permit-required confined spaces of pits, fuel vapors may overcome an employee and cause death due to asphyxiation.

A2.1.4. AVGAS with tetraethyl lead is highly toxic to the central nervous system. Tetraethyl lead can be: Inhaled, ingested, or absorbed directly through contact with petroleum product, or indirect contact with tank scale or tank rust.

A2.2. First Aid.

A2.2.1. Remove fuel-contaminated clothing and wash affected skin areas with soap and water.

A2.2.2. If fuels are swallowed, DO NOT induce vomiting. Get medical attention immediately.

A2.2.3. 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.

A2.3. Safety Precautions.

A2.3.1. Know the general characteristics of fuels.

A2.3.2. Verify that personal protective and fire protection equipment are available and in working order prior to operations involving fuel.

A2.3.3. All electrical equipment used in fuel operations must be properly grounded.

A2.3.4. Use adequate ventilation because fuel vapors can create an explosive atmosphere.

A2.3.5. Immediately clean up fuel spills.

A2.3.6. Ensure that eyewashes, emergency showers and personal protective and fire extinguishing equipment are available and operational prior to operations involving hydrocarbon fuels.

A2.3.7. Always wash hands thoroughly with soap and water after working with fuel.

A2.3.8. Consult the SDS for additional information.

Attachment 3

MINIMUM MANDATORY REQUIREMENTS FOR VEHICLE-MOUNTED ELEVATING AND ROTATING WORK PLATFORMS, AERIAL LIFT TRAINING PLANS, MANUALLY PROPELLED ELEVATING AERIAL PLATFORMS, SELF-PROPELLED ELEVATING WORK PLATFORMS, AND MOBILE TOWERS

A3.1. Training. All training will be accomplished by a qualified trainer/supervisor with knowledge and experience on all lifts for which they are conducting training and has been trained as a trainer/supervisor. **(T-1)** A trained trainer/supervisor must be able to effectively provide instruction on the topic using adult learning techniques. **(T-1)** 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.

A3.2. Model Specific Training. Model specific training will be documented on an DAF Form 55, *Employee Safety and Health Record,* or an equivalent authorized computerized information management system IAW DAFI 91-202. **(T-1)**

A3.3. Training Plans. At a minimum, training plans will include:

A3.3.1. Model specific classroom and hands-on proficiency training covering all machine functions. **(T-1)** This includes, but not limited to, the following (where equipped):

A3.3.1.1. Self-leveling platform.

A3.3.1.2. Oscillating and extendible/retractable axles.

A3.3.1.3. Travel alarm.

A3.3.1.4. Motion alarm.

A3.3.1.5. Beacon.

A3.3.1.6. Tilt alarm.

A3.3.1.7. Soft alarm.

A3.3.1.8. Horn.

A3.3.1.9. Boom limit switch.

A3.3.1.10. Variable speed control knob (all speeds).

A3.3.1.11. Drive enable switch.

A3.3.1.12. Foot switch (deadman switch).

A3.3.1.13. Emergency stop button.

A3.3.1.14. Rated workload.

A3.3.1.15. Unrestricted rated workload.

A3.3.1.16. Stick booms vs. articulating boom, etc.

A3.3.2. The purpose, use and location of all manuals (ANSI Standards, Operator Safety Manual, Manufacturer's Operator Manual and Technical Order, if applicable). **(T-1)**

A3.3.3. Purpose and function of all controls (platform and ground controls). **(T-1)**

A3.3.4. All safety devices, alarms, limit switches and operating characteristics specific to the equipment/vehicle used (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 bypassing or ignoring safety devices). **(T-1)**

A3.3.5. Hazardous location requirements. **(T-1)**

A3.3.6. Pre-start inspection. **(T-1)**

A3.3.7. Recognition of hazards associated with operation of the equipment. **(T-1)**

A3.3.8. Responsibilities associated with problems or malfunctions affecting operation of the equipment, including documentation of deficiencies and process for removing the equipment from service. **(T-1)**

A3.3.9. Factors affecting stability during use. **(T-1)**

A3.3.10. Workplace/site inspection (look for hazards like uneven floors or drop offs, floor, and overhead obstructions, etc.). **(T-1)**

A3.3.11. The purpose of placards and decals (what they are and what they mean). **(T-1)**

A3.3.12. Safety rules applicable to the task (e.g., overhead obstructions, electrical lines, working around other equipment, etc.). **(T-1)**

A3.3.13. 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). **(T-1)**

A3.3.14. Use of removable railings, guards, and attachments, including how to ensure they are properly secured when in use. **(T-1)**

A3.3.15. Fuel system. **(T-1)**

A3.3.16. Battery and charging requirements. **(T-1)**

A3.3.17. Safety harness and type of lanyard required for use with the equipment and appropriate attachment point location(s). **(T-0)**

A3.3.18. Spotter’s responsibilities (emergency controls, procedures, and PPE requirements). **(T-1)**

A3.3.19. Any other items affecting the safe operation of the equipment. **(T-1)**

A3.3.20. Hands on training covering all items above and during actual operations conducted under the direction of a qualified trainer/supervisor. The trainee will operate the equipment for a sufficient period of time to demonstrate proficiency with that specific model. **(T-1)**

A3.3.21. A written test will be administered by a qualified instructor to ensure the trainee understands all aspects of the equipment operation. **(T-1)** Passing score will be 85%. **(T-1)**

A3.4. Additional Requirements for Lifts.

A3.4.1. Operator training will be documented for each specific model of lift personnel are authorized to operate. **(T-1)** The organization will maintain a detailed lesson plan for each lift model that will be taught, including classes taught by contractors. **(T-0)**

A3.4.2. Operators will be knowledgeable of the TO(s) and manufacturer's manual(s) for the lift being operated. **(T-1)** Operators will know where the manuals are stored on the lift. **(T-0)**

A3.4.3. Supervisor will only permit trained personnel to operate or work from lifts. **(T-1)**

A3.4.4. Problems or malfunctions that affect safe operation of the lift will be repaired prior to using the lift. **(T-0)**

A3.4.5. Supervisors trained to operate aerial lifts can task certify employees only on lifts they are trained to operate.

A3.4.6. Each lift will have an AF Form 1800, *Operator's Inspection Guide and Trouble Report,* with pertinent manufacturers inspection/test information added. **(T-1)** The AF Form 1800 will be used to inspect/test the aerial lift prior to lift operation. **(T-1)**

A3.4.7. All inspections will be documented. **(T-1)** Documentation will be maintained for at least one year, or as required by applicable TO or other guidance. **(T-1)**