



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, DC

DAFMAN91-203_DAFGM2025-01
12 MAY 2025

MEMORANDUM FOR DISTRIBUTION C____
MAJCOMs/FLDCOMs/FOAs/DRUs

FROM: AF/SE
1400 Air Force Pentagon, Suite 5E1000
Washington, DC 20330-1400

SUBJECT: Department of the Air Force Guidance Memorandum to AFI 91-203, *Air Force Occupational Safety, Fire, and Health Standards*

By Order of the Secretary of the Air Force, this Department of the Air Force Guidance Memorandum immediately implements changes to DAFMAN 91-203, *Air Force Occupational Safety, Fire, and Health Standards*. Compliance with this memorandum is mandatory. To the extent its direction is inconsistent with other Department of the Air Force publications, the information herein prevails, in accordance with DAFI 90-160, *Publications and Forms Management*.

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

SEAN M. CHOQUETTE
Major General, USAF
Chief of Safety

Attachment:
Guidance Changes

Attachment
Guidance Changes

The below changes to DAFMAN 91-203, dated 25 March 2022, are effective immediately.

24.13.4. Entering or Leaving Flightline Driving Areas. All vehicles, to include wheeled AGE equipment being towed, except emergency and alert vehicles responding to an alert or emergency, shall stop prior to entering the flightline and accomplish an FOD check. **(T-2)** 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 prevented by local procedures, traffic flow on aircraft parking ramps shall be parallel to the noses of parked aircraft with the driver side toward the aircraft. **(T-1)** Vehicles shall not be driven diagonally across the parking ramp, but at 90-degree angles to the driving lanes. **(T-1)**

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

**DEPARTMENT OF THE AIR FORCE
MANUAL 91-203**



25 MARCH 2022

Safety

**AIR FORCE OCCUPATIONAL SAFETY,
FIRE, AND HEALTH STANDARDS**

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

ACCESSIBILITY: Publications and forms are available on the e-Publishing website at www.e-Publishing.af.mil for downloading or ordering.

RELEASABILITY: There are no releasability restrictions on this publication.

OPR: HQ AFSEC/SEG

Certified by: AF/SEI
(Colonel Lawrence A. Nixon)

Supersedes: AFMAN 91-203, 11 December 2018

Pages: 350

This manual implements Air Force Policy Directive (AFPD) 91-2, *Safety Programs*, and 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 manual applies to individuals at all levels who are uniformed members or civilian employees of the Regular Air Force, Air Force Reserve (AFR), the Air National Guard (ANG), the United States (US) Space Force, the Civil Air Patrol, and those who are contractually obligated to comply with Department of the Air Force (DAF) publications. This manual requires the collection and/or maintenance of information protected by the Privacy Act of 1974 authorized by Department of Defense Instruction (DoDI) 5400.11, *DoD Privacy and Civil Liberties Programs*. The applicable SORNs F024 AF IL C, *Motor Vehicle Operator's Records*, and F031 AF SP L, *Traffic Accident and Violation Reports*, are available at <https://dpclo.defense.gov/Privacy/SORNs.aspx>. 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 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 AF Form 847, *Recommendation for Change of Publication*; route AF Forms 847 from the field through the appropriate functional chain of command. Refer to Air Force Instruction (AFI) 91-202, *The US Air Force Mishap Prevention Program*, for guidance on submitting requests for variance to requirements of this 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 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/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 DAFI 33-360, *Publications and Forms Management*, for a description of the authorities associated to 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 variances/exemptions to non-tiered compliance items. The requesting office must send a copy of all approved waivers to the OPR of the Higher Headquarters publication being waived (see DAFI 33-360, paragraph 1.9.4.3.4) within 30 days of approval. Sending an email to the waived publication OPR that includes a completed AF Form 679, *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 reducing the size of the standard by referring the reader to OSHA safety standards and other consensus standards that were previously repeated. Chapters with similar information were combined to reduce redundancy and streamline requirements; a substantial amount of figures and tables were removed, and where appropriate, referenced to the original source; and language for administrative devices, that includes locks and tags not used for hazardous energy control have been moved to **Chapter 17**. Other changes include implementing required changes to fall protection procedures mandated by the Air Force Audit Agency, clarifying process safety management requirements, eliminating the requirement to use specific National Stock Numbers for specific equipment and personal protective equipment, clarifying fire protection and prevention requirements, and a rewrite of **Chapter 9**.

Chapter 1—INTRODUCTION	14
1.1. Objective.....	14
1.2. Roles and Responsibilities.....	14
1.3. Variances, Exemptions and Letters of Interpretation.....	15
1.4. How to Use This Document.....	16
1.5. Applying Standards.....	16
1.6. Job Hazard Analysis (JHA).	17

1.7.	Military-Unique and Nonmilitary-Unique Policy.....	17
1.8.	Documentation.....	18
1.9.	First Aid and Cardiopulmonary Resuscitation (CPR) Training.....	18
1.10.	Bloodborne Pathogen Training.....	18
1.11.	Process Safety Management (PSM) of Highly Hazardous Chemicals.	19
Chapter 2—GENERAL WORK PROCEDURES		21
2.1.	General Information.....	21
2.2.	Hazards.	21
2.3.	Jewelry.....	21
2.4.	Housekeeping.....	22
2.5.	Office Safety.	25
2.6.	Ergonomics.	27
2.7.	Roll-up Doors.	27
2.8.	Receiving/Loading Docks.....	27
2.9.	Walk-in Refrigerators and Freezers.	28
2.10.	Manual Material Handling.....	28
2.11.	3D Printers.....	29
Chapter 3—WEATHER SAFETY		30
3.1.	Responsibilities.....	30
3.2.	Two-tier Notification System.	30
3.3.	General Lightning Safety for all AF Activities and Operations. Note:.....	30
Chapter 4—SERVICES OPERATIONS		32
4.1.	Purpose.	32
4.2.	Laundry.....	32
4.3.	Lodging.....	32
4.4.	Food Service Operations.....	33
Chapter 5—NONDESTRUCTIVE INSPECTION (NDI) AND OIL ANALYSIS		34
5.1.	Scope.....	34
5.2.	Safety Precautions.....	34
5.3.	Supervisor Responsibilities.....	35
5.4.	Nondestructive Inspection Equipment and Fire Protection Systems.	35

Chapter 6—FIRE PREVENTION AND PROTECTION	36
6.1. Fire Extinguishers.....	36
6.2. General Requirements.....	36
Chapter 7—WALKING – WORKING SURFACES	41
7.1. General Requirements.....	41
7.2. Stairs and Ramps Requirements. Note.....	46
7.3. Fixed Ladders.	48
7.4. Portable Ladders.	51
Table 7.1. Ladders Workload Ratings.	52
7.5. Stepladders.....	55
7.6. Emergency Operations.....	55
Chapter 8—ELECTRICAL SAFETY	56
8.1. General Information.....	56
8.2. Receptacles.	56
8.3. Plugs.	56
8.4. Flexible Cords and Extension Cords.....	56
8.5. Disconnecting Means (Circuit Breakers and Disconnect Switches).....	57
8.6. Guarding of Live Parts.....	58
8.7. Equipment Grounding.....	58
8.8. Restrictions.	58
8.9. Electrical Installations and Equipment.	58
8.10. Additional Electrical Equipment Requirements.	59
8.11. Electronic Equipment.	59
8.12. Emergency Equipment (Electrical Safety).....	60
8.13. Automated External Defibrillator (AED).	62
8.14. Lighting.....	62
8.15. Moisture Guarding.....	62
8.16. Under-voltage Protection.	62
8.17. Work on Energized Equipment.....	62
Chapter 9—EMERGENCY SHOWER AND EYEWASH UNITS	64
9.1. Scope.....	64
9.2. Regulations and Standards.....	64

9.3.	Equipment - Acquisition.	64
9.4.	Location and Installation.	65
9.5.	Maintenance and Testing.	66
9.6.	Training.....	66
Chapter 10—	—GROUNDS, MOWING AND AGRICULTURE TRACTORS	67
10.1.	General Information.....	67
10.2.	Inspection/Maintenance.	67
10.3.	Mowing.....	67
10.4.	Edgers.	68
10.5.	Commercial Mowing and Turf Care Equipment.	68
10.6.	Tree and Hedge Trimming.....	69
10.7.	Fertilizers.	69
10.8.	Irrigation Systems.	70
10.9.	Agricultural Tractors and Implement Attachments.	70
Chapter 11—	—HAND TOOLS, PORTABLE POWER TOOLS AND MACHINERY	72
11.1.	General Requirements.....	72
11.2.	Tools.	72
11.3.	Machinery.	74
Table 11.1.	OSHA Standards for Machinery.....	76
11.4.	Specific Requirements for Machinery.	77
Chapter 12—	—MATERIAL HANDLING EQUIPMENT (MHE)	79
12.1.	Scope.....	79
12.2.	General Requirements.....	79
12.3.	Acquisition.....	81
12.4.	Inspections.	81
12.5.	Nuclear-certified Lifting Equipment.....	83
12.6.	Qualification and Training.....	83
12.7.	Testing.	84
12.8.	Powered Industrial Trucks.	86
12.9.	Conveyors.	87
12.10.	Manual Hoisting and Pulling Devices.	87
12.11.	Hoists.	88

	12.12. Slings.	90
	12.13. Mobile and Locomotive Cranes.	92
	12.14. Derricks.	93
	12.15. Related Hoisting Equipment.	94
	12.16. Portable Automotive Lifting Devices and Related Equipment.	94
Table	12.1. Quick Reference Guide for Material Handling Equipment.	95
Table	12.2. Synthetic Web Slings. 1,000 Pounds per Inch of Width – Single Ply (Rated in capacity in pounds).	97
Table	12.3. Synthetic Web Slings. 1,200 Pounds per Inch of Width – Single Ply (Rated capacity in pounds).	97
Table	12.4. Synthetic Web Slings. 1,600 Pounds per Inch of Width – Single Ply (Rated capacity in pounds).	98
Table	12.5. Number of Spacing of Clips for Ropes of Various Sizes. (If manufacturer’s recommendations are not available).	99
Chapter 13—FALL PROTECTION		101
	13.1. Scope.	101
	13.2. Hazards and General Information.	101
	13.3. Fall Protection Program.	102
	13.4. Fall Hazard Survey.	104
	13.5. Written Fall Protection and Rescue Procedures.	105
	13.6. Fall Protection Plans.	107
	13.7. Training.	107
	13.8. Equipment Inspections and Maintenance.	108
	13.9. Fall Mishap Reporting.	108
Chapter 14—PERSONAL PROTECTIVE EQUIPMENT (PPE)		109
	14.1. Scope.	109
	14.2. Training.	109
	14.3. Hazard Assessment and Equipment Selection.	109
	14.4. Proper Care and Maintenance.	114
Chapter 15—TRAINING SYSTEMS		115
	15.1. Scope.	115
	15.2. General Requirements.	115
	15.3. Facility Requirements.	116

15.4.	Training Systems Requirements.	117
15.5.	Requirements of Wheeled Vehicle Egress Assistance Trainers.	118
15.6.	Requirements for Aircraft Flight and Similar High Value Training Systems.	118
15.7.	Upgrade of Existing Aircraft Flight and Similar High Value Training Systems.	123
Chapter 16—	MOBILE ELEVATING WORK PLATFORMS AND SCAFFOLDING	124
16.1.	Scope.....	124
16.2.	Hazards.	124
16.3.	Training.....	124
16.4.	Inspections and Maintenance.....	125
16.5.	Vehicle-Mounted Elevating and Rotating Work Platforms.	126
16.6.	Manually-Propelled and Self-Propelled Mobile Work Platform and Scaffolds (Towers).....	130
16.7.	Scaffolding.....	137
Table 16.1.	Types of Scaffolding (not all inclusive).....	139
Chapter 17—	MISHAP PREVENTION SAFETY SIGNS, TAGS AND LABELING	141
17.1.	Scope.....	141
Table 17.1.	Regulatory Guidance for Mishap Prevention Safety Signs, Tags and Labeling	141
17.2.	Hazards and General Information.	142
17.3.	Training.....	143
17.4.	Sign Requirements.	143
17.5.	Safety, Fire Prevention and Health Tag Requirements.....	145
17.6.	Administrative Devices.....	147
17.7.	Safety Color Coding, Labeling and Marking for Piping Systems.	147
Chapter 18—	HYDROCARBON FUELS	149
18.1.	Scope.....	149
18.2.	Hazards.	149
18.3.	Training.....	152
18.4.	Personal Protective Equipment (PPE).	152
18.5.	Housekeeping.....	152
18.6.	Fire Prevention and Protection.....	153
18.7.	Inspection.....	154
18.8.	Fuel Storage Systems.....	154
18.9.	Fuel Servicing Operations.	155

18.10.	Aircraft Servicing.	156
18.11.	Fuel Laboratory Operations.	158
Chapter 19—COMPRESSED GASES		161
19.1.	Scope.....	161
19.2.	General Requirements.....	161
19.3.	Storage.	163
19.4.	Disposal and Shipping.	164
Chapter 20—WELDING, CUTTING AND OTHER HOT WORK		165
20.1.	Scope.....	165
20.2.	Hazards.	165
20.3.	Acquisition.....	166
20.4.	Training and Qualification.	166
20.5.	Precautions.....	167
20.6.	Personnel Protective Equipment (PPE).	169
20.7.	Types of Welding Equipment.	169
20.8.	Hot Work Locations.....	170
20.9.	Contractors.....	173
20.10.	Hot Work Permit.....	173
Table 20.1.	How To Fill Out AF Form 592, Hot Work Permit.	173
Chapter 21—HAZARDOUS ENERGY CONTROL		175
21.1.	Scope.....	175
Table 21.1.	Common Hazardous Energy Categories and Corresponding Sources.	175
21.2.	Hazardous Energy Control Program.	176
21.3.	Training.....	176
21.4.	Program Self-Inspections.....	176
21.5.	Authorized Lockout and Tagout Devices.	177
21.6.	Hazardous Energy Control Procedures.	177
Figure 21.1.	Eight-Step Hazardous Energy Control Procedure Checklist.	177
Figure 21.2.	Three-Step Release from Hazardous Energy Control Procedure Checklist.....	179
21.7.	Hazardous Energy Control Procedures When Establishing An Electrically Safe Work Condition.	181
21.8.	Contractors.....	181

Chapter 22—FLAMMABLES AND COMBUSTIBLES	182
22.1. Scope.....	182
22.2. Hazards.	182
22.3. Training.....	183
22.4. Personal Protective Equipment (PPE).	183
22.5. Housekeeping.....	183
22.6. Fire Protection.....	183
22.7. Building and Equipment Requirements.	185
22.8. Handling and Dispensing.....	191
Table 22.1. Classifications of Flammable and Combustible Liquids.	193
Chapter 23—CONFINED SPACES	194
23.1. Scope.....	194
23.2. Definitions.	194
23.3. Hazards.	195
Table 23.1. Common Hazards Involving Confined Spaces (Not all-inclusive).....	195
23.4. Responsibilities.....	196
23.5. Written Confined Space Program.	200
23.6. Entry into Immediately Dangerous to Life and Health (IDLH) Conditions.	201
23.7. Master Entry Plan.	201
23.8. Non-permit Confined Space Entry.....	203
23.9. MAJCOM/FLDCOM Mandatory Aircraft Confined Spaces.....	204
23.10. Training.....	204
23.11. Instructions for Completing the AF Form 1024, Confined Spaces Entry Permit. ...	205
23.12. Contractor Requirements.	206
Chapter 24—AIRCRAFT FLIGHTLINE – GROUND OPERATIONS AND ACTIVITIES	208
24.1. Scope.....	208
24.2. Specific Requirements.	208
24.3. Flightline Potentially Hazardous Areas and Operations.	210
24.4. Additional PPE Requirements.	212
24.5. Aircraft Parking Requirements.	213
24.6. Adverse Weather Conditions.	214
Table 24.1. Adverse Weather High Wind Safeguards.	215
24.7. Towing and Taxiing Aircraft.	215

24.8.	Aircraft Jacking Operations.	217
24.9.	Aircraft Engine Operations.	218
24.10.	Jet Aircraft Requirements.	220
24.11.	Aircraft Cleaning.	221
24.12.	Aircraft Tire Mounting and Servicing Operations.	222
24.13.	Flightline Vehicle Operations.	222
24.14.	Aircraft Hangar Operations.	225
24.15.	Aircraft Shop and Flightline Maintenance Operations.	227
24.16.	Fall Protection Requirements.	228
24.17.	Safety in Flightline Contractor Operations.	230
Chapter 25—	CIVIL ENGINEERING	232
25.1.	Scope.	232
Table 25.1.	Relevant CE-related References.	232
25.2.	Supervisory Responsibilities.	234
25.3.	Compressed Air.	234
25.4.	Shoring and Trenching.	235
25.5.	Barricades and Traffic Signs.	235
25.6.	Sanitation.	235
25.7.	Restrictions.	236
25.8.	Equipment Operations and Pavements.	236
25.9.	Carpentry and Structural Maintenance.	237
25.10.	Protective Coating Maintenance.	238
25.11.	Plumbing Maintenance.	238
25.12.	Refrigeration and Air Conditioning Maintenance.	239
25.13.	Heating Systems and Central Heating Plant Maintenance.	239
25.14.	Water and Wastewater Treatment.	239
25.15.	Aircraft Arresting Systems.	239
25.16.	Miscellaneous.	240
Chapter 26—	CRYOGENIC LIQUIDS	241
26.1.	Specific Hazards.	241
26.2.	General Requirements.	243
26.3.	Cryogenic Facility Siting.	245
26.4.	Occupational Health.	245

26.5.	Safety Precautions When Working With LN ₂ , LOX, LH ₂ and LNG.	246
26.6.	Fire Prevention and Protection.....	248
26.7.	Electrical Safety.....	249
26.8.	Housekeeping.....	249
26.9.	Receipt, Storage and Issue of LN ₂ or LOX.....	250
26.10.	Common Cryogenic Liquids, Their Properties and Precautions.....	250
Chapter 27—	INTERIOR SPRAY FINISHING	255
27.1.	Scope.....	255
27.2.	Safety.	255
27.3.	Health/Environmental Protection.....	256
27.4.	Fire Prevention.....	256
27.5.	Ventilation Systems.	257
27.6.	Storage and Handling.....	258
27.7.	Electrical.	259
27.8.	Location of Paint Shops, Dope Shops and Spray-Finishing Operations.....	260
27.9.	Paint Spray Booths.....	260
27.10.	Compressed Air Paint Spraying.....	261
27.11.	Drying Ovens.....	262
27.12.	Spray Painting of Aircraft.....	262
27.13.	Painting Radio and Radar Equipment.....	263
27.14.	Electrostatic Paint Spraying.....	264
27.15.	Airless Paint Spraying.	265
27.16.	Aerosol Cans of Spray Paint.	266
27.17.	Powder Coating.....	266
27.18.	Organic Peroxide Coating.....	267
Chapter 28—	COMMUNICATION CABLE, ANTENNA AND COMMUNICATION SYSTEMS	269
28.1.	Scope.....	269
28.2.	General Safety Practices.	269
28.3.	Training.....	272
28.4.	Safety Equipment and Devices.	272
28.5.	Tools and Equipment.	273
28.6.	High Voltage.....	274

28.7.	Aerial Work.	275
28.8.	Ground-Controlled Approach Radars.	276
28.9.	Single Phase Portable and Vehicle-Mounted Generators.	277
28.10.	Repairs and Adjustments.	277
28.11.	Power Distribution Panels.	278
28.12.	Radar and Microwave Equipment.	278
28.13.	Entering Manholes, Handholes and Unvented Vaults.	279
28.14.	Cables.	279
28.15.	Special Purpose Vehicles.	280
Chapter 29—BATTERIES – MAINTENANCE, HANDLING AND STORAGE REQUIREMENTS		281
29.1.	Scope.	281
29.2.	Safety.	281
29.3.	General Facility and Equipment Requirements for Battery Rooms and Areas.	281
29.4.	Fire Prevention.	283
29.5.	Ventilation Systems.	283
29.6.	Storage and Handling.	284
29.7.	Electrical.	285
29.8.	Installation and Care of Vehicle and Support Equipment Batteries.	285
29.9.	Aircraft Battery and Electrical System Specific Requirements.	286
Chapter 30—MOTOR VEHICLE – OPERATIONS AND MAINTENANCE		287
30.1.	Scope.	287
Table 30.1.	Additional Guidance for Motor Vehicle – O&M.	287
30.2.	Specific Hazards.	287
30.3.	General Safety.	287
30.4.	Occupational Health.	288
30.5.	Facility and Equipment Requirements for Vehicle Maintenance Operations.	288
30.6.	Fire Prevention.	289
30.7.	Ventilation.	290
30.8.	Cleaning With Solvents.	291
30.9.	Paint Shop.	293
30.10.	Air Compressors.	294
30.11.	Compressed Gas Cylinders. (Note	296

30.12. Lifting Devices.	296
30.13. Wheel and Tire Maintenance.	299
30.14. Maintenance Operations.	305
Chapter 31—COMPOSITE MATERIALS	311
31.1. Scope.....	311
31.2. Specific Responsibilities.....	311
31.3. General Requirements.....	311
31.4. Specific Applications.	312
31.5. Hazardous Waste Disposal.	313
31.6. Special Mishap Considerations.....	313
31.7. Use of Composite Materials in New System Acquisition, and System and Process Modifications.	313
Chapter 32—PRECISION MEASUREMENT EQUIPMENT LABORATORY	314
32.1. Scope.....	314
32.2. Hazards.	314
32.3. Ventilation Systems.	316
32.4. Electrical Safety for PMEL Operations.	316
32.5. Radioactive Material Safety.....	318
32.6. Equipment/Component Cleaning.....	319
32.7. Tools and Equipment.	319
Attachment 1—GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION	321
Attachment 2—SAFETY INSTRUCTIONS TO BE POSTED IN ALL INSTALLATION FUELS LABORATORIES	350

Chapter 1

INTRODUCTION

1.1. Objective.

1.1.1. OSHA safety guidance published in the DoL 29 CFR series provides employees a safe and healthful 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://cs2.eis.af.mil/sites/10178/Pages/SEGHomeV2.aspx>.

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 AFI 91-202, *The US Air Force Mishap Prevention Program*, and assigns responsibilities to individuals or functions to help commanders manage their safety and health program, ensuring they comply with OSHA 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 Air Force Occupational Safety and Health (AFOSH) 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 installation 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 Headquarters Air Force elements shall ensure policies and procedures are consistent with the guidance of this manual.

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

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

1.2.2.2. Act as approval authority for safety variances associated with T-1 and above wing/delta-level requirements in this manual.

1.2.3. MAJCOMs, FLDCOMs, DRUs and FOAs shall provide program oversight and supplement safety and health guidance, as necessary, ensure safety training is available to subordinate units. (T-1)

1.2.4. Commanders and Functional Managers shall:

1.2.4.1. Ensure and promote applicable occupational safety and health (OSH) guidance for workplace and operations is available to all personnel. (T-1)

1.2.4.2. Ensure and promote compliance with occupational safety, fire prevention and health program requirements in their areas of responsibility. **(T-1)**

1.2.4.3. Ensure a safe and healthful workplace is provided via a monthly spot-inspection program. **(T-1)**

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

1.2.4.4.1. OSHA directives. **(T-0)**

1.2.4.4.2. AFOSH directives. **(T-1)**

1.2.4.4.3. Air Force Policy Directives (AFPD). **(T-1)**

1.2.4.4.4. Air Force Instructions (AFI), Air Force Manuals (AFMAN) and any other associated directives. **(T-1)**

1.2.5. Supervisor. Supervisors will require workers 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. **(T-1)** Supervisors shall ensure employees are trained, using manufacturer's instructions or lesson plans, prior to the operation of any type of equipment or accomplishing assigned tasks. **(T-1)** Supervisors shall routinely evaluate employees on the proper and safe operation of all equipment and associated personal protective equipment (PPE). **(T-1)** Unsafe behaviors shall be corrected on the spot. **(T-1)** Supervisors will provide such instruction at time of initial assignment and refresher training, as required. **(T-1)** If instruction is not available, supervisors shall accomplish a job hazard analysis (JHA). **(T-1)** Additional supervisor responsibilities can be found in AFI 91-202.

1.2.6. DAF personnel (military and civilian) shall:

1.2.6.1. Comply with OSH guidance. **(T-0)**

1.2.6.2. Promptly report unsafe working conditions/activities including any safety, fire and health hazards and deficiencies to the supervisor. **(T-1)**

1.2.6.3. Promptly report injuries and illnesses to the supervisor, e.g., occupational illness and on-duty injury to DoD military and civilian personnel, and off-duty injury to DoD military personnel. **(T-1)**

1.2.6.4. Comply with PPE requirements, including its use, inspection and care; ensure required guards, interlocks and enclosures are properly used. **(T-1)**

1.2.6.5. Notify supervisors in advance if they have a medical condition or are taking medications that could interfere with their safe performance of assigned duties. **(T-1)**

1.3. Variances, Exemptions and Letters of Interpretation.

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

1.3.2. Air Force letters of interpretation (LOIs) are written in response to AFOSH-related inquiries submitted from DAF personnel or units regarding specific aspects of or terminology in this manual or with OSHA standards and guidance, 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 include 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 Air Force/Space Force operations. References to other Air Force publications and national consensus standards are provided as appropriate. Air Force/Space Force activities must comply with OSHA requirements at all times, unless the military-unique exemption applies in accordance with Department of Defense Instruction (DoDI) 6055.01, *DoD Safety and Occupational Health (SOH) Program*, and AFI 91-202. **(T-0)**

1.4.2. This publication is intended for use by fire, safety and health professionals, commanders, functional managers, supervisors and employees. It provides AFOSH requirements that shall provide equal or greater protection than applicable federal regulatory standards. **(T-1)** The information in this publication is for the protection of employees, Air Force/Space Force property and equipment, and to ensure compliance with Federal law. **Note:** This publication does not apply to state employees or ANG members not in federal status. **Note:** This publication may contain criteria not fully compatible with host-nation safety criteria. In case of conflict, safety offices shall facilitate coordinated concerns through their hierarchy for resolution.

1.5. Applying Standards. Air Force and Space Force personnel must comply with all applicable safety guidance during Air Force/Space Force operations. **(T-1)** If, or when, 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 Air Force standard contains both horizontal and vertical fire, safety and health standards/requirements within the various chapters. Generally, horizontal standards/requirements apply across all industries/activities; whereas, vertical standards/requirements apply to a specific industry/activity, e.g., construction or telecommunications. There are occupational safety and health mandates contained within one chapter of this publication which could be interpreted as vertical; however, because safety rules are established based upon hazards and not just tasks, the mandate may, in fact, be applied horizontally across several occupations. **Example:** Confined space requirements in **Chapter 23** – primarily a General Industry application, but may apply to applicable portions of aircraft maintenance tasks. For this reason, broad guidance cannot be codified to address all situations. If there is doubt, contact the local safety office for guidance. Resolve locally, when possible, using risk management techniques focused on the hazard and hazard mitigation.

1.5.1.2. When AFOSH guidance or other established safety criteria does not cover a situation, use non-Air Force 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 Department of Labor has the authority to grant exemptions to OSHA standards. Refer to AFI 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 installation occupational safety office for guidance and assistance.

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 in accordance with 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 unit 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 personal protective equipment (PPE), and include preventative measures in procedures to mitigate the hazards. Refer to AFI 91-202 for additional guidance.

1.7. Military-Unique and Nonmilitary-Unique Policy. The DAF shall apply AFOSH, OSHA, DoD and other non-DoD regulatory safety and health standards and guidance to military-unique workplaces, operations, equipment and systems in whole or in part, insofar as practicable. **(T-0)** DAF directive guidance is to comply with AFOSH, OSHA, DoD and other non-DoD regulatory safety and health standards and guidance as provided under federal law and in accordance with DoD policy with respect to military-unique and nonmilitary-unique workplaces, operations, equipment and systems. **(T-0)**

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

1.7.2. Nonmilitary-Unique. The term nonmilitary-unique refers to military and civilian workplaces, operations, equipment and systems 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. DAF shall comply with AFOSH, OSHA, DoD and other non-DoD regulatory safety and health standards and guidance with respect to nonmilitary-unique workplaces, operations, equipment and systems, regardless of whether work is performed by military or civilian personnel.

1.8. Documentation. This publication specifies 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 use of automated systems for tracking these activities, requiring specific paper forms may impede use of more efficient automated processes. Therefore, use of automated systems for documenting inspections, maintenance and other activities is acceptable in place of specified AFTO Forms 95 and 244 or other appropriate inspection, maintenance and general purpose forms 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 use of these forms. Check the prescribing directive(s) before discontinuing use of any forms.

1.9. First Aid and Cardiopulmonary Resuscitation (CPR) Training. Initial first aid/CPR training shall 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 current CPR certification expires. **(T-1)** Unit CPR instructors may be trained by the local medical group or trained directly by the American Red Cross or American Heart Association. Unit CPR instructors will, in turn, train unit personnel. **(T-1)** If CPR training is not provided by the host medical facility, any instructor receiving training directly from the American Red Cross or American Heart Association will be required to maintain the requirements and pay the costs related to maintaining a certification. **(T-1)** The unit CPR instructor will ensure training includes public access defibrillator training in accordance with AFI 44-177, *Public Access Defibrillator Program*. **(T-1) Note:** Self-aid and buddy care (SABC) 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.

1.10. 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 in accordance with 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, SABC. For workplaces with employees that meet this job description, supervisors shall establish a written exposure control plan and conduct training in accordance with 29 CFR § 1910.1030. **(T-0)**

1.11. Process Safety Management (PSM) of Highly Hazardous Chemicals.

1.11.1. 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 criteria in 29 CFR § 1910.119 shall be used in its entirety for program implementation and application unless otherwise specified. **(T-0)** PSM may also apply to explosives and pyrotechnics. Refer to 29 CFR § 1910.119, AFI 91-202 and Defense Explosives Safety Regulation (DESR) 6055.09_AFMAN 91-201, *Explosives Safety Standards*, for additional guidance. **Note:** Also refer to MIL-STD-882E, *Department of Defense Standard Practice: System Safety*, Task 108, *Hazardous Materials Management Plans*, which is the DoD's standard governing risk assessment and safety data requirements for hazardous materials management.

1.11.2. 29 CFR § 1910.119, Appendix A, *List of Highly Hazardous Chemicals, Toxics and Reactives*, contains a list of chemicals used in the DAF, whether the chemical is in a mixture or a byproduct of a chemical process and/or reaction.

1.11.3. Responsibilities.

1.11.3.1. The installation Occupational Safety (SEG) office shall:

1.11.3.1.1. Serve as the focal point for coordinating and implementing PSM procedures, to include leading the PSM team if one is required. **(T-1)**

1.11.3.1.2. With the assistance of the Hazardous Material Management Process Team, conduct and document an assessment of the installation's chemical quantities on-hand that are listed in 29 CFR § 1910.119, Appendix A. **(T-0)**

1.11.3.1.2.1. If the chemicals on the installation do not exceed the threshold quantities listed in 29 CFR § 1910.119, Appendix A, the installation SEG will document the assessment and note that, in accordance with 29 CFR § 1910.119, Appendix A, threshold quantities, a PSM program is not required. **(T-1)** In this case, a reassessment will be accomplished and documented at a minimum of every three years from the initial assessment or sooner when new chemicals or increased quantities of chemicals listed in 29 CFR § 1910.119, Appendix A, are introduced to the installation. **(T-1)**

1.11.3.1.2.2. If the chemicals on the installation exceed the threshold quantities listed in 29 CFR § 1910.119, Appendix A, the safety office will advise the installation commander a formal PSM program and PSM team led by the installation safety office is required by this manual. **(T-0)**

1.11.3.1.3. Ensure copies of OSHA-required PSM documentation are maintained in the installation safety office for OSHA's review for the life of the process. **(T-0)**

1.11.3.1.4. Assess installation operations and advise NAF/SE, FLDCOM/SE and MAJCOM/SE of the number and type of operations that fall under the PSM program. **(T-1)**

1.11.3.2. The Installation PSM Program Team, when required, shall:

1.11.3.2.1. Include representatives from the installation occupational safety office, Bioenvironmental Engineering (BE), HMP Program OPR (also called the installation

Hazardous Material Management Process team lead), Civil Engineer (CE), Environmental Management office, Fire & Emergency Services (F&ES) Flight, Emergency Management Flight and all highly hazardous chemical users, as defined in 29 CFR § 1910.119. **(T-1)**

1.11.3.2.2. Develop and coordinate the installation plan for employee participation. **(T-0)**

1.11.3.2.3. Meet as necessary to conduct and review process hazard analyses (PHA). **(T-1)**
Note: The PSM Program Team is not necessarily the same team that performs the PHA in 29 CFR § 1910.119(e). These PHAs will be performed by internal staff members, through a contract, or a combination of both. **(T-0)**

Chapter 2

GENERAL WORK PROCEDURES

2.1. General Information. This chapter provides general work procedures for a safe and healthful workplace, to include the wearing of jewelry, workplace safety, ergonomics and housekeeping. In accordance with AFI 91-202, the supervisor will ensure job safety training outline will evaluate and identify PPE requirements. **(T-1)** All facilities shall 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. Noise 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. The installation Bioenvironmental Engineer (BE), or joint base equivalent, conducts occupational environmental hazard risk assessments, then recommends appropriate engineering controls, administrative actions or PPE. 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 AFI 48-151, *Thermal Injury Prevention Program*, for guidance and information on thermal injuries and their prevention/treatment.

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 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, and flammable or combustible liquids. Refer to 29 CFR § 1910.1200, *Hazard Communication*, AFI 90-821, *Hazard Communication (HAZCOM) Program*, and **Chapter 22** of this publication.

2.3. Jewelry. Jewelry, such as rings, watches, bracelets and necklaces, that presents a potential for catching, snagging, pulling or tearing shall 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 shall 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 shall also be removed and metal framed eyeglasses shall be secured by a band or cord to prevent them from falling into energized electrical circuits or machinery. **(T-0) Note:** This prohibition includes conductive jewelry such as necklaces, bracelets, watches, etc. These items will permit inadvertent electrical current transfer to the worker.

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 shall 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 shall ensure such items do not create hazards during worker's 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 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 shall promptly report potholes and uneven surfaces to CE. **(T-0)**

2.4.1.1. Facility managers will ensure 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 shall be applied. **(T-1)** Snow and icicles above walkways shall be removed by the unit or a work request shall be submitted for areas that cannot be reached. **(T-1)**

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 shall be properly protected by molded housings, bridges or other covers approved for such use to prevent tripping. **(T-0)**

2.4.1.3. Briefcases, wastebaskets, etc., shall 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, and worn, frayed or damaged anti-slip material on stairs or inadequate lighting.

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 guard 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 AFMAN 32-7002, *Environmental Compliance and Pollution Prevention*, for approved hazardous waste disposal procedures and guidance. Safety Data Sheets required for each hazardous chemical, in accordance with AFI 90-821, can assist with the proper identification of waste prior to being removed for disposal, especially for wastes generated as a result of unused and/or expired hazardous chemicals. The supervisor will ensure use or storage of flammable liquids shall 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 shall 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, shall be stored in metal or noncombustible covered containers. **(T-1)** Remove hazardous material markings and/or placards, protruding nails, brads and staples from crates, cases, packing boxes, casks, boards and lumber to prevent injury to personnel.

2.4.4. Electric Buffing Machines. Supervisors shall ensure electric buffing machines are equipped with under-voltage/overvoltage 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 inches 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.

2.4.6. Lighting Fixtures. The supervisor will ensure tubular light fixtures (fluorescent/light-emitting diode) without self-locking tubes shall have shields, clamps or other devices installed to keep the tubes from falling out of the fixture. **(T-1)**

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

2.4.8. General Safe Practices. All areas, shops, yards, buildings and mobile equipment facilities/areas shall 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.

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

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

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

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

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

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

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

2.4.8.8. Compressed Air. Compressed air shall not be used for cleaning purposes except where 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 shall 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 shall 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 shall 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.

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

2.4.8.10. All work surfaces and floors shall be kept free of any visible accumulation of dust 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 shall have at least five (5) legs. **(T-1) Note:** Five (5) or more legged caster chairs are more stable and ergonomically sound than four (4) 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 heaviest objects/books on lower-level shelves.

2.5.2. Electrical Equipment.

2.5.2.1. Appliance, electrical equipment and other office machines shall 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*, and **Chapter 8** 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, 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 shall contact their installation Base Civil Engineer (BCE) when assistance is needed. **(T-2)**

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

2.5.4. Lighting. Consult the local civil engineering facility design section when specific guidance on lighting is required. Fluorescent light bulbs contain toxic materials and shall be managed in accordance with local hazardous waste disposal criteria. **(T-0)** Supervisors shall

ensure any stroboscopic effect with moving machinery is eliminated when using fluorescent lighting fixtures. **(T-1)** Work area lighting shall be installed to eliminate glare and harsh shadows. **(T-1)** Supplementary or additional lighting shall be provided where general lighting is not sufficient. **(T-1)**

2.5.5. Heating, ventilation and air conditioning systems shall be maintained and inspected by a trained HVAC system technician in accordance with American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers (ANSI/ASHRAE) 62.1, *Ventilation for Acceptable Indoor Air Quality*. **(T-1)** Filters shall 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 shall 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 shall 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 shall not try to stop elevators by placing a hand or foot in closing doors. **(T-0)** Employees shall not use elevators during emergency evacuation. **(T-0)**

2.5.6.3. Refer to 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*, for additional guidance on elevators.

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

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

2.5.9. Raised floor spaces shall contain a standard or ultra-sensitive smoke detection system as required by UFC 3-600-01. **(T-0)**

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

2.5.11. Floors shall not be cleaned with flammable or combustible liquids. **(T-0)** Follow the manufacturer's instruction and safety data sheet (SDS) guidelines when using cleaning agents for floors and facilities.

2.5.12. To prevent buildup of trash and foreign objects, sub-floors under raised floors shall be cleaned periodically, but not less than once every 60 days. **(T-1)** Sub-floors shall be inspected once each operational day to ensure no flooding or leaking is present, unless the sub-floor area is provided with an automatic water leakage detection system. **(T-1)** **Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

2.5.13. Utility trenches shall 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. **Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

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 occur when the body may not be positioned correctly for a work task or working conditions put a strain on the body. They may include sore muscles, improperly adjusted workstations and/or chairs, poor posture, frequent lifting, vibration, repetitive motion or awkward movement. Contact the installation BE for questions relating to ergonomics or to have an ergonomic assessment completed. Refer to OSHA website: <https://www.osha.gov/SLTC/ergonomics/controlhazards.html> and the U.S. Army Public Health Center website: <https://phc.amedd.army.mil/topics/workplacehealth/ergo/Pages/default.aspx> for additional guidance.

2.7. Roll-up Doors. Roll-up doors shall be maintained in good operating condition with door tracks free of debris and obstructions to allow smooth operation. **(T-1)** Operators shall conduct a visual inspection of door path and track-way and correct any discrepancies before operating door. **(T-1)** Individuals shall 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 shall have a crush sensor on the bottom of the door installed and operational. **(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 shall be located so there is an unobstructed view during door operation. **(T-1)**

2.7.1.4. Open and close motion shall be no faster than nine (9) inches per second. **(T-1)**

2.7.1.5. 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 entering or exiting the hangar with a vehicle through these doors, vehicle drivers will sound their horn to alert personnel. **(T-0)**

2.8. Receiving/Loading Docks. Frequently used loading docks shall be located away from principal streets and intersections. **(T-0)** Vehicles parked at docks shall not block general vehicular traffic unless control devices, such as cones, barricades or warning signs are used to redirect traffic. Loading docks shall adhere to fall protection requirements in [paragraph 7.1.5.3](#). **(T-1)**

2.8.1. Dock surfaces shall be smooth and even. **(T-0)** Where necessary, aiseways shall be marked. **(T-0)**. Edges of docks shall be marked with four-inch wide yellow lines when there is a chance of employees falling. **(T-0)** Markings of physical hazards shall be in accordance with

29 CFR § 1910.144, *Safety Color Code for Marking Physical Hazards*. (T-0) Where the potential for serious injury exists, removable railings shall be used. (T-1)

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

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

2.9. Walk-in Refrigerators and Freezers. A bypass or other type device shall 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 shall be provided and tested weekly and documented. (T-1) If the bell is inoperable, it shall 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, “Determine No One Is Inside Before Locking Door,” shall be mounted on the door’s exterior. (T-1). The letters shall be at least three (3) inches high. (T-1)

2.10. Manual Material Handling. 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) Some possible exposures to mishaps include, but are not limited to:

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

2.10.2. Remove doors or drawers to lighten load and to prevent shifting or falling hazards.

2.10.3. Secure cords, communication cables or other gear attached to the item to prevent tripping or snagging hazards.

2.10.4. For large or difficult to handle items, secure the load to the hand-truck or dolly with a cargo strap or other fastening device.

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

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

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

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

2.10.9. 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)

2.10.10. Evaluate the need for PPE.

2.10.11. Follow the guidelines in [paragraph 2.6](#) for additional guidance on proper lifting.

2.11. 3D Printers.

2.11.1. Conduct JHA using manufacturer's instructions and filament safety data sheet to determine hazards and proper controls. **(T-1)**

2.11.1.1. Request installation occupational safety office assistance, as needed, in development of JHA.

2.11.1.2. Request installation BE assessment of 3D printing operations to ensure proper ventilation and PPE evaluation.

2.11.2. Supervisors will develop a job safety training outline (JSTO) and provide employees with specific work place hazards and relevant protective measures. **(T-3)** Refer to AFI 91-202 for additional guidance on JSTOs.

Chapter 3

WEATHER SAFETY

3.1. Responsibilities.

3.1.1. The supporting Air Force weather organization is responsible for making initial notification of adverse or mission-limiting weather conditions to predetermined support agencies. **Note:** Adverse or mission-limiting weather conditions include strong and damaging surface winds, heavy rain, thunderstorms, hail, snow and freezing precipitation.

3.1.2. Each DAF installation shall 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, shall advise all on-duty supervisors and workers to take proper precautions. **(T-1)**

3.1.3. Each installation shall 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 forecast 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)** **Note:** During a Lightning Watch, non-explosive operations or activities may continue. 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 shall reassess the Lightning Watch and amend or cancel the watch as required in accordance with AFMAN 15-129. **(T-1)**

3.2.2. A Lightning Warning is in effect when lightning occurs within a five (5) nautical miles radius of the predetermined locations and activities. Personnel in affected locations or engaged in affected activities shall 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 shall be cancelled by the weather detachment or organization that initiated the warning. **(T-1)**

3.3. General Lightning Safety for all AF 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 absolutely 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 shall 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, shall cease whenever a Lightning Warning is in effect. **(T-0)** **Note:** Refer to AFI 23-201, *Fuels Management*, for additional guidance.

3.3.4. Locations with nuclear munitions will request notification of lightning within 10 miles of their location in accordance with DoDM 3150.02, *DoD Nuclear Weapon System Safety Program*, from their servicing weather unit. **(T-0)** Local procedures for these advisories are documented in DESR 6055.09_AFMAN 91-201, *Explosives Safety Standards*. **(T-0)**

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 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 shall meet the requirements of NFPA 99, *Health Care Facilities Code*, and Joint Commission Accreditation Manuals. (T-0)

4.2.1. Supervisors shall 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 shall be maintained on file for a rolling year. (T-2)

4.2.2. Facility Requirements.

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

4.2.2.2. Facilities located more than three (3) to four (4) 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 installation Fire Emergency Services (FES) Flight shall be immediately notified of any flammable solvent spills. (T-0) Contact BE and/or Environmental Management office for guidance on spill procedures.

4.2.4. Machinery producing potentially hazardous noise and/or vibration levels shall be identified and control measures initiated in accordance with 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 shall be stored in accordance with [Chapter 22](#). (T-0)

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

4.3. Lodging.

4.3.1. Some lodging supply operations require forklift trucks. Refer to 29 CFR § 1910.178, *Powered Industrial Trucks*, AFMAN 24-306, *Operation of Air Force Government Motor Vehicles*, and [Chapter 12](#) for additional guidance.

4.3.2. Kitchen Cleaning.

4.3.2.1. As needed, grease shall 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 shall be cleaned daily. (T-0) Microwave ovens with broken doors or latches shall 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 on equipment shall be properly guarded. (T-0) Refer to [Chapter 11](#) for additional guidance.

4.4.2.2. Knives and cutting attachments shall 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, shall be washed at least daily. (T-1) Hood filters in other areas shall be washed at least weekly. (T-1) Ducting shall be cleaned as necessary but at least once every six (6) months. (T-1) Cleaning of filters and ducts shall be documented in accordance with local procedures. (T-1) Cooking shall not be permitted under hoods without properly installed filters or when the fire extinguishing system is not operating. (T-1) Exhaust hoods shall 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 shall maintain manufacturer's instructions for all machinery or equipment under their control or develop local operating instructions (OI), to include job safety, maintenance, lubrication and 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, shall 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 nondestructive inspection 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 shall 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 shall not be operated when flammable vapors are present. **(T-0)**

5.2.2. Ionizing Radiation and X-ray Equipment. Refer to OSHA 1910.1096, *Ionizing Radiation*, DAFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, AFMAN 48-148 and 21 CFR § Parts 1020.30 through 1020.33 for additional guidance.

5.2.3. Electrical Safety. NDI equipment to be used in hazardous areas shall 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 shall 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 shall be conducted at least annually. **(T-0)**

5.2.6.2. Ventilation evaluation frequency is determined by BE in the occupational and environmental health risk assessment. 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. **Note:** For more details on permissible exposure limits, flow rate requirements and design criteria, refer to American Conference of Governmental Industrial Hygienists' *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and AFI 48-145, *Occupational and Environmental Health Program*. Ventilation for oil analysis program spectrometers shall also comply with technical order and manufacturer's requirements. **(T-1)** Refer to BE's occupational and environmental health risk assessment for additional guidance.

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 nondestructive inspection and oil analysis work. **(T-1)**

5.3.2. Ensure waste oil and cleaning rags do not accumulate in the oil analysis program lab. **(T-1)** Waste oil, not to exceed five (5) gallons, may be stored in the lab in an approved self-closing metal waste container. Waste cleaning rags and towels shall be removed from the lab at the end of each shift. **(T-1)**

5.4. Nondestructive Inspection Equipment and Fire Protection Systems. Contact the installation 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 and fire education safety on preventing fires, protecting themselves and intervening early when fire occurs. Refer to 29 CFR § 1910.157(a) for additional guidance. Coordination and approval of installation fire services is 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 in accordance with UFC 3-601-02, *Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems*. When a fire protection system is out of service follow procedures in accordance with AFI 32-10141, *Planning and Programming Fire Safety Deficiency Correction Projects*. **(T-1)**

6.2. General Requirements.

6.2.1. Facility Managers/Supervisors shall:

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

6.2.1.2. If further guidance is required, consult the installation Flight and Emergency Services (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 installation 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 installation 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 shall be provided in accordance with 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 shall 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 shall be shut down before it is covered with the

plastic sheeting. **(T-0)** This will reduce the possibility of the equipment overheating and catching on fire. The plastic sheeting shall be removed before restarting equipment. **(T-0)**

6.2.3. A survey of each server room by the installation BCE shall be requested to determine if a water hazard exists. **(T-1)** The building custodian shall 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 shall be maintained as required to prevent the loss of DAF resources. **(T-1)** The installation F&ES Flight shall inspect grease and heat removal hoods, ducts and exhausts at all food service facilities. **(T-1)** The FES inspection time and the contractor cleaning frequency shall be approved by the installation fire chief. **(T-1)** The unit 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 shall have in effect a written fire plan that addresses appropriate staff response to a fire emergency and appropriate education and training for all elements of the fire plan. **(T-2)** The plan will address facility-wide needs in response to fire, area-specific needs for all areas, training for all staff, employees and volunteers, and appropriate training for other non-staff personnel required to participate in the fire plan. **(T-2)** The installation fire chief or designee shall approve the fire plan. **(T-3)**

6.2.6. Portable Fire Extinguishers.

6.2.6.1. Fire Emergency Services (FES) Flight. The installation F&ES Flight manages the installation fire extinguisher program and is the authority for all matters involving fire extinguishers. The F&ES Flight shall provide facility managers 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 shall be developed to ensure occupants are trained in their use and extinguishers are maintained. **(T-3)**

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

6.2.6.4. Fire Extinguisher Purchase and Maintenance. Facility managers and using organizations shall budget for purchase and maintenance of fire extinguishers. **(T-3)** **Note:** Not applicable to flightline fire extinguishers.

6.2.6.5. All fire extinguishers shall meet the requirements of NFPA 10, *Standard for Portable Fire Extinguisher*. **(T-1)** **Note:** This includes flightline fire extinguishers.

6.2.6.6. Worker Responsibilities. All employees are responsible for fire extinguishers in their work areas. Employees shall ensure fire extinguishers are readily accessible with unobstructed access and are used only for the intended purpose. **(T-0)** F&ES Flights shall 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 shall:

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 installation F&ES Flight, for services. **(T-0)** Fire extinguishers removed from service shall 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 shall only be purchased with the approval of Vehicle Management to ensure the vehicle technical orders and AFIs require the vehicle to carry fire extinguishers. **(T-1)**

6.2.6.8. Visual Inspection. Managers and supervisors at all levels shall ensure a visual inspection is performed and documented monthly for all fire extinguishers under their control. **(T-0)** Extinguishers with discrepancies shall be removed from service 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. OIs on name plate legible and facing outward.

6.2.6.8.4. Safety seals and/or tamper indicators 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 shall also have an overheat protection device, an automatic thermostat control and must be disconnected when not in use. **(T-3)** **Note:** Space heaters shall not be used without the approval of the installation energy manager. **(T-3)** Refer to the installation energy management program for additional local guidance. For a current list of OSHA-recognized NRTLs, visit <https://www.osha.gov/dts/otpc/nrtl/nrtllist.html>.

6.2.7.2. Plug space heaters directly into a wall receptacle. Do not plug space heaters into extension cords or multiple outlet strips. **(T-3)**

6.2.7.3. Maintain a 36 inch minimum distance or in accordance with manufacturer’s instructions between any space heater and combustibles. **Note:** The more restrictive of the 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-3)**

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

6.2.10. Decorations.

6.2.10.1. Electric string lights and wiring on an OSHA-recognized NRTL list is authorized. **(T-0)**

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

6.2.10.3. Decorations shall be noncombustible or fire retardant. Use of an open flame is prohibited. **(T-3)**

6.2.11. Fire Alarm Systems. Supervisors shall ensure all personnel are familiar with the fire alarm systems, know how to report an emergency and how to activate the fire alarm system. **(T-0)** At no time shall a fire detection, suppression or alarm system or device be painted, blocked or obstructed in any manner. **(T-3)**

6.2.12. Emergency Evacuation Procedures.

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

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

6.2.12.3. Personnel shall immediately evacuate the building whenever the fire alarm activates, unless otherwise provided for in an approved building fire evacuation plan or when non-evacuation testing or maintenance is being conducted on the fire alarm system. **(T-3)** Installation commanders may approve in writing, with coordination from the installation 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 shall 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 a predetermined area for personnel to gather after evacuation so personnel can be accounted for. **(T-3)**

6.2.12.6. Appoint Emergency Action Procedures representatives to account for personnel at the predetermined meeting area. **(T-3)** This will help emergency response personnel determine who may still be in the building. At least two representatives per section shall be appointed; in case the primary leader is not in the building at the time of the emergency or is unable to evacuate the building, the alternate can fill in. **(T-3)** Sections with many personnel (20 or more) in their allocated space may require additional representatives. **(T-3)**

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

Chapter 7

WALKING – WORKING SURFACES

7.1. General Requirements. Obstacles in walk areas, liquid spills, sawdust accumulations and the use of slippery surface cleaners can cause slipping hazards and shall be cleaned up immediately to prevent slips, falls and injuries. **(T-0)** Refer to 29 CFR § 1910, Subpart D – *Walking-Working Surfaces*, for definition and additional guidance.

7.1.1. All walking-working surfaces shall be maintained in a clean and dry condition as much as possible. **(T-0)** Drip or oil pans shall be used whenever the possibility of spilling or dripping exists. **(T-0)** Where wet processes are used, drainage shall be maintained and false floors, platforms, mats, or other dry standing places should be provided where practicable. **(T-0)** If floor drains are present, floors shall be sloped to allow liquids to naturally flow to the drains. **(T-0)** Drains shall be kept clear to prevent clogging, especially when hazardous or contaminated materials are present. **(T-0)** In locations where wet processes do not normally occur, and drains are not available, wet areas shall be clearly marked (e.g., wet floor signage) and immediately cleaned up and dried before permitting other personnel to enter the area. **(T-0)** Protective footwear for wet slippery surfaces shall be provided where appropriate. **(T-1)**

7.1.2. Condition. Floors, aisles, and passageways shall be kept clear and in good repair, with no obstructions, free of defects that can endanger employees or interfere with handling of materials, or hinder people leaving during emergencies. **(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 shall be provided where general lighting is not sufficient. **(T-1)** Facility managers shall 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 BCE 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 shall be coordinated with the installation occupational safety office, who may assign a Risk Assessment Code, if warranted. **(T-1)**

7.1.3.2. All fluorescent light bulbs contain toxic materials and shall be managed in accordance with local disposal criteria for hazardous waste. **(T-0)** Consult with the installation Environmental Management Office on disposal guidance for hazardous waste materials. When fluorescent lighting fixtures are used, supervisors shall 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, shall be guarded. **(T-0)** **Note:** Manholes shall 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 shall be installed:

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

7.1.4.1.1. Railings and toeboards shall be permanently attached leaving only one exposed side, which shall have a removable railing. **(T-0)** When the exposed side is not in use, the railing shall be left in place. **(T-0)** Refer to 29 CFR § 1910.28 for specific detail on construction and installation.

7.1.4.1.2. Toeboards are required wherever falling objects may present a hazard. **(T-0)** Toeboards can be constructed of any 4-inch high rigid material, either solid or with openings not greater than 1 inch. They shall be securely fastened in place with not more than one-fourth inch clearance from the floor except at the entrance of the opening. **(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)** Refer to 29 CFR § 1910.29 for additional information.

7.1.4.2. Floor Opening Cover. A cover shall be used for less frequently used openings where traffic across the opening prevents the use of fixed railings, such as openings located in aisle spaces. **(T-0)** In addition, covers or guards shall be used to protect people from the hazards of open pits, tanks, vats, ditches, etc. **(T-0)** Refer to 29 CFR § 1910.29, *Fall Protection Systems and Falling Object Protection-Criteria and Practices*, for additional requirements.

7.1.5. Guards.

7.1.5.1. Every stairway and ladderway opening shall be guarded by standard railings and toeboards on all open sides, except at the entrance of the opening. **(T-0)** If there is danger of a person walking straight into the opening, a swinging gate or offset passage shall be used. **(T-0)**

7.1.5.2. Every covered opening in a surface, such as a skylight floor opening, shall be guarded by a skylight screen or standard railing with toeboards on all exposed sides. **(T-0)** Skylight screen grillwork or slatwork shall be capable of withstanding a load of at least 200 pounds applied at any area of the screen. **(T-0)** Refer to 29 CFR § 1910.28 for additional information.

7.1.5.3. All open-sided floors, platforms and runways four (4) feet or more above the ground or floor shall be guarded by a standard railing on all open sides, except at ramp entrance to a ramp, stairway or fixed ladder. **(T-0)** Collapsible or removable railings may be installed on a runway, but shall only be removed when a special task (such as oiling, shafting or filling tank cars) is being performed and other protective measures, approved by the installation occupational safety office, are used. **(T-0)** Railings shall be reinstalled when the task is complete. **(T-0)**

7.1.5.4. Every permanent or temporary wall opening (to include windows) less than 39 inches above the floor (where there is a four [4] foot or more drop) shall be protected from falling by use of: guardrail system, safety net system, travel restraint systems or personal fall arrest systems. **(T-0)** If a guardrail system is used, the guard may be removable, but shall be installed when the opening is not in use. **(T-0)** A toeboard shall be installed when falling materials may present a hazard. **(T-0)** Refer to 29 CFR § 1910.28 for additional information.

7.1.5.5. Guard railings shall consist of securely mounted top rails, intermediate rails and posts. **(T-0)** The vertical height shall 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) (Exception:** Guard railings in place constructed prior to 26 October 2016 shall consist of a top rail, intermediate rail and posts, or equivalent, and shall have a minimum vertical height of 36 to 44 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).

7.1.5.5.1. 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 (99 cm) above the walking-working surface. **(T-0)**

7.1.5.5.2. Midrails 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 toprail. **(T-0)**

7.1.6. Coefficient of Friction of Walking and Working Surfaces. The finished surface shall have a coefficient of friction of at least 0.5 for level surfaces and 0.8 for sloped surfaces, as measured using ANSI/American Society of Safety Professionals (ASSP) A1264.2, *Provision of Slip Resistance on Walking/Working Surfaces*, or other adopted nationally recognized standards. **(T-1)** Consult the installation BCE when coefficient of friction guidance for a specific work surface is required or needs to be determined. **(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 coatings or surface treatment used on them.

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

7.1.8. Interior Walking and Working Surfaces.

7.1.8.1. Layout. All interior walking and working surfaces that are part of the means of egress shall comply with UFC 3-600-01 and NFPA 101. **(T-0)**

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

7.1.8.1.1.1. Sufficient space shall 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 shall 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 shall 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 shall 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 shall consult with the installation 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 (2) to three (3) inches wide, shall be used when marking is necessary. **(T-1)**

7.1.8.1.2. Passageways, aisles and exit accesses shall be provided to permit free movement of employees and material, and shall be independent of clear zones and storage spaces and shall be clearly recognizable. **(T-0)** Markings shall be used unless impractical. **(T-0)** Floor markings shall provide a contrast to the floor color, such as yellow lines two (2) to three (3) 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 shall provide enough clearance in aisles, loading docks and through doorways to permit safe turns. **(T-0)** Obstructions that could create hazards shall not be permitted in aisles. **(T-0)** Aisles shall be at least two (2) 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 shall be at least 36 inches wide to permit free movement of workers, equipment and supplies. **(T-0)** A minimum of 18 inches shall 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 shall be provided and maintained around all electrical equipment. **(T-0)** Refer to 29 CFR § 1910.303, *General (Electrical)*, for additional information.

7.1.8.2. Condition.

7.1.8.2.1. Floors shall not be cleaned with flammable liquids. **(T-0)** In accordance with AFMAN 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 Program Team prior to use. **(T-2)** Adequate ventilation shall be provided and/or respiratory protection may be required. **(T-0)** Combustible or explosive dust shall be eliminated at the source. **(T-0)** If this is not possible, it shall 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 shall 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 shall be posted to warn employees of a slipping hazard and shall remain in place until floors have dried. **(T-0)** The size and placement of these signs shall be at the discretion of the supervisor, but shall be visible to those entering the hazardous area. **(T-0)** Refer to [Chapter 17](#) for additional information on safety, fire prevention and health signs.

7.1.8.2.4. Loading Capacity. Supervisors shall ensure equipment weight and distribution comply with maximum floor loading capacity for all above grade storage

areas (including areas above basements). **(T-0)** The weights of equipment, such as hoists suspended under a floor, shall also be considered when determining floor loading capacity. **(T-0)** The supervisor shall have signs that identify the floor load capacity determined by the installation BCE permanently installed in plain view of all employees. **(T-0)** CE shall approve the installation of all equipment weighing more than 500 pounds in any multi-story building. **(T-1)** Supervisors shall 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 the installation BCE.

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

7.1.9.2. Walkways. Lighting shall be used to highlight hazards. **(T-0)** When loose gravel or crushed rock is used for surfacing, the largest dimensions of material used shall not exceed one-half of an inch. **(T-0)** Motorized vehicles shall 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, shall be repaired. **(T-0)**

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

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

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

7.1.9.3.3. All open drainage ditches that present a hazard shall be clearly identified in the daytime, guarded by fences or barriers and illuminated or marked with warning flashers at night. **(T-0)**

7.1.9.4. Construction. All construction work shall be clearly identified by signs that can be read from at least 50 feet, in addition to barriers marked with night reflective materials. **(T-0)** Illumination or warning flashers shall 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 (6) feet of the edge to authorized and trained employees only in accordance with 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 (6) 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 (6) 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)**

7.2. Stairs and Ramps Requirements. **Note:** Egress components, such as stairs, ramps, guard rails or hand rails, 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 the installation BCE with recommendations from the installation 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. Strength. Stairs and fixed ramps shall be designed and built to carry a load of 5 times the normal live load anticipated but not less than a moving concentrated load of 1,000 pounds. **(T-0)**

7.2.3. Width. Stairs, if part of the exit access, shall have a minimum width of 36 inches if the occupant load of the building or structure is less than 50 persons. **(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, shall have a minimum width of 44 inches. **(T-0)** The authority having jurisdiction may reduce this requirement to 30 inches, with the concurrence of the Designated Fire Protection Engineer (DFPE) per UFC 3-600-01. For ramps or stairs not part of the exit access, a minimum width of 22 inches shall be provided. **(T-0)**

7.2.4. Angle of Rise. Stairs shall 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 in compliance 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 shall be installed. **(T-0)**

7.2.5. Ramps. Ramps not part of the exit access shall follow guidance in NFPA 101. 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.

7.2.6. Width of Landings. Landings and platforms not part of the exit access shall not be less than the width of the stairs and a minimum of 30 inches in length, measured in the direction of travel. **(T-0)** When doors or gates open directly onto a stairway, they shall 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 shall meet the requirements of NFPA 101. **(T-0)**

7.2.7. Vertical Clearance. Where there is less than six (6) feet, eight (8) inches of headroom over stairs, obstructions shall be padded. **(T-0)** When they cannot be padded, obstructions shall be color coded yellow or yellow-and-black stripes to highlight the hazards. **(T-0)** In all cases, caution signs shall be used to warn people of low clearances. **(T-0)**

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

7.2.9. 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.

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

7.2.11. Stair Railings and Guards. Every flight of stairs with four (4) or more risers shall have standard guardrails or standard handrails as called for in 29 CFR § 1910.25. **(T-0)** The width of the stair shall be measured clear of all obstructions except handrails. **(T-0)**

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

7.2.13. 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 shall have handrails on both sides and open risers. **(T-0)** Construction or installation after 17 January 2017 shall have stairs installed within the range of 30-50 degrees. **(T-0)**

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

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

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

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

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

7.2.14.5. 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)**

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

7.2.14.7. 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 walks 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 shall meet requirements of 29 CFR § 1910.23, *Ladders*. **(T-0)** Procurement specifications shall include permanent treatment for corrosion control so future treatment shall 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 shall be provided where access is daily or during each shift for gauging, inspection, regular maintenance or when carrying tools or equipment is normally required and sufficient space is available. **(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. Length. Ladders 24 feet or less shall 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. When platforms are required, they shall not be less than 24 inches wide by 30 inches long and shall be equipped with standard railings. **(T-0)** 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 shall meet the design requirements of the ladders which they serve. **(T-0)** Where a cage is installed, it shall extend a minimum of 42 inches above the top of landing, unless other acceptable protection is provided. **(T-0)** Cages shall extend down the ladder to a point not less than seven (7) feet nor more than eight (8) feet above the base of the ladder. **(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 existing fixed ladders more than 24 feet. **(T-0)**

7.3.1.2.3.1. Existing fixed ladders. Each fixed ladder installed before 19 November 2018, is equipped with a personal fall arrest system, ladder safety system, cage, or well,

7.3.1.2.3.2. New fixed ladders. Each fixed ladder installed on and after 19 November 2018, is equipped with a personal fall arrest system or a ladder safety

system.

7.3.1.2.3.3. Replacement. When a fixed ladder, cage, or well, or any portion of a section thereof, is replaced, a personal fall arrest system or ladder safety system is installed in at least that section of the fixed ladder, cage, or well where the replacement is located.

7.3.1.2.3.4. Final deadline. In accordance with 29 CFR § 1910.28(b)(9)(i)(D), on and after 18 November 2036, all fixed ladders are equipped with a personal fall arrest system or a ladder safety system.

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 personal fall arrest system 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 self-retracting lifelines and 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. **(T-0)**

7.3.1.2.4.4. Are offset from adjacent sections. **(T-0)**

7.3.1.2.4.5. 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 personal fall arrest system 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 shall be 75 to 90 degrees from the horizontal. **(T-1)** Ladders with a pitch in excess of 90 degrees are prohibited. Refer to 29 CFR § 1910.27, *Scaffolds and Rope Descent Systems* for additional information.

7.3.1.4. Load Capacity. All ladders, platforms, appurtenances and fastenings shall meet the load requirements of 29 CFR § 1910.23. **(T-0)**

7.3.1.5. Lighting. Adequate illumination shall be available when using ladders. **(T-0)** Lamps shall be installed so the light does not reflect in a climber's eyes. **(T-0)** Consult the installation BCE 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 shall 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 (7) feet shall 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 shall be provided. **(T-0)**

7.3.1.8. Electric Lines. Electrical conductors shall not be installed on or adjacent to fixed metal ladders, unless they are beyond reach and cannot be used as a handrail or grabbed inadvertently. **(T-0)** This distance shall be at least five (5) feet from the ladder. **(T-0)** If there is any potential for contact with parts of electric equipment or circuits, these parts shall be de-energized and locked out in accordance with **Chapter 21. (T-0)**

7.3.1.9. Rung Ladders. Rung ladders shall 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 shall comply with 29 CFR § 1910.24. **(T-0)**

7.3.1.10. Grounding and Bonding. Ladders and related equipment shall be grounded and/or bonded, to drain off accumulated static electricity when static electricity is hazardous to the work operation, such as fuel cell repair or refueling vehicle maintenance. **(T-0)** Static discharge plates shall also be provided. **(T-0)**

7.3.2. Inspections.

7.3.2.1. A formal, fully documented inspection of all fixed ladders shall be accomplished upon installation and at least every three (3) years thereafter. **(T-0)** These inspections shall be performed by the installation BCE 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, unit will submit a Work Order Request to the Civil Engineer Squadron. **(T-3)** Inspection documentation shall include the type 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 a CE responsibility. Information regarding RPIE is provided in DAFI 32-9005, *Real Property Accountability and Reporting*, and DAFMAN 65-605, Volume 1, *Budget Guidance and Technical Procedures*.

7.3.2.2. Climbers shall be alert to potential hazards and perform informal inspections of fixed ladders prior to every use. **(T-1)** No attempt to climb shall 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 shall meet the following requirements:

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

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

7.3.3.3. All welding shall be performed by a qualified welder. **(T-0)**

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 shall 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 shall 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 shall be disqualified as ladder users. **(T-1)**

7.3.5. Supervisors shall ensure climbers are trained to:

- 7.3.5.1. Check ladder for defects and slippery substances. **(T-0)**
- 7.3.5.2. Ensure 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)**
- 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. The following practices are prohibited:

- 7.4.1.1. Ladders set on unstable surfaces. **(T-0)**
- 7.4.1.2. Ladders placed in front of doors which open towards the ladder without proper guarding. **(T-0)**
- 7.4.1.3. Ladders used as scaffolds, unless specifically designed for that purpose. **(T-0)**
- 7.4.1.4. Personnel reaching too far out to the sides. **(T-0)**
- 7.4.1.5. Personnel standing too high to maintain their balance. **(T-0)**
- 7.4.1.6. Use of a defective ladder, e.g., broken rail or rung. **(T-0)**
- 7.4.1.7. Improvising and using a make-shift ladder. **(T-0)**
- 7.4.1.8. Personnel carrying materials in their hands while ascending or descending a ladder. **(T-0)**
- 7.4.1.9. Using a ladder with conductive side rails while working on electrical circuits or near live electrical lines, etc. **(T-0)**
- 7.4.1.10. Descending with their back to the ladder, unless specifically designed for that purpose. **(T-0)**
- 7.4.1.11. Paint wood ladders with an opaque coating, since possible defects may be covered up. **(T-0)**

7.4.2. Requirements.

7.4.2.1. Acquisition and Selection Considerations.

7.4.2.1.1. Portable ladders shall meet ANSI design and construction specifications. **(T-0)**

Exception: Fire department ladders shall be maintained and inspected in accordance with 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)**

7.4.2.1.2. There are a variety of ladder styles; selection, to include construction material and proper size, shall be based on where and how the ladder may be used. **(T-1)** Ladders come in five (5) workload ratings. Supervisors shall order Type IAA, IA or I ladders whenever possible. **(T-1)** Type II ladders shall only be considered when local purchase is required and local manufacturers cannot provide Type IAA, IA or I. **(T-1)** Type III ladders shall not be procured for industrial use. **(T-1)** Refer to **Table 7.1** for additional information.

Table 7.1. Ladders Workload Ratings.

Ladders Workload Ratings		
Duty Rating	Ladder Type	Working Load (Pounds)
Extra Heavy Duty	IA	300
Extra Heavy Duty	IAA	375
Heavy Duty	I	250
Medium Duty	II	225
Light Duty	III	200

7.4.2.2. Inspections. Thorough visual inspections of ladders shall be made by the supervisor when the ladder is initially received and prior to being placed in service. **(T-1)** Workers shall 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:

7.4.2.2.1. Evidence the ladder was exposed to excessive heat (such as in a fire) or corrosive substances. When ladders are so exposed, their ability to support the designed working load shall be questioned. **(T-0)** The ladder shall be retested in accordance with manufacturer's instructions. **(T-1)** **Note:** Any ladder with structural or other defects will be immediately tagged "Dangerous: Do Not Use" and removed from service until repaired. **(T-0)** Refer to 29 CFR § 1910.23(b)(10) for additional guidance.

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

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

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

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

- 7.4.2.2.6. Ladders with conductive side rails that are not marked for electrical hazards. Ladders not already marked with safety use instructions by the manufacturer shall be stenciled, “DANGER —DO NOT USE AROUND ELECTRICAL EQUIPMENT,” in two-inch high red letters or the largest letters the surface will allow (minimum letter size is one inch). **(T-0)**
- 7.4.2.2.7. 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.
- 7.4.2.2.8. Ladders with broken or missing steps, rungs or cleats, broken side rails, or other defects shall not be used. **(T-0)**
- 7.4.2.3. Maintenance. Proper maintenance ensures the safe condition of the ladder. Hardware, fittings and related equipment shall be checked frequently and kept in proper working condition. **(T-0)** All bolts and rivets shall be in place and secured. **(T-0)** Joints between steps or rungs and the side rails shall be tight. **(T-0)** Refer to 29 CFR 1910.23 for additional information.
- 7.4.2.3.1. Lubricate metal bearings of locks, wheels, pulleys, etc., in accordance with manufacturer’s instructions.
- 7.4.2.3.2. Replace frayed or worn rope.
- 7.4.2.3.3. Keep safety feet and other parts in good working condition.
- 7.4.2.3.4. Coat wood, metal and fiberglass ladders with a suitable protective material in accordance with manufacturer’s instructions. 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 come in contact with acids or alkali solutions with a locally approved coating. When location demands, protect metal ladders against corrosion caused by moisture or salt spray. When plastic, fiberglass ladder rails or surfaces have the appearance of exposed fibers or an apparent color change from weather exposure, they shall be washed with a mild liquid detergent solution and allowed to air dry to determine surface integrity. **(T-1)** Spray or brush the ladder rails with acrylic lacquer, epoxy or other locally approved coating sufficient to cover the exposed fibers. Following the first coat, lightly sand the fiberglass surface with “00” sandpaper, or equivalent, to smooth the glass bristles.
- 7.4.2.4. Ladders with defects which cannot be immediately repaired shall be removed from service and scheduled for repair or replacement. **(T-0)** Use an AF Form 979, *Danger Tag*, 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.
- 7.4.2.5. Requirements Applicable to All Ladders. Refer to manufacturer’s instructions. **(T-1)** Additionally, use the following OSHA requirements:
- 7.4.2.5.1. 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.

7.4.2.5.2. 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.

7.4.2.5.3. 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 shall 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)**

7.4.2.5.4. 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)**

7.4.2.5.5. Place straight and extension-type ladders in a position to have at least one foot of slope for each four (4) feet of ladder length. **(T-0)** For example, a 12-foot extension ladder must be 3 feet from the supporting structure.

7.4.2.5.6. 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 (5) feet in length.

7.4.2.5.7. 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.

7.4.2.5.8. Do not stand on the top cap of trestle or combination ladders, nor the top step of stepladders. **(T-0)** Occupational safety staffs shall evaluate and provide guidance for military-unique operations. **(T-1) Note:** Three-step aircraft ladders are exempted.

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

7.4.2.5.10. 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.

7.4.2.5.11. Ladders will be stored when not in use. **(T-1)** On the flightline and outdoor environments, ladders shall be laid down and secured when not in use. **(T-1)** Where possible, employees shall secure or remove the ladder to prevent unauthorized use or tripping hazards. **(T-1) Exception:** The more modern, durable, enhanced ladders such as the Little Giant[®] ladders can remain standing in environmentally controlled environments, e.g., hangars, spacious warehouses. **(T-1)**

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

- 7.4.2.6.1. Develop local procedures for raising and lowering the ladder, if not covered in the manufacturer's instructions.
- 7.4.2.6.2. To support the top of the ladder at a window opening, an approved attachment per the manufacturer of the ladder shall 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)**
- 7.4.2.6.3. Short ladders shall not be spliced together to provide long sections. **(T-1)**
- 7.4.2.6.4. Follow manufacturer's instructions for proper minimum overlap of two-section extension ladders.
- 7.4.2.6.5. A ladder shall not be used to gain access to a roof unless the top of the ladder extends at least three (3) feet above the point of support eave, gutter or roof line. **(T-1)**
- 7.4.2.6.6. Hooks may be attached at or near the top of portable ladders to provide added stability.
- 7.4.2.7. Personnel Training. Personnel who use ladders at any working height shall be trained in the care and use of different types of ladders. **(T-0)** The supervisor or a designated trainer shall conduct this training when an employee is first assigned. **(T-1)** Refer to [paragraph 7.3.5](#) for additional information on ladder training. All training shall include hands-on instruction to include inspection of ladders for defects, possible electrocution hazards, proper positioning and placement of ladders for various job sites. **(T-0)** Training shall be documented in accordance with instructions in AFI 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 shall 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 shall not be used for climbing because it is designed solely for increasing stability. **(T-0)**
- 7.5.4. Stepladders shall 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 AFI 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*.

8.1.1.2. Refer to [Chapter 2](#) and [Chapter 14](#) for additional guidance.

8.1.2. Only qualified electricians, using approved materials, shall install or perform electrical work in accordance with 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 shall not be linked to provide additional or more convenient outlets as this could overload electrical circuits. **(T-0)** At no time shall 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 shall be provided in accordance with the requirements of NFPA 70, Article 406.4 and Article 406.12. **(T-0)** These locations include child development centers per UFC 4-740-14, *Design: Child Development Centers, School-Age Facilities*, and many other facilities. **(T-0)**

8.2.3. Ground fault circuit interrupter (GFCI) shall be used in accordance with 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 (5) kilowatts (kW), where electrical generator conductors are insulated from the generator frame and other grounded surfaces, shall be permitted without GFCI protection. Receptacles shall be located outside wet process areas or protected by a GFCI. **(T-0)** To protect large areas, GFCI breakers shall 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.

8.4. Flexible Cords and Extension Cords. Flexible cords and extension cords shall only be used in accordance with 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 shall 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 shall 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

indications could be an indication of possible short circuiting or overheating. Defective cords shall 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 shall 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 shall be installed on equipment housings to prevent abrasion of cord insulation and to prevent pull or strain put on the cord's internal wiring. **(T-1)** Cords used with heating appliances, such as electric irons, shall meet the requirements of 29 CFR § 1910.303(b)(2). **(T-0)**

8.4.3. When possible, equipment power cords shall 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 shall only be used in accordance with 29 CFR § 1910.305. **(T-0)**

8.4.6. High wattage appliances such as refrigerators, microwaves, coffeemakers, heaters, etc., shall be plugged directly into a facility outlet. **(T-1)** 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:** In accordance with [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 shall only be used in accordance with 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 BCE, shall ensure electrical fuse, switch and circuit-breaker boxes are marked with correct voltage, current, wattage, foreign source of power or other ratings, as appropriate. **(T-1)** Personnel shall 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 shall 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 shall be readily accessible to employees and building management personnel. **(T-0)** Work space in front shall be clear and unimpeded and shall not be located where exposed to physical damage or in the vicinity of easily ignitable material. **(T-0)** Refer to 29 CFR § 1910, Subpart S for additional criteria.

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

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

8.5.5. If circuit breaker fails to close or immediately trips after resetting, a qualified electrical employee (electrician) shall be called to troubleshoot the circuit breaker, e.g., installation BCE shall 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 shall meet NFPA 70, Article 215. **(T-1)**

8.7. Equipment Grounding.

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

8.8. Restrictions. While working on or around live electrical equipment, workers are prohibited from wearing garments with exposed metallic fasteners or flammable articles such as celluloid cap visors. **(T-0)** Additionally, clothing shall 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 shall be complied with. **(T-0)** Motor data plates shall 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 in accordance with NFPA 70E and AFMAN 32-1065. **(T-0)** Refer to [paragraph 8.17](#) for work on energized equipment.

8.9.2. Supervisors shall ensure work areas are inspected for electrical hazards. **(T-1)** Sufficient workspace shall be provided and maintained around electrical equipment to permit safe

operation and maintenance in accordance with 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 shall 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 shall 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., shall not be operated or used in explosive atmospheres or in close proximity to combustible materials. **(T-0)**

8.10. Additional Electrical Equipment Requirements.

8.10.1. Close rack, panel or control box doors at all times except as necessary to accomplish authorized repairs.

8.10.2. Operators shall open and close equipment switches quickly and positively and shall not break contact between brushes and commutators or slip rings while equipment is operating. **(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, BE occupational and environmental health assessment), the installation occupational safety office or BE. Vacuuming, with a vacuum approved for the task, is an effective cleaning method. Refer to [paragraph 2.4.8.8](#) for compressed air cleaning requirements.

8.11.2. Technicians shall not use lead pencils, screwdrivers or other unapproved tools to make radio frequency energy tests on electronic equipment as serious burns can result from arcs or faults created by these conditions. **(T-1)**

8.11.3. Personnel shall not hold meters in their hand while performing measurements on energized circuits or equipment. **(T-1)** Use non-conductive, insulated gloves or other effective PPE when necessary to hold meters or metering cables. The holder shall stand on a non-conductive mat or dry surface while using the meter. **(T-1)** Refer to [paragraph 14.4.7](#) for additional guidance.

8.11.4. Workbenches.

8.11.4.1. Workbenches shall be kept clean at all times. **(T-1)**

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

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

8.11.5. Insulating Matting Specific Requirements (See 29 CFR § 1910.137, *Electrical Protective Equipment*).

8.11.5.1. Insulating matting shall be used near electrical apparatus or circuits in high voltage maintenance areas as an additional safety measure to protect personnel. **(T-1)** It shall be used to protect against accidental shock only and shall not be the only means of protection when handling energized wires and circuits. TOs 00-25-234 and 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*, provide information and instructions on control, use and marking of insulating matting. Insulating matting shall be permanently marked. **(T-0)**

8.11.5.2. Supervisors shall consult with installation 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 shall 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 shall be replaced when worn to manufacturer's recommended replacement requirements. **(T-0)** **Note:** Shoes with nails, spikes or cleats shall 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., shall be one continuous length or strip. **(T-1)** Where possible, matting shall continue 24 inches beyond the end of the equipment. Overlapping at corners is not required if it produces a tripping hazard. If more than one run or strip of matting is required, the activity supervisor shall determine the amount needed. **(T-1)**

8.11.5.6. Insulating matting shall not be used for nonskid applications such as walkways, hall runners, in front of work benches (non-electric) on work-and-test benches, etc. **(T-0)** General purpose low-cost matting shall be used as it is, and is satisfactory for areas where shock protection is not required. **(T-0)** No certification for 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 shall establish procedures requiring all accessories used with electronic and electrical equipment be serviceable and safe for use. **(T-1)** Supervisors shall 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 shall ensure emergency equipment is available at each operating location where maintenance is performed on 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 shall be situated in a conspicuous and prominent location at each site, well-marked and readily accessible in accordance with 29 CFR § 1910.151, *Medical Services and First Aid*. **(T-0)** Equipment shall be protected against chemical, mechanical or environmental deterioration and shall be inspected or tested for serviceability in accordance with 29 CFR § 1910.335, *Safeguards for Personal Protection*. **(T-0)** Emergency equipment shall consist of:

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

8.12.2. Cardiopulmonary resuscitation (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. Installation medical treatment facility can provide recommendations on contents of the first aid kit. **Note:** In accordance with OSHA's letter of interpretation for 29 CFR § 1910.151(b), a first aid kit is required if a medical facility is more than three to four minutes away. **(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 shall be suitable for voltages encountered in the work area. **(T-1)** **Note:** Electrical gloves shall be checked before use in accordance with UFC 3-560-01, and American Society for Testing Materials (ASTM) F496-85, *Specification for In-service Care of Insulating Gloves and Sleeves*, and shall be tested and marked with the next test due date. **(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.

8.12.9. A 15-foot length of natural fiber rope, preferably 1/2 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. Appropriate portable emergency signs constructed of nonconductive materials, such as AF Visual Aids (AFVA) 91-303, *DANGER—DO NOT ENERGIZE—PERSON WORKING ON ANTENNA*; AFVA 91-304, *DANGER—DO NOT ENERGIZE—WORK IN PROGRESS ON EQUIPMENT*; AFVA 91-305, *DANGER—INTERLOCKS DISABLED*; and AFVA 91-306, *DANGER—HIGH VOLTAGE*, are available through Air Force Publications web site at

<http://www.e-publishing.af.mil>. (T-1) Refer to **Chapter 17** for information on safety signs and tags.

8.12.15. Optional site-specific items (rescue breather; insulated lineman's gloves, etc.). (T-1)
Note: Protect electrostatic sensitive components and equipment in accordance with TO 00-25-234.

8.13. Automated External Defibrillator (AED). AED presence and use is governed by the host installation 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 BCE facility design office for specific guidance on lighting. Control of light is important to avoid glare and harsh shadows. Soft shadows are usually acceptable, but harsh shadows shall be avoided since they may obscure hazards or interfere with visibility. (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 worker during under-voltage situation or a power failure shall have an under-voltage device installed. (T-0) This device prevents the machine from starting up after a power interruption, exposing the worker to the hazards of moving parts.

8.17. Work on Energized Equipment.

8.17.1. Electrical circuits and equipment shall be de-energized before being worked on. (T-0) When authorized by the commander, applicable technical data or manufacturer's instructions, work may be performed on energized circuits and equipment as necessary to support a critical mission, prevent injury to personnel or to protect property. 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 shall act as safety observer. (T-1) All employees shall be trained in CPR and equipment shutdown procedures and responsible for immediate assistance in an emergency. (T-0) Install electrical equipment in accordance with 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 shall be used when necessary to work adjacent to energized circuits. (T-0)

8.17.2.2. Arc flash protection shall 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, shall 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 shall wear long sleeved, Arc Thermal Performance Value-rated PPE in accordance with UFC 3-560-01. **(T-0)**

8.17.2.4. Individuals operating or servicing electrical switch-gear over 15 kilovolts (kV) shall wear an appropriately 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 shall follow 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. 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. In accordance with 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 shall 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. 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 shall 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 shall be evaluated by the installation occupational safety and BE offices to determine the need for the installation and proper location of units. **(T-1)**

9.3.2.1. Rationale for decisions shall 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 shall be considered in determining the need for the units. **(T-0)**

9.3.3. Self-contained Units. Units shall 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 unfeasible to plumb an eye wash. Stored fluid shall 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 the installation medical services. Instructions and expiration dates shall be permanently affixed to the unit. **(T-1)**

9.3.4. Eyewash Bottles. Shall 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 the installation medical services. Local procedures shall be developed to prevent these units from being exposed to extreme temperatures. **(T-1)** Instructions and expiration dates shall 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 shall 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 shall 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 shall be protected from freezing or heating. **(T-1)**

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

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

9.4.2.6. Water supply used will be free of contaminants and shall not be delivered at extreme temperatures. Temperature shall be maintained between 60° and 100°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 shall remain activated without the use of the operator's hands on activated. **(T-1)** Activation of the equipment shall take one second or less. **(T-1)** Once activated, it shall remain on until intentionally shut off. **(T-1)**

9.5. Maintenance and Testing.

9.5.1. Permanently-installed shower and eyewash units shall be activated by the supervisor weekly to verify operation and to reduce accumulation of bacteria/sediment for 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 ANSI Z358.1, *Emergency Eyewash and Shower Standard*.

9.5.2. Supervisor or designated employee shall inspect unit(s) in accordance with 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 shall be maintained to show date of inspection and name of individual performing the test. **(T-0)** This documentation may be kept in a log, computerized or affixed to the equipment by tag or label. **Exception:** Units installed at missile sites, not permanently manned, shall be tested and documented by the team chief during the most frequently performed periodic inspection established for that system. **(T-1)**

9.5.3. Self-contained units shall be tested and inspected in accordance with the manufacturer's instructions and documented. **(T-0)**

9.5.4. Eyewash bottles shall be tested, refilled, maintained and disposed of in accordance with the manufacturer's instructions. **(T-0)**

9.5.5. All units shall be inspected by the installation 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 shall be evaluated by the installation occupational safety office for replacement or upgrade. **(T-1)**

9.6. Training. Workers shall be trained initially and annually thereafter, as part of the job safety training outline (JSTO), on the location and proper use of the emergency shower and eyewash station. **(T-1)** Include this training into the JSTO. Training shall 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 workers 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 grounds maintenance shall 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 shall 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 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 in accordance with AFI 24-301, *Ground Transportation*. **(T-1)**

10.1.2. PPE is determined through an evaluation of the hazards by the supervisor in consultation with the safety office and BE, and entered into the work center Job Safety Training Outline.

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)**

10.1.5. Employees will turn off equipment and allow to cool before refueling equipment. **(T-0)** Do not permit smoking in the 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 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 shall be used. **(T-0)**. Slow- moving vehicle emblems shall be used in accordance with 29 CFR § 1910.145(d)(10). **(T-0)**

10.2. Inspection/Maintenance. The operator shall 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*, shall 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 and ANSI B71.1, *Consumer Turf Care Equipment – Pedestrian-Controlled Mowers and Ride-On Mowers – Safety Specifications*. **(T-0) Note:** Manufacturer's specifications identifies if the powered mower meets the requirements of ANSI B71.1. Deadman controls will not be disabled. **(T-0)**

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

10.3.3. Operators shall 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 keep firm footing at all times. **(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 manufacturer's instructions when cleaning, repairing or inspecting the mower. **(T-1)**

10.3.8. Wear hearing protection when using lawn mowers BE determined to produce hazardous noise.

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 shall meet requirements in ANSI/Outdoor Power Equipment Institute (OPEI) B71.4., *Commercial Turf Care Equipment - Safety Specifications*. **(T-0)** Operators shall read 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 shall be installed in accordance with 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 shall 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, shall be included. (T-1) Workers shall be trained for emergency conditions, such as adverse weather. (T-0) All workers shall receive training in emergency rescue and life-saving first aid techniques, and fall protection/prevention. (T-1) Refer to 29 CFR § 1910.269, *Electric Power Generation, Transmission, and Distribution*, for additional guidance.

10.6.1. PPE is determined through an evaluation of the hazards by the supervisor in consultation with the safety office and BE, and entered into the work center Job Safety Training Outline.

10.6.2. Two or more employees and an on-site job supervisor, fully qualified in tree maintenance, shall 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 shall 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 shall 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 shall be removed from service immediately. (T-0) Each climber shall 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) shall be provided for each crew. (T-0) The nominal breaking strength of 1/2 inch ropes used for climbing shall not be less than 2,385 pounds. (T-0) Climbing and safety ropes shall not be spliced for repair or added length. (T-0) The ends of ropes shall be wrapped to prevent fraying. (T-0) A climbing rope shall always be used, even when work is performed from a ladder or lift device. (T-0) Refer to [Chapter 13](#) for additional fall protection requirements.

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 installation FES shall be notified of any evidence of heating, smoking, combustion or fire in fertilizer. (T-1) In accordance with NFPA 400, *Hazardous Materials Code*, no more than 60 tons of fertilizer (mixtures containing 60 percent or more by weight of ammonium nitrate) shall be stored in a location unless the location and storage facility have been approved by the installation FES. (T-0)

10.7.2. When spreading fertilizer, pellets shall not be directed toward anyone. (T-0) If personnel enter the area, the spreader shall be turned off. (T-0) Fertilizer spreaders shall be

cleaned and lubricated daily. (T-0) Safety glasses and gloves shall 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 [Chapter 21](#).

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 shall be fitted with Rollover Protective Structure. (T-0) If a tractor is not equipped with Rollover Protective Structure, it shall not be operated on sloped areas. (T-0) Rollover Protective Structure-equipped tractors shall 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 shall 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 shall be fastened to the movable portion of the seat to accommodate the ride motion of the operator. (T-0) Seatbelts shall 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 shall meet the requirements of 29 CFR § 1928.51 and military specifications. (T-0) Where commercially available, agricultural tractors and implement attachments shall be purchased with noise levels at the operator position of less than 85 Decibels-A-Weighted (dBA). (T-0)

10.9.3. Training. Every employee who operates an agricultural tractor shall be trained in safe operating procedures and practices dictated by the work environment in accordance with the commander's approved training program. (T-0) A training plan shall be developed and, at a minimum, shall include all attachments used by the organization and a copy of the most recent noise hazard survey conducted in accordance with 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 shall be marked with a placard stating: "Caution – Hazardous Noise – Operator Ear Protection Required." (T-0)

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

10.9.6. Guarding and Shielding. All power take-off shafts, including rear-, mid-, or side-mounted shafts, shall be shielded to protect employee 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 shall not be allowed on tractors, the draw bar or towed equipment, except where the equipment is specifically designed to allow riders. **(T-0)** Speed shall 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 in accordance with 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 shall 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 shall 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 shall include a requirement for the tool to meet or exceed requirements in 29 CFR § 1910.243, *Guarding of Portable Powered Tools*, and 29 CFR § 1910.304, *Wiring Design and Protection*. **(T-0) Note:** When possible, low noise power tools or tools with noise reduction attachments shall 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 shall 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 Mil Specs exist. **(T-0)** If a machine is not specifically covered by this publication, a Mil Spec or an OSHA standard, the installation occupational safety office shall 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 shall enforce strict tool control procedures. **(T-1)** Use of personally owned hand and power tools shall be prohibited. **(T-1)** Tools shall be properly stored when not in use. **(T-1)** Appropriate PPE shall be provided to employees and use enforced. **(T-1)**

11.2.1. Hand Tools.

11.2.1.1. In accordance with 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 shall frequently inspect all hand tools required for the operation. **(T-1)** Defective tools shall be immediately removed from service. **(T-0)**

11.2.1.4. Employees carrying hand tools while on ladders, scaffolds, platforms or work stands shall use carrying bags, e.g., shoulder bags or backpacks, or tool belts for tools that are not in use. **(T-0)** Employees shall 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 shall 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 shall be repaired or replaced. **(T-0)**

11.2.2.2. Chisels and Punches. Chisels shall be kept sharp with the edge and striking surface ground true. **(T-0)** Cold chisels and punches with mushroom heads shall not be used. **(T-0)** A chisel or punch holding device shall be used when working space permits. **(T-0)** The angle of cut shall be away from the body. **(T-0)** Safety goggles shall 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, shall not be used. **(T-0)** Wrenches shall not be struck with a hammer unless designed for this purpose. **(T-0)** Worn box wrenches or sockets shall be replaced. **(T-0)**

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

11.2.2.5. Saws. Crosscut saws shall be used for cutting (wood or lumber) across the grain, rip saws for cutting with the grain and hacksaws for cutting metal. **(T-0)** Saws with broken teeth or broken or cracked handles shall not be used. **(T-0)** Saw teeth shall be kept sharp and well set to prevent binding. **(T-0)** If a saw binds while cutting, the employee shall 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 shall 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 shall not be hammered on to make a cut. **(T-0)** Cutters are designed for use on wire, rods or bolts, and shall 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, shall be stored in a holder or sheath. **(T-0)** Employees shall always cut away from their body. **(T-0)** Hacking motions shall not be applied when cutting. **(T-0)** Jackknives, multipurpose tools or pocketknives with locking capability shall 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, shall never be used in place of crowbars and wrecking bars. **(T-0)** Crowbars shall 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 shall not be used. **(T-0)** Case-hardened steel tools shall never be used to strike crowbars or wrecking bars. **(T-0)** Only plastic, wood or soft metal objects shall be used to hammer on pry-type bars. **(T-0)**

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

11.2.2.10. Shovels, Rakes, Ice Chippers and Sod Lifters. None of these tools shall be used as prying tools. **(T-0)** Replace defective handle immediately. These tools shall 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 shall be positioned where the working surface cannot be stepped on. **(T-0)**

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

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

11.2.3.1. Electric power tools shall either be of the approved double-insulated type or grounded in accordance with 29 CFR § 1926, Subpart K, *Electrical*. **(T-0)** The use of electric cords for hoisting or lowering shall 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 shall 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 shall be grounded in accordance with the NFPA 70 to prevent electric shock. **(T-0)** Approved three-wire cords shall be used to effectively ground these tools. **(T-1)** The ground prong of a three-wire plug shall never be removed. If a cord is found with the ground prong removed, it shall be removed from service, rendered unusable and turned in for repair or replacement. **(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, shall be grounded, unless double insulated. **(T-0)** GFCI devices shall be used in accordance with the NFPA 70. **(T-0)** Refer to 29 CFR § 1910.304 for additional information.

11.2.4. Powder-actuated tools. Powder-actuated tools shall meet the requirements of 29 CFR § 1926.302(e). **(T-0)** Employees using powder-actuated tools shall pass a written and hands-on practical use examinations. Employees shall carry their certification card while using these tools. **(T-0)** **Note:** Storage of powder-actuated shells may require an explosive storage license. Contact the installation 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 Job Safety Training Outlines (JSTO). **(T-1)** In the absence of

manufacturer guidance, supervisors shall develop JHAs and local OIs in accordance with TO, DAFMAN, OSHA and other related guidance. **(T-1)** Training shall include job safety, maintenance (e.g., cleaning and sanitizing, lubrication), and inspection. **(T-1)** Identify location of training instructions (e.g., manufacturer's manuals, JHAs or local OIs) 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 shall periodically evaluate machinery or equipment operators to ensure they are following proper and safe operating procedures. Machines shall be used only for work within the rated capacity specified by the machine manufacturer. **(T-0)**

11.3.1.3. Machines shall 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 shall comply with PPE requirements for each particular 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 in close proximity to machines/equipment shall 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 shall 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 shall allow all moving parts to come to a complete stop before any attempt is made to clean or clear jammed work or debris from any part of a machine. **(T-0)** Chips or other particles shall 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 shall 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's inspection shall be conducted prior to the start of each shift, following a new setup or when operators change. **(T-0)** This inspection shall ensure operating components are in good working order, and guards, interlocks and other protective devices are activated or in place, operating properly and in proper adjustment. **(T-0)** Records of inspections and any machine maintenance shall be maintained on AFTO Form 244 in accordance with TO 34-1-3.

11.3.2.3. Repairs or maintenance beyond the operator's qualifications shall 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, shall be performed in accordance with 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. **(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 shall 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 shall operate shop machinery or equipment. **(T-0)** Training shall be documented and immediately available in the work center.

11.3.4.1. Operators shall 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 shall receive training on hazardous energy control procedures contained in **Chapter 21**, as appropriate, to ensure the purpose of the program is understood. **(T-1)** **(Note:** Services craft or hobby shop patrons shall be trained by the supervisor or a designated trainer on the proper operation, safety procedures, hazard recognition and emergency procedures for each piece of equipment they will use.) **(T-1)** An Arts and Crafts Equipment Qualification card shall be issued to identify the machinery the patron is authorized to operate. **(T-1)** Personnel shall not operate machines or equipment if this card is not available. **(T-1)** Services patrons, e.g., base hobby shops, shall receive general awareness training to understand the Hazardous Energy Control program, but shall not apply or remove locks or tags. **(T-1)**

11.3.5. Machine Layout Requirements.

11.3.5.1. Machines subject to movement because of vibration, rotation or other reasons shall 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 shall be provided around each machine. **(T-0)** The installation occupational safety office and CE shall 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 shall 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 shall be installed in accordance with NFPA 70. **(T-0)**

11.4.2. Safeguarding devices shall be installed, adjusted and used in accordance with 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 shall be installed when ripping material. **(T-1)** Anti-kickback dogs and fingers shall 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, shall be guarded to prevent accidental human contact with the saw blade. **(T-0)** The guard shall 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 shall be performed by the supervisor with consultation from the installation 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 shall be at least eight (8) feet above the work level, e.g., floor, platform or passageway. **(T-0)** Refer to 29 CFR § 1910.212 for additional information.

11.4.4.3. Machines with live parts shall be in an enclosed area with a locked entrance. **(T-1)** The enclosure (wall or fence) shall be at least eight (8) feet high. **(T-1)** Refer to 29 CFR § 1910.219 for additional information.

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 shall 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 shall 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 workers. **(T-0)** Refer to AFMAN 48-146, *Occupational and Environmental Health Program Management*, and 29 CFR § 1910.94, *Ventilation*, for additional guidance.

11.4.7. Illumination. Refer to [paragraph 7.1.3](#) for additional guidance.

11.4.8. Machine energy isolating devices shall be capable of being locked out by a designed hasp or other attachment or an integral part to which, or through which, a lock can be affixed or the energy isolated by simply disconnecting an electrical plug. **(T-1)**

11.4.9. Wheel and Spindle Speeds.

11.4.9.1. The spindle rpm of grinders shall be shown on the machine in a location readily visible to the operator. **(T-0)** It is the supervisor's and employee's responsibility to verify the speed of the wheel spindle to ensure the speed is correct for the size and type of wheel used. Refer to 29 CFR § 1910.215 for additional information.

11.4.9.2. All grinding wheels shall have the operating speed affixed to the wheel. **(T-0)** Those without a rating shall 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. This equipment includes transport equipment, positioning equipment and storage equipment. **Note:** [Table 12.1](#) provides a comprehensive list of reference sources.

12.1.1. Hazards. Injury or death may occur when MHE are improperly operated, inadvertently driven off loading docks, tipping, striking personnel, etc. Most injuries and property damage are caused by unsafe operating procedures, lacking of safety-rule enforcement, personnel not wearing required personal protective equipment (PPE), insufficient or inadequate training and operator error. The most common hazards associated with lifting equipment are overloading, dropping or slipping of the load from improper hitching or sling, obstruction to load passage and failure to stabilize the load during the movement.

12.1.2. Administrative areas/offices must be protected from exhaust buildup either by distance or positive air flow pressure in relation to the warehouse activities. **Note:** When internal combustion engine equipment is used inside warehouses, ventilation requirements shall be determined by the installation BE to preclude exposure of workers to carbon monoxide gas. **(T-1)**

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. Please check the prescribing directive(s) before discontinuing use of any forms. Maintenance units shall follow documentation guidance in AFI 21-101, *Aircraft and Equipment Maintenance Management*, and 00-20 series TOs. **(T-1)** Units shall 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 Not in Regular Service. Cranes, hoists and derricks idle for at least one month, but less than six months, shall be inspected prior to placing in service. **(T-0)** Cranes, hoists and derricks idle for six months or more shall be given a complete inspection as defined in [paragraph 12.4](#), prior to placing in service. **(T-0)** Standby cranes and derricks shall be inspected at least semiannually. **(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.

12.2.3. 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 installation F&ES Flight, BE and Occupational Safety office. **(T-2)** The equipment shall be parked so it does not block fire aisles, fire-fighting equipment, fire alarm boxes, stairways, elevators or fire exits. **(T-0)** The warehouse supervisor shall conduct daily inspections to ensure powered materials handling equipment is parked in designated locations, equipment does not contain excessive grease and lint, and gasoline lines,

tanks, oil seals and so forth are not leaking. **(T-1)** A minimum of 10-foot clearance shall be maintained between parked equipment and combustible materials. **(T-1)**

12.2.3.1. Operators shall 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 shall be fueled outdoors. **(T-1)**

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

12.2.3.3. Units with internal combustion engines shall not be refueled inside warehouses or while the engine is running. **(T-1)** Refueling shall be accomplished in outside areas approved by the installation F&ES Flight. **(T-2)** When fuel is spilled during servicing, operations shall be stopped and equipment cleaned up in accordance with local procedures prior to restarting fuel servicing operations. **(T-1)** Notify the installation F&ES Flight and Environmental Management office if a significant spill occurs.

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

12.2.5. Storage Racks/Shelving. The load size and rating of storage racks/shelving shall be determined by the manufacturer's specifications or by a structural/civil engineer or a certified testing agency if manufacturer's specifications do not specify the load size and rating for the storage racks/shelving. **(T-1)** Workers shall 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 shall be documented appropriately. **(T-1)**

12.2.5.1. Inspections of storage racks/shelving units shall follow manufacturer's instructions. **(T-1)**

12.2.5.2. Inspection shall include frequency inspection and preventative maintenance, inspection of all recommended storage racks/shelving components. **(T-1)**

12.2.5.3. Inspections shall be documented on AFTO Form 95, *Significant Historical Data*, or MAJCOM/FLDCOM or locally devised automated systems. **(T-1)**

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

12.2.7. Where MHE is used in warehouses or industrial workplaces, sufficient space clearances shall be allowed for aisles, loading docks, doorway entrances, overhangs and passageways with no obstructions that could create a hazard. **(T-0)** Operators shall use caution when traveling on docks or loading platforms and remain clear of the edge. **(T-0)** Passengers shall not ride on powered lift equipment unless a passenger seat is part of the manufacture design. **(T-0)**

12.2.8. The maximum load capacity shall 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 shall be changed accordingly. **(T-1)**

12.2.9. Roll-up Doors. See [paragraph 2.7](#) for roll up door requirements.

12.2.10. 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.

12.2.10.1. Spotters will remain in full view of the operator at all times. (T-1)

12.2.10.2. At a minimum, spotters will be trained on forklift time length compared to cargo, load stability and standard hand signals between operator and spotter. (T-1)

12.2.10.3. Supervisors will establish a spotter training plan within the unit and document initial and three-year refresher training in appropriate records, e.g. AF Form 623, *Individual Training Record Folder*, AF Form 1098, *Special Task Certification and Recurring Training*, AF Form 55, *Employee Safety and Health Record*, or MAJCOM/FLDCOM-directed record system. (T-1)

12.2.10.4. Refer to [paragraph 30.3.3.2](#) for additional guidance.

12.2.11. Forklifts shall not be operated on an incline greater than that allowed by the manufacturer.

12.3. Acquisition.

12.3.1. Commercially procured materials handling and lifting equipment or parts shall comply with design manufacturing requirements and specifications in OSHA standards and as applicable, ANSI/ASME requirements and specifications. (T-0) Local modifications of centrally procured materials handling equipment shall be coordinated with the installation occupational safety office and with approval of equipment item managers. (T-1) Local purchase acquisition requests shall be coordinated with the installation occupational safety office. (T-1)

12.3.2. Lever-operated hoists shall meet the requirements and specifications of recognized industry standards. (T-0) Slings procured for DAF use shall comply with design and manufacturing requirements in 29 CFR § 1910.184, *Slings*, and ANSI/ASME B30.9, *Slings*. (T-0) Locally manufactured slings that do not meet the engineering requirements of ANSI/ASME B30.9 are prohibited and shall be disassembled and removed from service. (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/slides/tables-figures.html>).

12.3.3. Capacity of all lever-operated devices shall 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, shall be procured. (T-1) Lowering under load shall be by operation of the hoist lever. (T-1)

12.3.4. Overhead hoists shall meet design specifications, characteristics and rules of ASME B30.7, *Winches*, ASME B30.10, *Hooks*, and ASME B30.16, *Overhead Underhung and Stationary Hoists*. (T-0) When applicable, a system safety program shall be established. (T-1) **Note:** Nuclear-certified hoists must also meet requirements in [paragraph 12.5](#) and AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*. (T-1)

12.4. Inspections. MHE, specifically hoists, slings, cranes, derricks, powered industrial trucks and associated components, will be inspected for damage or wear at intervals specified (frequent and/or periodic), including observations during operation. (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)**

12.4.1. Prior To Use. A visual/prior to use inspection (pre-operational) inspection will be performed by the operator or designated person prior to the first use of each shift. **(T-1)**

12.4.2. Frequent. A visual inspection will be performed by the operator or designated person at certain intervals: normal use – monthly; heavy use – weekly; severe use – daily. **(T-1)** **(Note:** These intervals will apply unless MAJCOMs/FLDCOMs or installations have more stringent directives.) The record of inspection shall be maintained by the using agency until the next periodic inspection has been performed. **(T-1)** If slings are damaged, defected or abuse is detected, remove the sling from service until periodic testing is accomplished. **(T-1)**

12.4.3. Periodic. A complete inspection will be performed by a qualified person 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.

12.4.3.1. 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.

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

12.4.3.3. 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's instructions, where available, for additional guidance.

12.4.4. Inspections for each item shall be documented (separate documentation). **(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)** **Note:** Units shall 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. 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)**

12.4.6. Mandatory Monthly Inspections. Wire ropes, chains and hooks associated with overhead and gantry cranes shall be thoroughly inspected monthly. **(T-0)** Inspections for each item shall 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 in accordance with this chapter and applicable ANSI standards or manufacturer instructions. **(T-1)** **Note:** Units shall review the Air Force Records Disposition Schedule for disposal guidance for historical records of all inspection, repair and test documentation. **(T-1)**

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

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

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

12.4.10. Inspections shall be documented in accordance with [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 AFMAN 91-118. **(T-1)**

12.5.1. The annual load test may be performed as either a static or dynamic test as determined by a qualified person.

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 or critical loads. **(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 nondestructive inspection (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 shall 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:** Hooks repaired by welding or reshaping are not authorized on nuclear-certified hoists or lifting equipment used to lift critical loads. **Note:** Painted hooks shall 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 or equipment and will be in accordance with applicable DAF guidance, OSHA requirement or manufacturer's instructions or guidance. **(T-0)** Organizations requiring MHE training shall designate qualified personnel as unit instructors for unit trainees. **(T-1)** Appropriate shop supervisor and vehicle control officer or noncommissioned officer shall 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, shall be accomplished by the unit in accordance with AFMAN 24-306. **(T-1)** Lesson plans shall include formal instruction, hands-on demonstrations by the instructor with practical exercises performed by the trainee and an evaluation of the trainee's performance to confirm their knowledge of equipment operations and service instructions. **(T-1)**

12.6.3. MHE training will be in accordance with applicable technical data and manufacturer's instructions, e.g., cranes, hoists, conveyors, forklifts. **(T-1)** A qualified instructor shall evaluate each operator at least once every three (3) years and provide refresher training, as applicable. **(T-1)** MHE shall be operated only by properly trained, and qualified personnel or trainees under direction supervision of a qualified trainer/instructor. **(T-1)** The operator shall be familiar with all operating controls and be instructed in the operations to be performed. **(T-1)** Training should include warnings, manufacturer's instructions and requirements from this manual and OSHA guidelines, as applicable.

12.6.4. Mobile cranes shall 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 vehicle/truck cranes shall be licensed in accordance with 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 shall be kept by the using organization and appropriate entries shall be made in the individual's training records. **(T-1)**

12.6.5. Training Currency for Deployment. Supervisors shall ensure personnel scheduled for deployment are current/trained in operations on this equipment prior to deploying. **(T-0)** Additionally, supervisors at deployed locations shall verify personnel are current in operations before they operate the equipment, and provide additional training as needed for personnel to safely operate any new type equipment. **(T-0)**

12.7. Testing.

12.7.1. All new hoists, cranes, slings, derricks and other similar lifting devices, regardless of type, required to lift any type of load shall be tested prior to initial use by a qualified person. **(T-0)** This load test shall be at not less than 100 percent or more than 125 percent of the rated load, unless otherwise recommended by the manufacturer, and annually thereafter at not less than 100 percent or more than 125 percent of rated capacity. **(T-0)** Refer to 29 CFR § 1910.179, *Overhead and Gantry Cranes*, 29 CFR § 1926.552, *Material Hoists, Personnel Hoists and Elevators*, 29 CFR § 1926.1433, *Design, Construction and Testing*, and applicable ASME's B30 Codes and Standards for additional guidance.

12.7.2. DAF materials shall be designated as critical loads for purposes of lifting or hoisting by an appropriate Program Manager or the functional manager at the facility where the lift will occur. **(T-1)** Prior to accomplishing load tests on equipment attached to facility structural members, a qualified person, e.g., civil engineer, shall 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 shall 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 shall 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 shall 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 qualified person, e.g., civil engineer shall 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)** The test shall be conducted as follows:

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

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

12.7.3.1.3. 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 (2) runways (multiple-truck cranes), the crane will also transport the test load the full length of the runway with the trolley or carrier positioned at each intermediate end truck. **(T-0)**

12.7.3.1.4. For monorail systems, follow ASME B30.17, *Cranes and Monorails (With Underhung Trolley or Bridge)*, for the hoist test and transport test load by the carrier for the full length of the monorail system. **(T-0)**

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

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

12.7.3.2. Slings. Prior to use, each new, repaired or reconditioned alloy steel chain sling, including all welded components in the sling assembly, shall be proof tested by a qualified person. **(T-0)** Periodic load testing shall only be accomplished with written permission and procedural guidance from the sling manufacturer or equivalent DAF organization (e.g., the specific equipment TO or the item manager for locally manufactured equipment). **(T-1)**

12.7.4. Operational Tests. All new hoists, cranes and other similar lifting devices which have had load-suspension parts altered, replaced or repaired shall be operationally tested before use. **(T-0)** Rebar steel shall not be used for test weight lift points. **(T-0)** Conduct tests first by hand, if practical, and then under slowest possible speed. Test with increasing speeds up to maximum speed. Actuated mechanisms shall be located so they trip switches or limiting devices in sufficient time to stop motion without damage to the hoisting arrangement. **(T-0)** On hoists having adjustable trip-setting limit devices, care shall be exercised to achieve adjustment setting without the load block striking the hoist frame or without all the slack being taken out of the unloaded chain or less than one wrap of rope on the drum. **(T-0)**

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

12.7.4.2. Operational testing shall 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, testing of all limit, 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 shall be operationally tested to ensure compliance with this publication and requirements in 29 CFR § 1926, Subpart CC, *Cranes and Derricks in Construction*. **(T-0)** All new derricks shall have the manufacturer's certification that all required testing has been accomplished. **(T-0)**

12.8. Powered Industrial Trucks.

12.8.1. Local modifications of centrally procured materials handling equipment shall be done only with approval of equipment item managers. **(T-1)** **(Note:** Modifications and additions, which affect capacity and safe operation, require manufacturer's written approval. However, some manufacturers may void the warranty of equipment modified without their approval. Therefore, coordinate with the installation contracting and occupational safety offices prior to contacting the equipment item manager.)

12.8.2. Safe Operations.

12.8.2.1. The maximum load capacity shall be posted on each piece of lifting equipment, in view of the operator. **(T-0)** If equipment is modified, the capacity, operation and maintenance instruction plates, tags or decals shall be changed accordingly. **(T-0)**

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

12.8.2.3. When a forklift is used to elevate personnel, an approved safety pallet shall be used. **(T-0)** The operator shall remain at the controls at all times when personnel are on the safety pallet, but shall not move the forklift. **(T-0)** Instructions prohibiting movement of the forklift with personnel on the safety pallet shall be posted on the pallet in plain sight, visible to the operator and all personnel. **(T-0)**

12.8.2.4. Whenever possible, electric or battery powered equipment shall be used indoors. **(T-1)** Internal combustion engines shall not be operated inside buildings unless an exhaust system or other ventilation approved by 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 pressure in relation to the warehouse activities. When internal combustion engine equipment is used inside warehouses, BE personnel shall determine ventilation requirements to preclude exposure of workers to carbon monoxide gas. **(T-1)** Refer to DESR 6055.09_AFMAN 91-201 for operating in explosives and weapons areas.

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

12.8.2.6. Operators shall use caution when traveling on docks or loading platforms and remain clear of the edge. **(T-0)**

12.8.2.7. Operators shall 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:** When side-loading vans are not available, munitions containers with permanently installed skids may be pushed or pulled into open-ended vans with the use of a spotter. Ensure safety precautions, such as keeping personnel clear of potentially hazardous areas, have been considered and included in the procedure.)

12.8.2.8. Operators shall set brakes and dock locks or put wheel chocks in place to prevent any movement of trucks, trailers or railroad cars while loading or unloading. **(T-0)**

12.8.2.9. 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)**

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

12.8.3. Maintenance.

12.8.3.1. Repairs to material handling equipment assets under Vehicle Management's control shall be accomplished by Vehicle Maintenance (maintenance agreement may be necessary for locally procured assets). **(T-1)** Deviations to this requirement shall be approved by host Vehicle Maintenance or installation vehicle maintenance contractor. **(T-1)**

12.8.3.2. Equipment shall be cleaned in designated locations and only with cleaning agents approved by the installation F&ES Flight and BE. **(T-1)**

12.9. Conveyors.

12.9.1. Safe Operations. Workers shall 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. Workers will report defective or worn shafts, rollers or bearings that may break and permit rollers to fall from the frame. **(T-0)** Refer to **Chapter 21** for additional guidance on lockout/tagout 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)**

12.9.2. Inspections. Supervisors shall ensure the entire conveyor system is inspected daily. **(T-1)** Defective parts that affect safe operation of the system shall be replaced prior to continued operation. **(T-0)** Operators shall ensure crossover walkway surfaces are in good condition. **(T-0)**

12.9.3. Maintenance. No work shall be initiated on a power conveyor until the power switch or disconnect has been locked and tagged out. **(T-0)** Refer to **Chapter 21** for lockout/tagout procedures.

12.10. Manual Hoisting and Pulling Devices.

12.10.1. Safe Operations.

12.10.1.1. Lever-operated hoists shall 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 shall be used. **(T-0)**

12.10.1.2. Hoist cables, ropes and chains shall not be wrapped around the load. **(T-0)** Use only slings or other approved lifting fixtures. **(T-0)** **Example:** Cargo straps shall not be used for lifting, unless stated in approved Air Force technical data. **(T-1)**

12.10.1.3. Extensions to levers, such as cheater bars or pipes, unless designed and permanently installed by the manufacturer, shall not be used to increase leverage. **(T-0)**

12.10.1.4. Manually operated lever hoists shall only be operated by personnel trained on use of the equipment. **(T-0)** Operator qualifications shall be as determined by the facility manager, shop supervisor or designated representative. **(T-2)**

12.10.1.5. The rated capacity shall not be exceeded except for authorized load tests. **(T-0)**

12.10.1.6. Hoists shall be attached to well-defined dead-end points capable of withstanding the intended load. **(T-0)**. **Note:** Lifeline attach points shall not be used for hoists. **(T-0)**

12.10.2. Maintenance. Maintenance shall be performed in accordance with 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 shall meet design specifications, characteristics and rules of ASME B30.7, *Winches*, B30.10, *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 shall be established. **(T-1)** **Note:** Nuclear-certified hoists must also meet requirements in AFMAN 91-118. **(T-1)**

12.11.2. Safety Requirements.

12.11.2.1. Hoist platforms shall 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, shall be used in hoist operations. **(T-0)**

12.11.2.3. Hoist engines and motors shall be guarded to protect personnel. **(T-0)**

12.11.2.4. Self-locking brakes, capable of holding at least 125 percent of the rated capacity, shall be installed on all hoists. **(T-0)**

12.11.2.5. The conductors and switches of electric hoists shall be guarded against accidental contact. **(T-0)**

12.11.2.6. All loads shall be balanced on hoist carriages and secured to prevent slipping or shifting. **(T-0)**

12.11.2.7. Latch-type safety hooks shall be installed on all hoists. **(T-0)**

12.11.2.8. Load Rating. The rated capacity shall be permanently marked on the hoist or its load block and shall be legible from the operating position. **(T-0)** The rated capacity for each member of the suspension device, when used as intended, shall be equal to the other suspension members to which it is attached. **(T-0)** When this is not feasible, a plan shall be developed to identify special precautions that shall be taken to ensure the lowest rated suspension member's rated capacity is not exceeded. **(T-0)**

12.11.2.9. Warnings. Supervisor will ensure information concerning operating procedures shall be posted by all hoists or displayed on a label affixed to the hoist, controls or block. **(T-1)**

12.11.3. Safe Operations.

12.11.3.1. The rated capacity shall 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 shall ensure that all frequent and periodic inspections are completed prior to use. **(T-0)**

12.11.3.2. When a *Danger, Out of Order, Do Not Start* or *Equipment Lockout* tag is attached to the starting controls, the hoist operator shall not apply power to the unit or start operations until the condition has been corrected and the tag and any lock(s) are removed. **(T-0)**

12.11.3.3. The operator shall be familiar with the equipment and its proper care. **(T-0)** If adjustments or repairs are necessary or any damage is observed or suspected, the operator shall promptly report the problem to the supervisor. **(T-0)**

12.11.3.4. Hoisting the load. Ensure that:

12.11.3.4.1. Hoist ropes or chains are not twisted about each other. **(T-0)**

12.11.3.4.2. The load does not contact any obstruction. **(T-0)**

12.11.3.4.3. Ropes or chains are protected against sharp edges of the load. **(T-0)**

12.11.3.5. The rope or chain shall be properly seated on the drum sheaves or sprockets before starting the lift. **(T-0)** Hoists shall not be operated until the hoist unit is centered over the load. **(T-0)**

12.11.3.6. A hoist shall not be used for hoisting personnel unless specifically designed for this purpose and only if it is the safest means of accomplishing the work. **(T-0)** Loads shall not be carried over personnel. **(T-0)**

12.11.3.7. The operator shall test the brakes each time a load is handled by raising the load just enough to clear the floor or supports and checking for brake action. **(T-0)** The lift shall be continued only after ensuring the braking system is operating properly. **(T-0)**

12.11.3.8. Suspended loads shall not be left unattended. **(T-0)**

12.11.3.9. If a load must remain suspended for a considerable time, a pawl or other equivalent means, rather than the brake alone, shall be used to hold the load. **(T-0)** The ground area below the suspended load shall be barricaded to prohibit entry of personnel or equipment. **(T-0)**

12.11.4. Maintenance.

12.11.4.1. Preventive Maintenance. The using organization shall establish a preventive maintenance program based on the manufacturer's recommendations. **(T-1)** **Note:** If manufacturer's instructions cannot be obtained, the using organization shall contact the DAF equipment item manager for assistance. **[T-1]** Preventive maintenance shall be documented in accordance with [paragraph 12.2.1](#), as appropriate. **(T-1)**

12.11.4.2. Lubrication. All moving parts of the hoist for which lubrication is specified shall 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 shall be followed. **(T-0)** Machinery shall 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 shall be in accordance with technical data, manufacturer's instructions or applicable ASME B30 standard. **(T-1)**

12.11.4.4. Adjustments and Repairs. Repair, replacements or adjustments shall be made as necessary to ensure correct performance of all hoist components. **(T-0)**

12.11.4.5. Maintenance Procedures. The following precautions shall be taken before adjustments or repairs are started on a hoist:

12.11.4.5.1. A lock and a danger or equipment lockout tag shall be placed on the hoist and all energy controls (air, electrical, hydraulic, etc.) locked out in accordance with [Chapter 21](#) 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 in accordance with [Chapter 21](#). **(T-0)**

12.11.4.5.2. Drum pawls shall be engaged or other means provided to prevent load ropes from inadvertently rotating the mechanism. **(T-0)**

12.12. Slings. Refer to 29 CFR § 1910.184 and ANSI/ASME B30.9 for additional guidance. **Note:** Locally manufactured slings that do not meet the engineering requirements of ASME B30.9 are prohibited and shall be disassembled and removed from service. **(T-1)** **Note:** Written proof test certification is not required for new synthetic rope slings manufactured in accordance with ASME B30.9 and not used to lift nuclear or critical loads. **(T-1)**

12.12.1. DAF primarily uses four types of slings: ally steel chain, wire rope, metal mesh and synthetic web slings. **Note:** Refer to ASME B30.9 for guidance on other types of slings.

12.12.2. ASME B30.9 provides the required markings and identifications for each type of sling.

12.12.3. Specific Requirements.

12.12.3.1. Alloy Steel Chain Slings.

12.12.3.1.1. Prior to use, all new, repaired or reconditioned alloy steel chain slings, including all welded components in the sling assembly shall be proof tested to 200 percent of rated capacity. **(T-0)**

12.12.3.1.2. For multiple leg slings, each leg shall be proof tested to 200 percent of the single leg rated load. **(T-0)**

12.12.3.1.3. Alloy steel chain slings shall not be used with loads more than the rated capacities. **(T-0)**

12.12.3.1.4. Worn or damaged alloy steel chain slings and attachments shall not be used until repaired (or reconditioned) and proof tested by the manufacturer or a qualified person. **(T-0)**

12.12.3.1.5. Refer to 29 CFR § 1910.184 and ASME B30.9 for additional guidance.

12.12.3.2. Wire Rope Slings.

12.12.3.2.1. Prior to initial use, all new wire rope slings shall be proof tested as follows:

12.12.3.2.1.1. Proof load for swaged-socket and poured-socket assemblies shall be in accordance with the wire rope or fitting manufacturer's recommendations. **(T-0)**

12.12.3.2.1.2. Proof load for single leg hand tucked slings shall be not less than 100 percent or more than 125 percent of the rated capacity. **(T-0)**

12.12.3.2.1.3. Proof load for mechanical splice single leg slings and endless slings shall be 200 percent of the vertical rated capacity. **(T-0)**

12.12.3.2.1.4. Proof load for multiple leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single leg sling of the same size, grade and construction of rope. **(T-0)**

12.12.3.2.2. Wire rope slings shall not be used with loads in excess of capacities. **(T-0)**

12.12.3.2.3. Only new rope shall be used to fabricate slings. **(T-0)** Use of repaired or reconditioned rope is prohibited. **(T-0)**

12.12.3.2.4. Refer to 29 CFR § 1910.184 and ASME B30.9 for additional guidance.

12.12.3.3. Metal Mesh Slings.

12.12.3.3.1. All new and repaired metal mesh slings, including handles, shall be proof tested at a minimum of 150 percent of their rated capacity before use. **(T-0)** Elastomer impregnated slings shall be proof tested before they are coated. **(T-0)**

12.12.3.3.2. Except for required proof tests, metal mesh slings shall not be used to lift loads in excess of their rated capacities. **(T-0)**

12.12.3.3.3. Refer to 29 CFR § 1910.184 and ASME B30.9 for additional guidance.

12.12.3.3.4. 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 shall be followed. **(T-0)**

12.12.3.4. Natural and Synthetic Fiber Rope Slings.

12.12.3.4.1. Prior to use, new fiber rope slings shall be proof tested to 200 percent of the vertical rated load. **(T-0)**

Fiber rope slings made from conventional three-strand construction rope shall not be used with loads in excess of rated capacities. **(T-0)**

12.12.3.4.2. Cargo straps shall not be used as a sling or part of a sling configuration. **(T-0)**

12.12.3.4.3. Only new rope shall be used to make fiber rope slings. **(T-0)** Use of repaired or reconditioned fiber rope slings is prohibited. **(T-0)**

12.12.3.4.4. Refer to 29 CFR § 1910.184 and ASME B30.9 for additional guidance.

12.13. Mobile and Locomotive Cranes. All crawler, locomotive and truck cranes shall meet design specifications, characteristics, and rules of ANSI/ASME B30.5, *Mobile and Locomotive Cranes*. **(T-0)**

12.13.1. Specific Requirements.

12.13.1.1. A substantial and durable rating chart with clearly legible letters and figures shall be securely fixed to the crane cab in a location easily visible to the operator while seated at the control station. **(T-0)** A duplicate load rating chart (legible from the ground) shall also be provided on the outside of the crane. **(T-0)** The load rating chart for truck cranes shall list loads for the crane operating both with and without counterweights. **(T-0)**

12.13.1.2. Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets and reciprocating parts shall be guarded, as they may create a hazard to personnel. **(T-0)**

12.13.1.3. Some crane hazards, such as rotating equipment or holes, cannot be mechanically safeguarded. Personnel will exercise extreme care when exposed to unguarded rotating equipment or holes. **(T-1)** Such conditions shall be clearly marked with appropriate warning decals. **(T-0)**

12.13.1.4. Cranes shall be designed to protect operators from falling objects, swinging loads and cable failures. **(T-0)** Cranes that are operated in inclement weather, shall protect the operator from the weather. **(T-0)**

12.13.1.5. An audible warning device shall be provided when hoisting operations or moving equipment might endanger personnel in the work area. **(T-0)** The device control shall be within easy reach of the operator. **(T-0)**

12.13.2. Safe Operating Practices.

12.13.2.1. The operator will sound or give an audible warning signal each time before traveling (backing), and when approaching workers or other congested areas. **(T-1)** The signal may be mechanical (automatic) or oral.

12.13.2.2. 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)**

12.13.2.3. Operators shall 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 in accordance with [paragraph 12.2.1](#), as appropriate. **(T-1)**

12.13.2.4. All controls shall be tested by the operator at the start of a new shift. **(T-0)** Controls that do not operate properly shall be adjusted or repaired before continuing operation. **(T-0)**

12.13.2.5. No crane shall be loaded beyond its rated capacity, except for test purposes. **(T-0)** Weight of all loads shall be determined before lifting. **(T-1)**

12.13.2.6. The crane shall not be operated while anyone is on the load or hook. **(T-1)**

12.13.2.7. On truck mounted cranes, loads shall not be lifted over the front area of the truck unless specifically allowed by manufacturer's operating instructions. **(T-1)**

12.13.2.8. When two (2) or more cranes are used to lift one load, one designated person shall 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)**

12.13.2.9. A designated supervisor shall 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 shall be in accordance with his/her determination. **(T-0)** Specified tire pressures shall be maintained. **(T-0)** The boom shall be carried in line with the direction of motion, sudden starts and stops shall be avoided and tag or restraint lines shall be used to minimize swinging of the load. **(T-0)**

12.13.2.10. All crawler, locomotive and truck cranes shall 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)**

12.13.3. Maintenance.

12.13.3.1. The Vehicle Fleet Manager or Vehicle Management Superintendent shall establish a preventive maintenance program based on this publication and crane manufacturers' instructions. **(T-1)**

12.13.3.2. After adjustments and repairs have been made, the crane shall not be operated until all guards have been reinstalled, trapped air removed from hydraulic system, safety devices reactivated and maintenance equipment removed. **(T-0)** Adjustments to operating mechanisms, safety devices, control systems and power plants shall be maintained to ensure correct functioning. **(T-1)**

12.13.3.3. All replacement parts or repairs shall have at least the original manufacturer's design safety factor. **(T-0)**

12.13.3.4. Lubrication. All moving parts of the crane, where lubrication is specified, shall be regularly lubricated in accordance with 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 shall be stationary when lubricated, with all controls in the "OFF" position, the main power control switch, if equipped, locked out or "OFF" and pawls applied. **(T-0)**

12.14. Derricks. Refer to 29 CFR § 1910.181, *Derricks*, and 29 CFR § 1926.1436, *Derricks*, for guidance and information.

12.15. Related Hoisting Equipment.

12.15.1. Wire ropes, chains and hooks associated with cranes, hoists, slings and other types of lifting equipment shall be thoroughly inspected in accordance with [paragraph 12.4.6.](#) (T-0) Inspection for each item shall be documented in accordance with [paragraph 12.2.1.](#) (T-1) For routine and preventative maintenance on wire ropes, chains, sheaves, equalizers and other related equipment, refer to applicable OSHA and ASME B30-series standards.

12.15.2. Hooks. Refer to ASME B30.10, *Hooks*, for additional guidance and information.

12.15.2.1. Repairs by welding or reshaping are not recommended as a standard practice. If such repairs are attempted, they shall only be accomplished by a qualified person, and the hook shall be tested to the load requirements of the specific equipment in use. (T-0) **Note:** Hooks repaired by welding or reshaping are not authorized on nuclear-certified hoists or lifting equipment. 12.15.2.2. Rated capacity for a hook, when used as intended, shall be equal to other suspension members to which it is attached. (T-0) When this is not feasible, special precautions shall be taken to ensure the hook's rated capacity is not exceeded. (T-0)

12.15.2.3. Hooks shall 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 shall be replaced. (T-0) **Note:** Painted hooks shall 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.

12.15.2.4. Where operations require removal or replacement of hooks and/or lifting fixtures, the lifting capacity of the hooks/lifting fixtures shall be marked on the hook/lifting fixture and readily identifiable to the hoist/crane operator to prevent overloading the crane or hook/lifting fixture when load capacities are different. (T-0)

12.15.2.5. Hooks, rings, oblong or pear-shaped links, welded or mechanical coupling links or other attachments shall have a rated capacity at least equal to that of the alloy steel chain with which they are used. (T-0) The sling shall not be used in excess of the rated capacity of the weakest component. (T-0)

12.16. Portable Automotive Lifting Devices and Related Equipment.

12.16.1. Requirements. All personnel shall observe all safety precautions in this chapter and those recommended by the manufacturers of the portable automotive lifting devices. (T-1) Always read the owner's manual before operating the 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.

12.16.2. Maintenance and Inspection.

12.16.2.1. Maintenance. The portable automotive lifting devices shall be maintained in accordance with the product instructions. (T-0)

12.16.2.2. Inspection.

12.16.2.2.1. Visual inspection shall be made before each use of the portable automotive lifting devices by checking for abnormal conditions, such as cracked welds, leaks and damaged, loose or missing parts. **(T-1)**

12.16.2.2.2. Other inspections shall be made per product operating instructions. **(T-1)**

12.16.2.2.3. Each portable automotive lifting devices shall 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's or supplier's authorized repair facility.

12.16.2.2.4. 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 devices be made by a manufacturer's or supplier's repair facility and that any defective parts, decals or safety labels or signs are replace with manufacturer's or supplier's specified parts. A list of repair facilities is available from the manufacturer or supplier.

Table 12.1. Quick Reference Guide for Material Handling Equipment.

QUICK REFERENCE GUIDE FOR MATERIAL HANDLING EQUIPMENT		
MHE	OSHA Standard	ANSI/ASME Standard
Materials Handling Equipment	29 CFR § 1910, Subpart N, <i>Materials Handling and Storage</i>	ANSI/ASME B30.16, <i>Material Handling</i>
Hooks and Related Hoisting Equipment	29 CFR § 1910.244, <i>Other Portable Tools and Equipment</i> 29 CFR § 1926.1413, <i>Wire Rope—Inspection</i> 29 CFR § 1926.1414, <i>Wire Rope—Selection and Installation Criteria</i>	AMSE B30.10, <i>Hooks – Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings</i>
Manual Hoists	29 CFR § 1926.552, <i>Material Hoists, Personnel Hoists and Elevators</i>	ASME B30.21, <i>Lever Hoists</i>
Overhead and Gantry Cranes	29 CFR § 1910.179, <i>Overhead and Gantry Cranes</i> 29 CFR § 1926.554, <i>Overhead Hoists</i> 29 CFR § 1926.1438, <i>Overhead and Gantry Cranes</i>	ASME B30.2, <i>Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)</i>
Powered Industrial Trucks	29 CFR § 1910.178, <i>Powered Industrial Trucks</i>	American National Standards Institute/Industrial Truck Standards Development Institute Foundation (ANSI/ITSDF) B56.1A,

QUICK REFERENCE GUIDE FOR MATERIAL HANDLING EQUIPMENT		
		<i>Safety Standard for Low Lift and High Lift Trucks</i>
Slings	29 CFR § 1910.184, <i>Slings</i>	ASME B30.9, <i>Slings</i>
Mobile and Locomotive Cranes	29 CFR § 1910.180, <i>Crawler Locomotive and Truck Cranes</i> 29 CFR § 1926.1400, <i>Cranes and Derricks in Construction</i> 29 CFR § 1926.1433, <i>Design, Construction and Testing</i>	ASME B30.5, <i>Mobile and Locomotive Cranes</i>
Derricks	29 CFR § 1910.181, <i>Derricks</i> 29 CFR § 1926, Subpart CC, <i>Cranes and Derricks in Construction</i> 29 CFR § 1926.1436, <i>Derricks</i>	ASME B30.6, <i>Derricks</i>
Overhead Hoists (Underhung)	29 CFR § 1926.554, <i>Overhead Hoists</i>	ASME B30.16, <i>Overhead Hoists (Underhung)</i>
Cranes and Monorails	29 CFR § 1926.406, <i>Specific Purpose Equipment and Installations</i>	ASME B30.17, <i>Cranes and Monorails (With Underhung Trolley or Bridge)</i>
Cableways and Conveyors	29 CFR § 1926.555, <i>Conveyors</i>	ASME B30.19, <i>Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings</i>
Personnel Hoists	29 CFR § 1926.552, <i>Material Hoists, Personnel Hoists and Elevators</i> 29 CFR § 1926.1431, <i>Hoisting Personnel</i>	ASME B30.23, <i>Personnel Lifting Systems</i>
REFERENCE MATERIAL		
Subject	Reference	
Aircraft Equipment Management	AFI 21-101, <i>Aircraft and Equipment Maintenance Management</i>	
Lifting Equipment Design for Nuclear Weapon Systems	AFMAN 91-118, <i>Safety Design and Evaluation Criteria for Nuclear Weapon Systems</i>	
Operators Training	AFI 24-301, <i>Ground Transportation</i>	
MHE for Aircraft Loading/Unloading	TO 36M-1-141, <i>Operator and Operation Instruction—Material Handling Equipment System Components of 463</i> TO 36M2-3-35-11, <i>Operation and Operator Maintenance Instructions, Truck, Aircraft Cargo Loading/Unloading 60,000 Pound Capacity</i> TO 36M2-3-45-1, <i>Halvorsen 25K Aircraft Cargo Loaders</i>	
MHE in Weapons and Explosive Areas	DESR 6055.09_AFMAN 91-201, <i>Explosives Safety Standards</i>	

QUICK REFERENCE GUIDE FOR MATERIAL HANDLING EQUIPMENT	
Lockout/Tagout Procedures	Chapter 21
Sling Guidance	OSHA's <i>Tables and Figures: Guidance on Safe Sling Use</i>
Note: This table is not all-inclusive. DAF adopts all the standards in the ASME B30-series.	

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	Triangle -- Choker slings, type I Triangle -- Triangle slings, type II
------------------	---

(inches)	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

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
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
1/4	3	4-3/4	15	3
1/2	3	11-1/2	65	3
5/8	3	12	95	3-3/4
3/4	4	18	130	4-1/2
7/8	4	19	225	5-1/4
1	5	26	225	6
1-1/8	6	34	225	6-3/4
1-1/4	6	44	360	7-1/2
1-3/8	7	44	360	8-1/4

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 inspect periodically and retighten.
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.

Chapter 13

FALL PROTECTION

13.1. Scope. This chapter applies to all workplaces and covers all walking-working surfaces unless specifically covered by another chapter or industry.

13.1.1. General Industry. Fall protection shall be provided whenever employees can fall four (4) feet or more. **(T-0)** This four (4) foot rule applies to all walking and working surfaces and includes open-sided floors and platforms, wall openings and window wall openings at a stairway landing, floor, platform or balcony with a drop of four (4) feet or more. Refer to 29 CFR § 1910, Subpart D – *Walking-Working Surfaces*, for additional requirements, and [paragraph 13.2.4](#) for types of fall protection. **Exception:** Refer to [paragraph 7.1.9.5](#) for vehicle repair, service and assembly pits.

13.1.2. Construction Operations. Fall protection shall be provided when employees can fall six (6) feet or more during construction operations. **(T-0)** This six (6) foot rule applies to all walking and working surfaces, including roofs, open-sided floors and platforms, wall openings and window wall openings at a stairway landing, floor, platform or balcony with a drop of six (6) feet or more. Refer to 29 CFR § 1926, Subpart M – *Fall Protection* (29 CFR § 1926.500), for additional requirements.

13.1.3. Work on low-slope roofs shall be in accordance with 29 CFR § 1910.28(b)(13) and 29 CFR § 1926.501(b)(10). **(T-0)**

13.1.4. Aircraft Flightline Operations. Flightline operations will meet the requirements of this chapter and [Chapter 24](#). **(T-0)**

13.1.5. Portable Ladders. Refer to **Chapter 7**, 29 CFR § 1910.23, *Ladders*, and 29 CFR § 1926.1053, *Ladders*, for additional requirements and guidance.

13.1.6. Powered Platforms, Aerial Lifts and Scaffolding. Refer to **Chapter 16**, 29 CFR §§ 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.

13.1.7. Fire and Emergency Services. Fall protection shall be provided for FES personnel when exposed to falls greater than four (4) feet during routine operations as stipulated by General Industry standards (29 CFR § 1910, Subpart D).

13.1.8. ANSI/ASSP Z359.0, *Definitions and Nomenclature Used for Fall Protection and Fall Arrest*, and ANSI/ASSP Z359.2, *Minimum Requirements for a Comprehensive Managed Fall Protection Program*, are incorporated by reference as referenced by this chapter.

13.1.9. This chapter does not apply to portable ladders or when employers are inspecting, investigating or assessing workplace condition 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(a)(2), *Duty to Have Fall Protection and Falling Object Protection*, for specific exemptions to this paragraph.

13.2. Hazards and General Information.

13.2.1. General Hazards.

13.2.1.1. Falls from open-sided floors and platforms, wall openings and window wall openings at a stairway landing, floor, platform or balcony with a drop of four (4) feet or more.

13.2.1.2. Working over dangerous equipment and machinery that is not covered or guarded to eliminate the hazard.

13.2.2. Hazards to consider when using personal fall arrest systems equipment to protect from damage when used.

13.2.2.1. Electrical.

13.2.2.1.1. Wire rope or rope covered wire lanyards, some plastics (such as nylon) and wet lanyards are conductive and shall not be used near electrical hazards. **(T-0)**

13.2.2.1.2. Metal personal fall arrest systems connectors.

13.2.2.2. Thermal.

13.2.2.3. Chemical.

13.2.2.4. Sharp edges and abrasive surfaces.

13.2.3. Refer to **Chapter 2** and **Chapter 14** for additional guidance on workplace hazards and proper PPE.

13.2.4. Types of Fall Protection.

13.2.4.1. Passive. Passive fall protection, such as guardrails, work stands and platforms (aircraft maintenance stands, e.g., B-1, B-4, B-5), nets, ladder cages 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 the preferred option. **Note:** Nets do not prevent an employee from falling, but does prevent an employee from hitting the next level.

13.2.4.2. Active. Active fall protection devices include, but are not limited to, ladder climbing devices and personal fall arrest, positioning and restraint systems (requiring employees to wear a harness and attach to an anchorage or lifeline).

13.2.4.2.1. Positioning and restraint systems. Fall restraint/positioning systems restrict an employee's range of movement preventing the individual from falling.

13.2.4.2.2. Personal Fall Arrest Systems (PFAS). 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 paragraph **13.8** and **29** CFR § 1910.140, *Personal Fall Arrest Systems*, for additional guidance on PFAS.

13.3. Fall Protection Program.

13.3.1. Unit 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 and guidance for the fall protection program. **(T-1)** An example statement can be found in ANSI/ASSP Z359.2.

13.3.2. Responsibilities.

13.3.2.1. Unit Commander. The unit commander is ultimately responsible for the development and implementation of the fall protection program that promotes a safe and healthful workplace.

13.3.2.2. Unit Fall Protection Program Administration. The unit fall protection program will be administered and managed by a competent person as defined in [paragraph 13.3.2.4](#). The unit commander will assign a person to act as an administrative liaison between the unit and the installation Occupation Safety office. **(T-1)** The competent person will be identified in writing by the unit commander and meet the requirements of ANSI/ASSP Z359.0 and ANSI/ASSP Z359.2. **(T-1)** This includes providing and evaluating fall protection training, and, as applicable, developing, implementing, monitoring and evaluating the fall protection program to assure unit compliance with ANSI/ASSP Z359.2 and as defined in 29 CFR § 1910.21(b). **(T-0)**

13.3.2.3. Qualified Person. In accordance with ANSI/ASSP Z359.0, the qualified person shall:

13.3.2.3.1. Be trained and meet the responsibilities outlined in ANSI/ASSP Z359.2 and as defined in 29 CFR § 1910.21(b). **(T-0)**

13.3.2.3.2. Be designated in writing by the unit commander. **(T-1)** If the qualified person comes from outside the organization, documentation of the service agreement will be kept on file. **(T-1)**

13.3.2.4. Competent Person. In accordance with ANSI/ASSP Z359.0, the competent person shall:

13.3.2.4.1. Be trained and meet the responsibilities outlined in ANSI/ASSP Z359.2 and as defined in 29 CFR § 1910.140(b). **(T-0)**

13.3.2.4.2. Be designated in writing by the unit commander. **(T-1)**

13.3.2.5. Authorized Person. Authorized person will meet the definition outlined in 29 CFR § 1910.21(b) and ANSI/ASSP Z359.0 and meet all applicable responsibilities in ANSI/ASSP Z359.2. **(T-0)**

13.3.2.6. Installation occupational safety. The installation occupational safety office (or applicable tenant safety office) will provide advice and guidance to the Unit Fall Protection Program Administrator in the management of the unit fall protection program. **(T-1)** These duties include:

13.3.2.6.1. 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 13.5](#). **(T-1)**

13.3.2.6.2. Identifying unabated fall hazards and providing a risk assessment code (RAC) and tracked in accordance with AFI 91-202. **(T-1)**

13.3.2.6.3. Conduct thorough annual review of fall protection program elements and documents annually in safety inspection/assessment reports. **(T-1)** **Note:** Occupational safety professionals do not meet the requirements of a qualified person or competent person in accordance with ANSI/ASSP Z359.0 and will not be used to fulfill those roles, unless they meet requirements found in [paragraphs 13.3.2.3](#) and [13.3.2.4](#). **(T-1)**

13.3.2.7. Fire & Emergency Services (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 13.4](#) and [paragraph 13.5](#). (T-1) The F&ES Flight may also act as the competent rescuer when they meet the requirements as defined in ANSI/ASSP Z359.0 to perform rescue at height when included in the organizational rescue plan and agreed to by the installation fire chief.

13.3.2.8. Authorized Rescuers. Authorized rescuers will meet the definition outlined in ANSI/ASSP Z359.0 and meet all applicable responsibilities in ANSI/ASSP Z359.2. (T-1)

13.3.2.9. Supervisors. Supervisors shall: (**Note:** Refer to AFI 91-202 for additional responsibilities.)

13.3.2.9.1. 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 [paragraph 13.7](#).

13.3.2.9.2. Be familiar with the shop's typical work assignments and fall protection/fall arrest systems required. (T-1)

13.3.2.9.3. Be responsible for the procurement of fall protection/fall arrest systems required by the organization or shop as directed by the qualified person. (T-1)

13.3.2.9.4. Be able to provide recommendations for qualified and competent personnel in the organization to the unit commander. (T-1)

13.3.2.9.5. Be designated in writing by the unit commander. (T-1)

13.3.2.10. Trainers. Trainers will be designated in writing by the unit commander. (T-2)
Note: If the trainer comes from outside the organization, documentation of the service agreement will be kept on file. (T-1)

13.3.3. Fall Protection Assessments.

13.3.3.1. The unit fall protection program administrator will assess the compliance of the fall protection program requirements, with assistance of the competent/qualified person, as needed. (T-1) Findings will be documented and corrected. (T-1)

13.3.3.1.1. Final report will be routed to the unit commander for review and signature within 10 days of assessment completion. (T-1)

13.3.3.1.2. The unit fall protection program administrator will maintain a minimum of three (3) years of completed assessments. (T-1)

13.3.3.2. The installation or tenant unit's Occupational safety office will complete an annual assessment of fall protection program requirements for each unit and document results as required in AFI 91-202. (T-1)

13.4. Fall Hazard Survey.

13.4.1. 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 unit competent/qualified person(s)

and comprised of the work center supervisors, authorized persons, installation occupational safety office and F&ES Flight. **(T-1)** Team composition allows all personnel to have input on the hazards and best ways to protect against those hazards. Refer to ANSI/ASSP Z359.2 for additional guidance about fall hazard surveys.

13.4.2. A fall hazard survey will include:

13.4.2.1. Identification of fall hazards and include details of each hazard such as: **(T-1)**

13.4.2.1.1. Means of access to the fall hazards.

13.4.2.1.2. Locations of the fall hazards.

13.4.2.1.3. Tasks that create exposure to fall hazards.

13.4.2.1.4. Hidden fall hazards that are not always readily apparent.

13.4.2.2. 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.

13.4.2.3. Identification of environmental factors that will affect the installation, use, inspection, maintenance and dismantling of any fall protection system. **(T-1)**

13.4.2.4. A risk assessment to determine the level of risk for each fall hazard identified. **(T-1)** Assign risk assessment codes (RACs), as necessary. Refer to AFI 91-202, *The US Air Force Mishap Prevention Program*, for additional guidance on RACs.

13.4.2.5. Appropriate abatement actions, as required by AFI 91-202. **(T-1)**

13.4.2.6. Selected fall protection method(s) for each identified hazard. **Note:** If personal fall arrest systems are selected, the calculation of all clearances will be included in the written fall protection procedures. Employees shall not use PFAS until adequate clearances are available.

13.4.3. Competent or qualified person will prepare the fall hazard survey report and submit copies to the unit fall protection program administrator, F&ES Flight and installation occupational safety office. **(T-1)**

13.4.4. Fall hazard surveys will be updated or re-accomplished when changes occur in the work center. **(T-1)** Completed fall hazard surveys will be maintained by the unit fall protection program administrator and be available to all qualified, competent and authorized workers for reference. **(T-1)**

13.4.5. When fall hazards are identified resulting from item or equipment upgrades, modification or replacements, the DAF item managers (depot level) shall perform necessary functions (e.g., describing planned upgrades, costs, timetables and prioritization), for DAF equipment not meeting fall protection standards. **(T-1) Note:** Reference [paragraph 24.16](#) for further details.

13.5. Written Fall Protection and Rescue Procedures.

13.5.1. Fall protection and rescue procedures will be documented specifically for each workplace and 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 shall be prepared and modified by a qualified or competent person as defined in this chapter. **(T-1)** Fall protection and rescue procedures shall be reviewed every two years for currency and accuracy. **(T-1)**

13.5.2. Written procedures shall include:

13.5.2.1. Purpose of the fall protection procedure. **(T-1)**

13.5.2.2. Location and photographs/diagrams of the fall hazard(s) and fall protection system setup. **(T-1)**

13.5.2.3. Appropriate standards, regulations or requirements for the task(s) conducted. **(T-1)**

13.5.2.4. Training requirements for the fall protection procedure based on the fall protection equipment required. **(T-1)**

13.5.2.5. Fall protection system design parameters. **(T-1)** **Note:** Include fall calculations based on identified equipment and equipment design parameters, which include a detailed list of PPE and who developed the procedure, when it was developed, system certifications and inspection logs.

13.5.2.6. Equipment requirements. **(T-1)**

13.5.2.7. Procedures documenting how to safely erect, use and dismantle the fall protection equipment. **(T-1)**

13.5.2.8. Preparatory actions to be conducted by the supervisor to ensure authorized persons know the fall protection and rescue procedures. **(T-1)**

13.5.2.9. Steps to take when work is completed, e.g., clean up, storage. **(T-1)**

13.5.2.10. A detailed rescue plan, which includes: **(T-1)**

13.5.2.10.1. Coordination with outside rescue agencies (installation F&ES Flight, contracted rescue unit, etc.) to determine requirements to ensure prompt rescue of fallen personnel as part of preplanning. **(T-1)** Ensure the outside rescue agency completes pre-planning prior to work start.

13.5.2.10.2. Procedures to contact the rescue agency if a fall occurs. **(T-1)**

13.5.2.10.3. Training on actions an authorized person can take to attempt self-rescue, when possible. **(T-1)**

13.5.2.10.4. Actions to be taken by the organization to rescue fallen authorized personnel, when possible. **(T-1)**

13.5.2.10.5. Location of rescue anchorage. **(T-1)**

13.5.2.10.6. Equipment needed. **(T-1)**

13.5.2.10.7. Location of attachment to fallen employee's harness. **(T-1)**

13.5.2.10.8. Specific actions to achieve successful rescue. **(T-1)**

13.5.2.10.9. Required training for rescuers. **(T-1)**

13.5.3. The unit shall establish good lines of communication with the installation F&ES Flight or a contracted rescue agency for prompt rescue of a fallen worker. **(T-1)** When rescue by the F&ES Flight or contracted agencies is unavailable, then the unit shall ensure a unit rescue team is available. **(T-1)** **(Warning:** Hanging in a harness for an extended period of time can be fatal. Consideration should be given to purchasing and utilizing suspension trauma prevention devices as an adjunct to a six-minute rescue plan as outlined below.) In accordance with ANSI/ASSP Z359.4, *Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components*, prompt rescue means getting to the subject within six (6) minutes after an accidental fall.

13.6. 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 shall be coordinated with the installation 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 installation occupational safety office, shall be developed. **(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 Risk Assessment Codes, to partially or totally eliminate need for procedural controls. **(T-1)** Consistent with OSHA guidelines, cost shall not be a consideration for selecting the fall protection plan's procedural controls versus implementing fall protection. **(T-0)**

13.7. Training. Before employees are exposed to a fall hazard, training shall be completed in accordance with 29 CFR § 1910.30, *Training Requirements*. **(T-0)** Trainers conducting fall protection and rescue training shall meet the requirements of ANSI/ASSP Z490.1, *Criteria for Accepted Practices in Safety, Health and Environmental Training*. **(T-1)**

13.7.1. Qualified and competent persons will be trained in accordance with ANSI/ASSP Z359.2 to meet requirements found in 29 CFR § 1910.21(b) and 29 CFR § 1910.140(b). **(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)**

13.7.2. Authorized personnel will be trained by a competent or qualified person trainer in accordance with ANSI/ASSP Z359.2. **(T-1)**

13.7.3. Program administrators shall be trained on all equipment and practices applicable to the scope of work in accordance with ANSI/ASSP Z359.2. **(T-1)**

13.7.4. Retraining. Supervisors shall ensure authorized persons are retrained in accordance with 29 CFR § 1910.30(c). **(T-0)**

13.7.5. Recurring Training. Recurring training shall be performed at least annually. **(T-1)** The training shall establish employee proficiency, include an in-depth review of current and previous procedures and introduce a new or revised control methods and procedures, as necessary. **(T-1)**

13.7.5.1. Personnel trained as competent and authorized persons shall be retrained at least every two years. **(T-1)** Annual refresher training shall be conducted the year following attendance in the initial course. **(T-1)**

13.7.5.2. Competent and authorized persons who are also identified as rescuers must meet requirements as identified in [paragraph 13.3.2.8](#). (T-1)

13.7.6. Training Documentation. All training, e.g., familiarization, initial, retraining and recurring, shall be documented in accordance with AFI 91-202, with the required information detailed in OSHA Publication 2254, *Training Requirements in OSHA Standards*. (T-0)

13.8. Equipment Inspections and Maintenance.

13.8.1. Personal fall arrest systems (PFAS) users shall comply with TO 00-25-245, *Operations Instructions - Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, and manufacturer's instructions for inspection, maintenance, cleaning and storage. (T-1) If defects or damage to equipment or inadequate maintenance of equipment is found, the equipment shall be immediately tagged unserviceable and removed from service. (T-1) Unserviceable PFAS will be destroyed to prevent further use. Inspections shall be documented in accordance with TO 00-25-245 or manufacturer's instructions, whichever is more restrictive. (T-1)

13.8.2. Authorized person(s) shall inspect PFAS prior to use. (T-0)

13.8.3. Supervisors shall ensure all PFAS components receive a thorough inspection at least quarterly. (T-1) This inspection shall be documented and maintained for at least one year. (T-1) **Exception:** Components of a PFAS that have been professionally installed and certified will be inspected in accordance with manufacturer's instructions, at the interval recommended by the manufacturer, and by a person qualified to perform the inspection. Inspection shall be documented and maintained. (T-1)

13.8.4. Supervisors shall maintain manufacturer's instructions and performance testing information for PFAS used by their employees. (T-1)

13.8.5. For overseas locations, the use of anchorage points is authorized when the host country provides documentation of applicable testing and inspections.

13.9. Fall Mishap Reporting. Falls from heights, regardless of whether an injury or damage has occurred, will be reported to the servicing occupational safety office and investigated by a competent person and occupational safety personnel. (T-0) A mishap investigation will be accomplished to determine the cause of the fall and used to correct any issues found in procedures, equipment or rescue, as applicable. (T-0)

Chapter 14

PERSONAL PROTECTIVE EQUIPMENT (PPE)

14.1. Scope. This chapter establishes DAF specific personal protective equipment (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 *Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program*, 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 shall be provided to each affected employee who is required to use PPE when accomplishing any work activity. **(T-0)** Supervisors shall train each employee in accordance with 29 CFR § 1910.132(f), *Training*, and applicable manufacturer's instructions. **(T-0)** Respiratory protection training shall be in accordance with 29 CFR § 1910.134, *Respiratory Protection*, and AFI 48-137. **(T-0)** Hearing protection shall be in accordance with AFI 48-127.

14.2.2. Retraining. Affected employees shall be retrained in accordance with 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/used. **(T-0)**

14.2.2.4. Other conditions as specified in 29 CFR § 1910.147(f)(3) requires retraining. **(T-0)**

14.2.3. Supervisor shall document training in accordance with [paragraph 1.7](#) and AFI 91-202. **(T-1)** Respiratory training shall be documented in accordance with AFI 48-137. **(T-1)**

14.3. Hazard Assessment 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 hazard assessment 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, it shall be provided by the command and/or functional manager. **(T-1)** Subordinates are not responsible for providing their own PPE. A documented job hazard analysis (JHA) shall be conducted to determine if hazards are present and take actions necessary to protect employees from injury, illness or death in accordance with 29 CFR § 1910.132(d), *Hazard the Assessment and Equipment Selection: Personal Protective Equipment – General Requirements*. **(T-0)** Units should consult with the installation occupational safety office and BE if they have questions regarding

PPE. BE is responsible for selecting respirator and filter types, and fit testing for users requiring respiratory protection.

14.3.1. Supervisors shall:

14.3.1.1. Conduct and document hazard assessments in accordance with 29 CFR § 1910.132(d). **(T-0)** Refer to [paragraph 1.5](#) and AFI 91-202 for additional guidance on JHA.

14.3.1.2. Contact BE and Environmental Management 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 shall ensure that PPE is provided, used and maintained in a sanitary and serviceable condition in accordance with manufacturer's instructions. **(T-0)**

14.3.2. DAF personnel shall 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 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 be worn with appropriate eye protection at all times. **(T-0)** In the case of primary protection, other protective devices such as safety goggles shall be worn. **(T-0)**

14.3.4. Respiratory Protection. BE, as the OPR for the Air Force Respiratory Protection Program, recommends and approves all respiratory protection devices and shall 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 control 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, shall

be provided and use proper protective head gear. **(T-0)** Typical examples of these areas are construction sites, flightlines and warehouses. Protective helmets must 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., shall secure their hair, especially long hair, to prevent it 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 shall ensure workers working on or near underground or aerial installation, construction and certain maintenance-related jobs wear an approved safety helmet (as determined by a property conducted hazard assessment) at all times. **(T-1)** The chinstrap shall be worn during work aloft or anytime the helmet may fall off the workers head while performing a specific task possibly resulting in injury to workers or damage to property. **(T-1)** Refer to ANSI/ISEA Z89.1 for additional guidance on chinstraps. **(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 shall not be used as a substitute for safety helmets, where applicable. Their use shall be determined by the supervisor's hazard assessment, in conjunction with the installation 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 Air Force directive on hazardous noise exposure policies, responsibilities and procedures, including hearing protective device information. Contact BE for information on the Air Force Hearing Protection Program. Refer to AFI 48-127 for additional guidance and information.

14.3.7. Electrical Workers' Clothing and Equipment. Electrical clothing shall be used in accordance with 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 shall be used in accordance with 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 shall be provided and used. **(T-0)** Sleeves, padded arm protectors, hand pads and other items shall be worn to protect the hands and arms when hot or sharp materials are handled. **(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 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 shall

select appropriate hand protection based on the characteristics required for the task to be performed, dexterity required, conditions present, duration of use, frequency, physical stresses, limitations of protective clothing and degree of exposure to identified hazards. **(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 shall not be relied upon solely to protect the back from injury. Back support belts should be unfastened when the individual is not presently involved in a lifting motion, to prevent the possibility of muscle atrophy from prolonged usage.

14.3.10. Foot and Leg Protection (Safety Shoes, Toe Caps, Leggings, etc.). Protective footwear shall be provided and worn when there is a reasonable possibility of foot injuries from heavy or sharp objects and electrical and/or static electricity. **(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. Supervisor's safety assessment shall identify those areas, operations and occupations which require protective leg or footwear. **(T-1)** All individually issued safety footwear used in DAF operations shall meet the requirements of ASTM F2412, *Standard Test Methods for Foot Protection*, and ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*. **(T-0)**

14.3.10.2. Safety shoes shall be sturdy and have an impact-resistant toe. **(T-0)** Only shoes meeting or exceeding 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 information. Metal insoles in shoes protect against puncture wounds. Additional protection, such as metatarsal guards, may be necessary for some job tasks. Nonskid shoes shall be worn where floors may be wet or slippery. **(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 shall be issued footwear which protects against the possibility of frostbite. **(T-0)**

14.3.11. Knee Protection. Knee pads may be used by workers who are required to kneel while performing most of their work or by workers with known knee problems that could be compounded by working in a kneeling position.

14.3.12. 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, shall be used to limit chemical contact before considering use of PPE. **(T-0)**

14.3.12.1. Chemical Protective Clothing Selection. Workplace supervisors shall contact 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, Safety Data Sheets (SDSs) and manufacturer's instructions. Check with 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 shall be considered when selecting chemical protective clothing. **(T-0)** Review the SDS and contact 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 shall 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 worker's ability to successfully accomplish the task.

14.3.13. Welding, Cutting and Brazing Specific PPE. Welding, cutting and brazing PPE requirements and usage shall be in accordance with 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, shall be provided and use reflective equipment or shall 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 guidance regarding selection of reflective clothing.

Note: Personnel whose job requires them to perform some function in the traffic/flightline environment shall 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 shall 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. **Note:** If metallic coating on heat reflective clothing is conductive, it shall 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 shall coordinate with the installation occupational safety and 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 shall 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 instruction for guidance on personal fall arrest systems.

14.4. Proper Care and Maintenance. Workers shall maintain all PPE in accordance with manufacturer's instructions to include being kept clean and in good repair. **(T-0)** Previously used PPE shall be disinfected before reissue to another worker. **(T-0)** Contaminated PPE that cannot be decontaminated shall be disposed of in a manner that protects employees from exposure to hazards. **(T-0)** Contact BE to determine the appropriate disposal measures of contaminated PPE. Functional managers shall 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, *Grounding and Electrical Systems*, 29 CFR § 1910.137, Table I, and 29 CFR § 1910.141, *Sanitation*, for more information on cleaning specific equipment.

14.4.1. Shop supervisors shall ensure shop personnel use the protective clothing and equipment that will protect them from work hazards. **(T-0)**

14.4.2. Workers shall keep their hands and face clean, change clothes and wash skin contaminated with solvents, lubricants or fuels, and keep hands and soiled objects out of their mouth. **(T-0)** No food or drink shall be brought into or consumed in areas exposed to toxic materials, chemicals or industrial shop contaminants nor shall drinking water sources such as water fountains be located in those areas. **(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 shall provide on-site laundry and shower facilities in accordance with 29 CFR § 1910.141. **(T-0)** Additionally, showers and laundry facilities shall be provided when the installation occupational safety office or BE determine 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 16-1007, *Management of Air Force Operational 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) shall determine the fire prevention requirements for trainers not covered in AFI 16-1007.

15.1.1. Hazards. Protective measures, such as grounding, conductive floors and benches, humidity control, antistatic packaging of spare components and other controls shall be used as needed to prevent electrostatic discharge. (T-1) Refer to [paragraph 1.5](#) and/or [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 2A10B:C located in accordance with NFPA10, *Standard for Portable Fire Extinguishers*, must be provided with 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 shall 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 shall be disposed of in suitable noncombustible containers, conspicuously labeled as to contents and with self-closing lids. (T-0) These containers shall be emptied when full and at least at the end of each working shift. (T-0) Contact the installation Environmental Management office for disposal procedures for combustible hazardous waste. Refer to [Chapter 22](#) for additional guidance.

15.2.3.2. Building floors, especially raised floors, shall be kept smooth, clean and free of obstructions and slippery materials. (T-0)

15.2.3.3. Floors shall 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 under raised floors shall be cleaned periodically, but not less than once every 60 days. (T-1) Sub-floors shall be inspected once each operational day to ensure no flooding or leaking is present, unless

the sub-floor area is provided with an automatic water leakage detection system. **(T-1)**
Note: Any change in facility or room use requires reassessment of the cleaning schedule.

15.2.3.5. Utility trenches shall 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 Protection Flight may allow extending the time between cleanings. **Note:** Any change in facility or room use requires reassessment of the cleaning schedule.

15.2.3.6. Hot Work. Hot work permits will not be issued until the requirements in NFPA 51B, *Fire Prevention During Welding, Cutting and Other Hot Work*, are met. **(T-0)** Consult with the installation 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 installation Occupational Safety office, CE, Fire & Emergency Services (F&ES) Flight and BE shall coordinate on all plans. **(T-1)**

15.3.2. Location. Training systems shall be located in facilities protected by automatic sprinkler systems. Piloted and unpiloted aircraft flight trainers must be located in spaces with additional ultra-sensitive smoke detection as well. Electronic procedures training must also be located in spaces with additional ultra-sensitive smoke detection.

15.3.3. Existing facilities housing training devices with internal fire detection and alarm systems do not require ultra-sensitive systems but shall be provided with a standard smoke detection system. **(T-1)**

15.3.4. Training system spaces shall be separated from other spaces and/or occupancies and operationally distinct adjacent equipment spaces in the facility by a minimum of 1-hour fire rated construction, extending from structural floor to structural ceiling and/or roof. **(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 shall be provided to shut off the space from the remainder of the facility upon any facility fire alarm indication. **(T-0)** Activation of the facility fire detection system shall shut down the air handling system. **(T-0)** An air handling system which serves an individual training system does not have to be deactivated for facility fire alarm indications for conditions originating outside the training system space.

15.3.6. Communications and interconnecting cable and wiring in training system and raised floor spaces shall 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 shall 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 shall be provided for all incoming power to the training system. **(T-0)** New training system facilities shall have surge protection for the entire facility. **(T-0)**

15.3.7.2. All power and distribution circuits shall comply with NFPA 70 and UFC 3-520-01, *Interior Electrical Systems*. **(T-0)**

15.3.8. Drainage. Drainage shall be provided in utility trenches and motion bays. **(T-0)**

15.3.9. Hydraulic Pump Rooms. Hydraulic pump rooms shall be of 1-hour fire rated construction, except rooms which contain more than 250 gallons of hydraulic fluid, which shall be of 2-hour fire rated construction. **(T-0)**

15.3.10. Emergency Lighting. Emergency lighting shall be provided in accordance with 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 shall be used in cockpits, seats, shrouds, cable ties, cable coverings and auxiliary insulation for heat, electrical, sound, etc. **(T-0)** The flame spread rating for these materials shall not exceed 75 and smoke development shall not exceed 100 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*. **(T-0)** Alternately, materials shall be considered acceptable that meet one of the following: certification under California State Fire Marshall Title 19; listing under Underwriters Laboratories (UL) 94, *Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*, or equivalent OSHA-recognized NRTL certification; or successful testing under ANSI/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 shall be designed to automatically shut down on sudden or excessive flow in the hydraulic lines when the fluid level is low or when excessive hydraulic fluid temperature is sensed. **(T-0)**

15.4.2.2. Flexible hoses shall 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 shall 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 shall 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 shall comply with the requirements in NFPA 101. **(T-0)**

15.4.2.3.3. For aircraft flight and similar high value training systems, access ramps shall automatically deploy after motion is stopped — even when power is removed. **(T-1)**

15.4.2.4. Hydraulic pump controls shall be designed so operation of the facility fire alarm or training system fire alarm system shuts down the pumps. (T-1) This feature is not required for wheeled vehicle egress assistance trainers.

15.4.3. Emergency Lighting. Emergency lighting shall be provided in all enclosed occupied training spaces in accordance with 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 shall 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 shall be padded and loose objects secured that could present a head strike hazard to trainees during unit rollover. (T-0) Padding shall comply with flammability requirements in [paragraph 15.4.1](#). (T-0)

15.5.3. Walkways. Walkways shall be padded where the trainees egress to minimize the potential for injury to personnel should a trainee fall from the vehicle doors. (T-1) Padding shall 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 2A-10BC shall be located within immediate vicinity of the instructor/operator. (T-1)

15.5.5. Power Failure. A means shall be provided to manually-rotate the unit to a safe position for trainee egress in case of loss of power or failure of the powered rotation motor. (T-1)

15.5.6. Egress Procedures. Procedures shall be established to provide safe emergency occupant egress from the unit, such as when the unit fails to fully rotate to the design rollover position. (T-1)

15.5.7. Loading and Seating. Approved occupant seating and loading limits shall be posted in the immediate vicinity of the unit. (T-1) Prohibited seating arrangements shall 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. Trainee shall 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 Similar 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 in accordance with [paragraph 15.3.2](#).

15.6.1.2. Existing training systems in spaces protected by a standard smoke detection system shall have an internal fire detection and alarm system. (T-1) This system shall interconnect all detection and annunciation devices with the various training system

components (cabinets, instructor operator station, cockpit, motion base, etc.). **(T-1)** This system shall 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 shall 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, shall produce a distinctive audible signal. **(T-1)** Activation of the second detector, e.g., the one calibrated to the higher activating temperature, shall activate the facility detection system through the training system fire alarm panel and de-energize the simulator and all peripheral equipment. **(T-1)**

15.6.1.2.2. Ultra-sensitive smoke detection systems shall be provided to protect electrical, electronic/and computer cabinets. **(T-1)** A minimum two-stage warning capability shall be provided. **(T-1)** The first, more sensitive stage shall produce a distinctive audible signal. **(T-1)** Activation of the second, less sensitive stage shall activate the facility detection system through the training system fire alarm panel and de-energize the simulator and all peripheral equipment. **(T-1)**

15.6.1.2.3. If detection equipment is located in an unoccupied area, e.g., computer rooms, a means shall be provided to positively alert operators at the instructor operator station. **(T-1)** If multiple unoccupied computer areas are present, then a means shall 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, shall be installed in accordance with NFPA 72, *National Fire Alarm and Signaling Code*. **(T-0)** Each detection device shall 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 shall be powered by a dedicated circuit with backup battery power and connected to the facility electrical supply ahead of the training system disconnect switch. **(T-1)**

15.6.1.5. The fire detection system shall be capable of operating from both 50 and 60 hertz. **(T-1)**

15.6.1.6. The system fire detection and alarm control panel shall be designed to transmit both coded fire and trouble signals to the fire alarm and receiving center or other monitoring service (when not located on a DoD installation) in accordance with NFPA 72. **(T-0)** This may be through the facility fire alarm transmitter or an independent fire alarm transmitter. Contact the installation Fire Protection Flight for fire alarm and receiving equipment requirements. **(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 shall be notified of the alarm condition through audible (siren, horn, bell, etc.) and visual (strobe) cues. **(T-1)** Occupants of the facility (including those in the training spaces) shall exit the facility immediately without delay, following the facility's preexisting emergency

evacuation plan. **(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 condition 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 shall 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. Required functions upon activation of the facility fire suppression system (without activation of a suppression system in any training system area):

15.6.1.7.2.1. Occupants in the training spaces shall be notified of the alarm condition through audible (siren, horn, bell, etc.) and visual (strobe) cues. **(T-1)** Occupants of the facility (including those in the training spaces) shall exit the facility immediately without delay, following the facility's preexisting emergency evacuation plan. **(T-1)**

15.6.1.7.2.2. The training system power source shall 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 shall be notified upon activation of the first, less sensitive stage of ultra-sensitive smoke detection systems or upon activation of the first detector in dual fixed-temperature type systems. **(T-1)**

15.6.1.7.3.2. The training system shall 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 shall automatically turn emergency power off. **(T-1)**

15.6.1.7.5. Training staff shall 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:

15.6.1.7.6.1. The training system fire alarm system shall notify occupants throughout the facility of the alarm condition through audible (siren, horn, bell, etc.) and visual (strobe) cues. **(T-1)**

15.6.1.7.6.2. All personnel throughout the facility, including those in training areas, shall exit the facility immediately without delay, following the facility's preexisting emergency evacuation plan. **(T-1)**

15.6.2. Fire Stops. All cable trays, utility trenches, etc., that connect to spaces outside training system spaces shall have fire stops installed every 25 feet. **(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, shall 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)** Air handling systems dedicated to an individual training system need not be deactivated upon facility fire alarm indications unless originating within the training system.

15.6.4. Specifications for Cable and Wiring.

15.6.4.1. Polyvinyl chloride coated wire shall 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*, shall 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 shall comply with NFPA 70, Article 670, *Industrial Machinery*, and those in the training system space and other areas of the facility or other facilities shall comply with NFPA 70, Article 725. **(T-0)**

15.6.4.3. Power and signal cable groups in which heat cannot quickly dissipate shall contain a heat sensor wire or other heat sensing device. **(T-1)**

15.6.4.4. Cable and wiring for the training system fire alarm system shall 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 shall 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 shall 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 shall 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 shall be provided in easy reach of the operators at the instructor operator station. **(T-1)** Normally, a standard manual

fire alarm station shall be provided on the operator's console with provision to interconnect to the facility alarm and detection system, and to initiate a training system emergency power off. **(T-1)**

15.6.7.2. Smoke detection devices shall 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 shall alert the training system occupants and the operators at the instructor operator station. **(T-1)**

15.6.7.3. A facility alarm annunciator shall be installed when the instructor operator station is located 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 shall be provided in cockpits and other enclosed crew stations. **(T-1)** Battery powered detectors shall not be used.

15.6.8.2. The cockpit shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 located in a facility fully protected by a wet pipe sprinkler system.

15.6.9.2.1.2. Flight training devices and associated controls are located 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) shall 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 shall 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 shall 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](#) shall 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 Similar High Value Training Systems. Existing facilities and training systems may continue in use while awaiting 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 AFOSH standards or previous (superseded) revisions of this AFMAN. Training systems currently identified to be upgraded to previous (superseded) editions of this AFMAN 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 shall be regularly serviced and maintained in operational condition.

15.7.4. Halon. Existing Halon fire suppression systems shall be placed on manual activation and automatic discharge mechanisms disabled. **(T-1)** Existing Halon fire suppression systems shall not be re-serviced following discharge and the training device shall remain operational. **(T-1)** Training systems developed with Halon fire suppression systems shall transition to current standards during any major modification. **(T-1)**

Chapter 16

MOBILE ELEVATING WORK PLATFORMS AND SCAFFOLDING

16.1. Scope. This chapter establishes DAF-specific vehicle-mounted elevating and rotating platforms, including work platforms and aircraft maintenance equipment used for elevating workers 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-Working 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. Electricity.

16.2.4. Faulty/broken equipment, e.g., loose/bad planking.

16.3. Training.

16.3.1. Training shall be provided to each affected employee who is required to perform work on mobile elevating work platforms and scaffolding. **(T-0)** Supervisors shall train each employee:

16.3.1.1. In accordance with 29 CFR § 1910.30, *Training Requirements – Walking-Working Surfaces*, and applicable manufacturer’s instructions. **(T-0)**

16.3.1.2. Involved in erecting, disassembling, moving, operating, repairing, maintaining, inspecting or performing work on a scaffold in accordance with 29 CFR § 1926.454, *Training Requirements – Scaffolds*. **(T-0)**

16.3.1.3. Required to use vehicle-mounted elevating and rotating work platforms before using this equipment. **(T-0)** This shall include “hands-on-training” prior to actual “on-the-job” training tasks. **(T-1)**

16.3.2. Retraining. Affected employees shall be retrained in accordance with 29 CFR § 1910.30(c) and/or 29 CFR § 1926.454(c), e.g., change in their job assignments, a change in the work processes that present a new hazards or when there is a change type of PPE used; or other conditions as specified in 29 CFR § 1910.30(c) or 29 CFR § 1926.454(c). **(T-0)**

16.3.3. Supervisor shall document training in accordance with [paragraph 1.9](#) of this manual and AFI 91-202. **(T-1)**

16.4. Inspections and Maintenance.

16.4.1. Inspection and Test Procedures for Aerial Ladders and Articulating and Extendible Boom Platforms.

16.4.1.1. Prior to performing any mobile elevating work platform inspections, the supervisor or designee must conduct a site assessment to identify and eliminate any hazards that may interfere with the safe operation of the equipment during the required inspections. **(T-1)**

16.4.1.2. Aerial ladders shall be inspected and tested annually or immediately following any activity when it is known, or suspected, to have been loaded beyond its maximum load capacity, or immediately following any repair of any ladder assembly structural or mechanical component. **(T-0)** Inspections are the joint responsibility of the principal operator and vehicle mechanic qualified to perform annual inspections. Document inspections and tests in accordance with AFI 24-302, *Vehicle Management*. **(T-1)** Qualified F&ES Flight personnel may perform many of the tests and inspection actions; however, it is recommended they be performed by a third-party testing company or the aerial device manufacturer. A record of the inspection and tests shall be documented in accordance with AFI 24-302. **(T-1)**

16.4.1.3. Articulating and extendible boom platforms shall be inspected and tested annually. **(T-0)** Special inspections and tests shall be conducted immediately following any use where the work platform may have been loaded beyond the manufacturer's rated capacity, or immediately following any repair of a boom or work platform assembly structural or mechanical component. **(T-0)** Refer to the manufacturer's instruction for inspection requirements. Inspections shall be a joint effort by the principal operator and a vehicle mechanic qualified to perform annual inspections of the vehicle. **(T-1)** The inspection and test shall be documented in accordance with 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 shall not apply and testing shall be accomplished in accordance with applicable TOs or manufacturer's instructions. **(T-1)**

16.4.1.4. Refer to 29 CFR § 1926.1431, *Hoisting Personnel – Cranes and Derricks in Construction*, for information on use of cranes or derricks to hoist personnel work platforms.

16.4.2. Maintenance and Repair of Powered and/or Mobile Units.

16.4.2.1. If deficiencies affecting safe operation are discovered during the daily operator inspection (or during use), the equipment shall immediately be removed from service until repaired. **(T-0)** The manufacturer's recommended maintenance procedures shall be followed and tests outlined in [paragraph 16.4.1](#) shall be conducted prior to returning an aerial device to service following repairs to the ladder, boom or work platform. **(T-1)**

16.4.2.2. All repairs shall be accomplished by qualified personnel. **(T-0)**

16.4.2.3. Users shall inspect and maintain aerial platforms to ensure proper operation. (T-1) The frequency of inspection and maintenance shall be based on the manufacturer's instructions and compatible with operating conditions and severity of the operating environment. (T-1)

16.4.2.4. Aerial platforms not in safe operating condition shall be immediately removed from service and tagged "do not use" until repaired. (T-1) A qualified person shall make repairs in accordance with manufacturer's instructions. (T-1) This periodic inspection shall include those requirements in paragraphs 16.6.4.3 and 16.6.4.5. (T-1)

16.5. Vehicle-Mounted Elevating and Rotating Work Platforms.

16.5.1. All vehicle-mounted elevating and rotating aerial devices shall meet the requirements of the ANSI A92.2., *Vehicle Mounted Elevating and Rotating Aerial Devices*. (T-1) Modifications shall conform to ANSI A92.2 and 29 CFR § 1910.67, *Vehicle-Mounted Elevating and Rotating Work Platforms*, and shall be documented on the appropriate form. (T-1) 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)

16.5.2. Modifications. Modifications shall conform to ANSI A92.2 and 29 CFR § 1910.67 and shall 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)

16.5.3. Clearances.

16.5.3.1. Electrical. Maintain the following clearances when operating aerial lifts under, over, by or near electric power lines.

16.5.3.1.1. For lines rated 50 kV or less, the minimum clearance between lines and any part of the aerial lift shall be at least 10 feet (305 centimeter [cm]). (T-0)

16.5.3.1.2. For lines rated over 50 kV, the minimum clearance between lines and any part of the aerial lift shall be at least 10 feet (305 cm) plus 4 inches (10 cm) for each 10 kV over 50 kV. (T-0) Refer to 29 CFR § 1910.269, *Electric Power Generation, Transmission and Distribution*, for additional information.

16.5.3.2. **Exceptions:** Requirements in paragraph 16.5.3 do not apply if:

16.5.3.2.1. The aerial device is insulated for the work and work is performed by trained communications outside plant workers, line clearance tree-trimming workers or exterior electric linemen.

16.5.3.2.2. 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.

16.5.3.2.3. 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 for additional information.

16.5.3.2.4. 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 3.1.

16.5.3.2.5. An aerial lift or equipment contacts an electrical conductor. In this instance, the vehicle, equipment and attachments shall be considered energized. Personnel standing on the ground shall not contact any part of the lift unless using protective equipment rated for the voltage. **(T-0)** Refer to [Chapter 28](#) for additional information.

16.5.3.3. Aircraft. When operating aerial lifts under, over, by or near aircraft, ensure adequate clearance is maintained to allow for slight movement of both the aircraft and aerial equipment caused by light winds. See [paragraph 16.5.5.8](#).

16.5.4. Proximity Warning Devices. Proximity warning devices may be installed on aerial platforms, but will not release the operator from assuring safe clearance in accordance with [paragraph 16.5.3](#). **(T-0)**

16.5.5. Operations.

16.5.5.1. ANSI A92 standards require aerial device manufacturers provide manuals to dealers and direct sale purchasers. DAF users shall ensure manuals are readily available (stored in weather-resistant compartment provided by manufacturer) to workers. **(T-1)** These manuals shall contain:

16.5.5.1.1. Description, specifications and ratings of the aerial device. **(T-1)**

16.5.5.1.2. Operating instructions for aerial device and its auxiliary systems. **(T-1)**

16.5.5.1.3. Precautions relating to multiple configurations such as performing aerial work from a moving vehicle. **(T-1)**

16.5.5.1.4. Instructions regarding routine maintenance and frequency of recommended maintenance. **(T-1)**

16.5.5.1.5. Replacement part information. **(T-1)**

16.5.5.1.6. Instruction markings per [paragraph 16.5.5.2](#). **(T-1)**

16.5.5.2. Each aerial device shall have a clearly visible plate or plates (located in a readily accessible area) stating:

16.5.5.2.1. Make, model and manufacturer's serial number. **(T-1)**

16.5.5.2.2. Rated capacity. **(T-1)**

16.5.5.2.3. Platform height. **(T-1)**

16.5.5.2.4. Maximum recommended operating pressures of hydraulic and/or pneumatic systems. **(T-1)**

16.5.5.2.5. Hazards inherent in operation of an aerial device. **(T-1)**

16.5.5.2.6. Manufacturer's marking which describes the function of each control. **(T-1)**

16.5.5.2.7. 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.

16.5.5.2.8. Qualification voltage and date of test, if applicable. (T-1)

16.5.5.2.9. Year of manufacture. (T-1)

16.5.5.2.10. Number of platforms. (T-1)

16.5.5.2.11. Category of aerial device. (T-1)

16.5.5.2.12. 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 shall 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.

16.5.5.3. Before a mobile unit is moved for travel, the aerial device shall be secured in the specified lower traveling position (to prevent rotation) by the use of cradles or locking devices in accordance with manufacturer's instructions. (T-0)

16.5.5.4. The unit shall be visually inspected and lift controls tested prior to each shift or day's work to determine the unit and controls are in safe working condition. (T-0) The override feature explained in [paragraph 16.5.5.5](#) shall be tested at this time. (T-0) in accordance with ANSI A92.2, a record of this test shall only be documented if a discrepancy was found with the unit during the inspection. (T-1)

16.5.5.5. Articulating and extendible boom platforms, primarily designed as personnel carriers, shall have both platform (upper) and lower controls. (T-0) Upper controls shall 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 shall precede use of the control itself and shall be maintained simultaneously during use of the controls. (T-0) The unlocking device may be incorporated into each control. Lower controls shall override upper controls. (T-0) Controls shall be plainly marked with their function. (T-0) The override mode shall prevent boom movement with the lower control station unattended. Lower level controls shall not be operated without permission from the employee in the lift, except in an emergency. Whenever a worker is in or on an elevated work platform, at least one person qualified to operate the equipment shall act as a safety observer who will maintain visual or voice contact with the operator from a safe location. (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 allows for such operations.

16.5.5.5.1. Emergency Stop. The platform shall have an emergency stop control which will stop all platform movement. (T-0) This control shall not require continuous operator actuation to stop movement. (T-0)

16.5.5.5.2. Outrigger Controls. Aerial device outrigger controls shall be guarded to protect against inadvertent operation, and shall return to neutral when released by the operator. (T-0) These controls shall be located so the operator can see the outrigger being operated. (T-0)

16.5.5.6. Boom and basket load limits specified by the manufacturer shall not be exceeded. **(T-0)**

16.5.5.7. Aerial lift trucks shall not be moved with the boom elevated and personnel in the basket unless the lift truck is specifically designed for such operation. In all cases, the manufacturer's operating instructions shall be followed. **(T-0)**

16.5.5.8. Vehicle-mounted elevating and rotating work platforms shall not be used during high winds, thunderstorms or any other adverse or mission-limiting weather conditions which could endanger workers using the platform. **(T-0)** Refer to the operator's manual or applicable TO for specified wind limits.

16.5.5.9. Platforms other than buckets or baskets shall include a guardrail system which shall:

16.5.5.9.1. Include a top rail, 42 inches high (plus or minus 3 inches), and at least one rail approximately midway between top rail and platform surface around its upper periphery. **(T-0)** Both rails shall withstand 300 pounds of force applied in any direction without ultimate failure. **(T-0)**

16.5.5.9.2. Include toeboards on all sides of platforms. **(T-0)** Toeboards shall be a minimum of four inches, securely fastened in place and with not 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, electrical wires or equipment below the platform, a Job Hazard Analysis should be performed to determine the best approach to ensure protection from falling objects in accordance with 29 CFR § 1910.28, *Duty to Have Fall Protection and Falling Object Protection*. **(T-0)**

16.5.5.9.3. Include access for personnel entering the platform in the lowered position. **(T-0)** Access steps or rungs shall have a slip-resistant surface. **(T-0)**

16.5.5.10. A full body harness and lanyard (sized to limit free fall distance to six (6) feet or less, or the free fall distance permitted by the system, whichever is less) shall be worn by each bucket or platform occupant. **(T-0)** Each lanyard shall be attached to a designated anchor point on the boom or basket. **(T-0)** Refer to 29 CFR §§ 1910.67 and 1010.140, *Personal Fall Protection Systems—Personal Protective Equipment*, for additional information.

16.5.5.11. Belting off to an adjacent pole, structure or equipment while working from an aerial lift shall not be permitted. **(T-0)**

16.5.5.12. Workers shall stand firmly on the basket floor, not sit or climb on edge of basket or use planks, ladders or other devices for a work position. **(T-0)**

16.5.5.13. Climber's equipment shall not be worn while performing work from an aerial lift. **(T-0)**

16.5.5.14. Aerial devices, including insulated aerial devices, shall not be brought into contact with energized or potentially energized conductors. **(T-0)** Workers shall not rely on dielectric capabilities of aerial devices. **(T-0)**

16.5.5.15. Consult BE prior to work near suspected sources of non-ionizing radiation, e.g., radar and microwave equipment. **(T-1)** Refer to [Chapter 29](#) for additional guidance.

16.5.5.16. Before using an aerial device, the worksite shall be surveyed for hazards, such as un-tamped earth fills, ditches, drop-offs and floor obstructions, debris, overhead obstructions and electrical conductors, weather conditions and presence of unauthorized persons. **(T-0)**

16.5.5.17. Before and during each use, the operator shall:

16.5.5.17.1. Check for overhead obstructions and electrical conductors. **(T-0)**

16.5.5.17.2. Ensure load weight does not exceed manufacturer's rated capacity. **(T-0)**

16.5.5.17.3. Ensure outriggers and stabilizers are used if required by manufacturer's instructions. **(T-1)**

16.5.5.17.4. Ensure guardrails are properly installed, including bolts, pins or other locking devices on removable railings and attachments, and that gates are closed. **(T-0)**

16.5.5.17.5. Use outrigger pads when necessary to provide firm footing. **(T-0)**

16.5.5.17.6. Set brakes. **(T-0)**

16.5.5.17.7. Chock wheels before using the lift on an incline. **(T-0)**

16.6. Manually-Propelled and Self-Propelled Mobile Work Platform and Scaffolds (Towers).

16.6.1. Work platforms with work levels four (4) feet or higher shall have guardrails, midrails and toeboards in accordance with [paragraph 16.5.5.9](#) on all four (4) sides of the work platform. **(T-1)** **Exception:** A toeboard is not required at the access opening.

16.6.2. Working Loads:

16.6.2.1. Work platforms and scaffolds shall carry their designed load under all conditions of use. **(T-0)**. Aircraft maintenance work platforms shall support design loads listed in their TOs. **(T-1)**. Parts, additions or accessories for safe use of platforms and scaffolds shall be part of the design. **(T-1)**.

16.6.2.2. Specific design and construction requirements are not part of this publication due to the wide variety of materials and design possibilities. However, the design used shall produce a mobile ladder stand or scaffold that will safely hold specified loads. **(T-1)** Materials selected shall be strong enough to meet test requirements and protected against corrosion and deterioration. **(T-1)** Work platforms shall be conspicuously marked with the maximum intended load. **(T-1)**

16.6.2.2.1. The design working load of ladder stands shall be calculated based on one or more 250-pound persons with 50 pounds of equipment each. **(T-0)**

16.6.2.2.2. Scaffold design work loads shall be calculated based on:

16.6.2.2.2.1. Light – Designed and constructed for a work load of 25 pounds per square foot. **(T-0)**

16.6.2.2.2.2. Medium – Designed and constructed for a work load of 50 pounds per square foot. **(T-0)**

16.6.2.2.2.3. Heavy – Designed and constructed for a work load of 75 pounds per square foot. **(T-0)** **Note:** Ladder stands and scaffolds shall support at least four (4)

times the design work load. (T-0)

16.6.2.3. Mobile ladder stand and scaffold materials shall meet strength, dimension and weight specifications in this publication to safely support the design work load. (T-0)

16.6.2.4. Bolts or other fasteners used to assemble ladders, scaffolds and towers shall be large enough and in sufficient quantity at each connection to develop designed strength. (T-0)

16.6.2.5. The operator shall ensure there are no sharp edges, burrs or other hazards to personnel on exposed surfaces. (T-0)

16.6.3. Work Levels.

16.6.3.1. Maximum work level height shall not exceed four (4) times the minimum or least base dimension (width) of any mobile ladder stand or scaffold. (T-0) Where the basic mobile unit does not meet this requirement, suitable outrigger frames shall be used to obtain this least base dimension or the unit shall be tied with guy wires or braced to keep the unit from tipping. (T-0)

16.6.3.2. The minimum platform work level width for mobile scaffolds (towers) shall not be less than 20 inches. Ladder stands shall have a minimum step width of 16 inches. (T-0)

16.6.3.3. The supporting structure for the work level shall be rigidly braced, using cross bracing or diagonal bracing with rigid platforms at each work level. (T-0)

16.6.3.4. Ladder stand steps shall have slip-resistant treads or a slip-resistant coating. (T-0)

16.6.3.5. The work level platform of scaffolds shall be wood, aluminum, plywood planking, steel or expanded metal, for the scaffold's full width, except for necessary openings. (T-0) Work platforms shall be secured to the support structure. (T-0) Planking shall be 2-inch (nominal) scaffold grade minimum 1,500 fiber (f) (stress grade) lumber or equivalent. (T-0)

16.6.3.6. Scaffold work platforms four (4) feet or higher shall have guardrails, midrails and toeboards in accordance with [paragraph 16.5.5.9](#). (T-0)

16.6.3.7. Scaffolds shall have a climbing ladder or stairway (for access and egress) affixed or built into the scaffold. (T-0) The ladder or stairway shall be located so it will not tip the scaffold. (T-0) A landing platform shall be provided at intervals not exceeding 30 feet. (T-0)

16.6.3.8. Self-propelled elevating work platforms and manually-propelled mobile work platforms shall not be moved with personnel on the working platform unless allowed by manufacturer's instructions. (T-0) Locking pins or other devices, as required, shall be in place in accordance with 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:

16.6.3.8.1. Guardrails, midrails, and toeboards shall be installed on all exposed sides in accordance with [paragraph 16.5.5.9](#). (T-0)

16.6.3.8.2. The floor or surface, on which the scaffold is being moved, shall 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)**

16.6.3.8.3. The minimum dimension of the scaffolding base when ready for rolling shall be at least one-half of the height. **(T-0)** Outriggers, if used, shall 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.

16.6.3.8.4. All tools and materials are secured or removed from the platform before the mobile scaffold is moved. **(T-0)**

16.6.3.8.5. Employees on the mobile scaffold shall be advised by a spotter and be aware of each movement in advance. **(T-0)**

16.6.3.8.6. 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.

16.6.3.8.7. The force necessary to move the mobile scaffold shall be applied as close to the base as practicable and provision shall be made to stabilize the tower during movement from one location to another. **(T-0)**

16.6.3.9. When a guardrail system, or a porting of a guardrail system, is to be removed from a mobile work platform, and the platform is elevated to four (4) feet or more, personal fall protection must be used and attached to a designated anchorage point. **(T-0)** Self-propelled work platforms manufactured without an approved structural anchor point shall have protective guardrails, midrails (when required) and toeboards installed on all open sides in accordance with [paragraph 16.6.1](#) **(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 shall be provided and used on all removable railings and attachments. **(T-0)**

16.6.3.10. Personal fall arrest equipment anchorages shall be capable of supporting at least 5,000 pounds (22.2 kilonewton [kN]) per worker attached or shall be designed, installed, and used as part of a complete personal fall arrest system which maintains a safety factor of two, under the supervision of a qualified person. **(T-0)** Refer to Chapter [13](#) and [29](#) CFR § 1910.140 for additional guidance.

16.6.3.11. Lanyards, D-rings, snap-hooks and all fall arrest system components shall meet the requirements of 29 CFR § 1910.140. **(T-0)**

16.6.4. Operations.

16.6.4.1. Training requirements in [paragraph 16.3.1](#) also apply to all manually-propelled elevating aerial platforms and self-propelled elevating work platforms. Operators shall also be trained on the location and use of the manufacturer's instructions. **(T-1)**

16.6.4.2. Aerial platforms shall be given a visual inspection and functional test in accordance with manufacturer's instructions before use each day or at the beginning of each shift. **(T-0)**

16.6.4.3. Inspection deficiencies shall be documented in accordance with applicable TO or local procedure for stands not covered by a TO. **(T-0)** A visible indicator, e.g., AF Form 981, *Out of Order Tag*, or other means shall be affixed to stands removed from service until repaired and returned to service. **(T-0)**

16.6.4.4. Refer to [paragraph 16.5.5.16](#) for workplace inspection information.

16.6.4.5. The operator shall ensure the following before each elevation of the platform:

16.6.4.5.1. The aerial platform is operated on a surface within the manufacturer's limits. **(T-0)**

16.6.4.5.2. Outriggers, stabilizers, extendable axles or other stability enhancing means are used as required by the manufacturer. **(T-0)**

16.6.4.5.3. 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)**

16.6.4.5.4. 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)**

16.6.4.5.5. There is adequate clearance from overhead obstructions. **(T-0)**

16.6.4.5.6. Minimum safe approach distances to energized power lines and parts are maintained. **(T-0)**

16.6.4.5.7. All personnel on the platform shall wear required fall protection devices and other safety gear. **(T-0)**

16.6.4.6. Controls for manually elevated platforms shall be clearly marked for direction and function. **(T-0)** Controls for platform elevating and lowering mechanisms shall be self-locking and readily accessible from the ground. **(T-0)** Controls at the platform are optional.

16.6.4.7. Upper controls of power elevated platforms shall be:

16.6.4.7.1. Clearly marked as to direction and function. **(T-0)**

16.6.4.7.2. A type that automatically returns to the off or neutral position when released. **(T-0)**

16.6.4.7.3. Protected against inadvertent operation. **(T-0)**

16.6.4.7.4. Readily accessible to the operator. **(T-0)**

16.6.4.7.5. 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)**

16.6.4.8. Aerial platforms with a powered elevating assembly shall have a clearly marked emergency lowering means readily accessible from ground level. **(T-0)**

16.6.4.9. The aerial platform shall have a readily identifiable emergency stop device at upper control and lower control stations that will stop powered functions and platform movement. **(T-0)**

16.6.4.10. The control system shall be designed so a single control system malfunction will not cause unintended platform movement. **(T-0)**

16.6.5. Wheels and Casters.

16.6.5.1. Wheel and casters shall be sized to support four times the design working load. **(T-0)**

16.6.5.2. Scaffold casters shall have a positive wheel and (or) swivel lock to prevent movement. Two of the four casters on ladder stands shall swivel and be lockable. **(T-0)**

16.6.5.3. Screwjacks or other means for adjusting height shall be provided where leveling of the elevated work platform is required. **(T-0)**

16.6.5.4. At least two (2) brakes, wheel locks or permanently installed jacks shall be operable on all mobile work platforms. **(T-0)**

16.6.6. Mobile Tubular Welded Frame Scaffolds:

16.6.6.1. Scaffolds shall be designed to comply with 29 CFR § 1910.27. **(T-0)** The installation BCE office is the authorizing agency for scaffold erection. **(T-0)**

16.6.6.2. Scaffold vertical members shall be properly braced by cross or diagonal braces. **(T-0)** Braces shall automatically square and align vertical members so the erected scaffold is always plumb, square and rigid. **(T-0)**

16.6.6.3. Spacing of panels or frames shall be consistent with loads imposed. **(T-0)** Frames shall be placed one on top the other with coupling or stacking pins to provide vertical alignment of legs. **(T-0)**

16.6.6.4. Panels shall be locked together vertically by pins or equivalent if uplift can occur. **(T-0)**

16.6.7. Mobile Tubular Welded Sectional Folding Scaffolds.

16.6.7.1. General. Scaffolds, including sectional stairway and sectional ladder scaffolds, shall be designed and erected in accordance with paragraphs [16.5.1](#), [16.5.2](#), [16.5.4](#) and **(T-0)**

16.6.7.2. Stairway. Each section of folding stairway scaffold shall include a stairway, detachable work platform and a set of pivoting and hinged folding diagonal and horizontal braces. **(T-0)**

16.6.7.3. Sectional Folding Stairway Scaffolds. These are medium duty scaffolds (light duty when equipped with a “high clearance” base section). **Note:** High clearance bases have a greater open space so the scaffold may be placed over obstructions like machinery or shrubbery. When high clearance bases are used to support sectional folding stairway scaffolds, the entire scaffold’s load capacity shall be reduced. **(T-0)** Sectional folding stairway scaffolds shall not exceed 4 ½ feet in width and 6 feet in length. **(T-0)**

16.6.7.4. Sectional Folding Ladder Scaffolds. Sectional folding ladder scaffolds are light duty scaffolds (includes special base [open end] sections designed for high clearance over obstructions). For special applications, 6-foot folding ladder scaffolds, except high clearance base sections, shall be designed as medium duty scaffolds. **(T-0)** A sectional folding ladder scaffold shall not exceed 6 feet 6 inches in width for a 6-foot long unit, 8 feet 6 inches for an 8-foot unit, or 10 feet 6 inches for a 10-foot long unit. **(T-0)** End frames

of sectional ladder and stairway scaffolds shall be designed so horizontal bearers provide support for multiple planking levels. (T-0)

16.6.8. Mobile Tube and Coupler Scaffolds:

16.6.8.1. Design. Units shall be designed in accordance with 29 CFR § 1910.27. (T-0)

16.6.8.2. Material. Couplers shall 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.

16.6.9. Mobile Work Platforms.

16.6.9.1. Design. Units shall be designed in accordance with paragraphs 16.5.1, 16.5.2 and 16.5.4. (T-0)

16.6.9.2. Base Width. The minimum base width shall conform to paragraph 16.6.3.2. (T-0)

16.6.9.3. Bracing. Rigid diagonal bracing to vertical members shall be provided. (T-0)

16.6.10. Mobile Ladder Stands:

16.6.10.1. Design. Units shall comply with applicable requirements of paragraphs 16.5.1, 16.5.2 and 16.5.4. (T-0)

16.6.10.2. Base Width. Minimum base width shall be in accordance with paragraph 16.6.3.2 (T-0) Maximum base section length shall be the total length of combined steps and top assembly, measured horizontally, plus 5/8 inch per step of rise. (T-0)

16.6.10.3. Steps. Steps shall be designed and installed in accordance with 29 CFR § 1910.23, *Ladders*. (T-0)

16.6.10.4. Handrails. Units with at least 3 treads and 4 risers, or rising more than 30 inches, shall be equipped with a stair rail and handrails in accordance with 29 CFR § 1910.28 and 29 CFR § 1926.1052, *Stairways*. (T-0) Handrails shall be at least 29 inches high and the same height all along the step, measured vertically from the center of the step. (T-0)

16.6.10.5. Load design shall meet requirements of paragraph 16.6.2.2.1. (T-0)

16.6.11. Mobile Work Platforms and Ladder Stands shall:

16.6.11.1. Meet criteria in paragraphs 16.6.9 and 16.6.10 (T-0) If these mobile work platforms have steps, they shall meet mobile ladder stand criteria for step dimensions and handrails. (T-0)

16.6.11.2. 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 shall be in good repair. (T-0) Repair worn surfaces with suitable materials or make safe using abrasive or non-slip materials. (T-0)

16.6.11.3. Have guardrails on all open sides of aircraft maintenance platforms. (T-0) Removable guardrails removed for material handling, shall be replaced as soon as material handling is complete. (T-1) Protective guardrails are not required at the platform entrance if there is a ramp or stairway (angle less than 60 degrees) in accordance with paragraph 16.6.1 Protective guardrails shall only be removed from the side(s) of the platform positioned as close as practical (less than 14 inches) and parallel to aircraft, building or other working surface. (T-0) Guardrails shall be installed on all open sides if platform

levels are four (4) feet or higher above ground or floor. **(T-0)** Bolts, pins or other locking devices shall be provided and used on all removable railings and attachments. **(T-0)** Only guardrails and toeboards meeting criteria in [paragraph 7.1.4.1](#) shall be used. **(T-0)**

16.6.11.4. Ensure prior to any user ascending a raised mobile platform: all locking devices (e.g., pins, collars) shall be installed, hydraulic pressure shall be released, the platform shall be slowly lowered until locking devices are securely engaged and hydraulic pressure valve(s) shall be closed. **(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 shall be met prior to starting any task or work. **(T-0)**

16.6.11.4.1. Ascending/descending work platform. The aerial platform shall include means for personnel to use in entering onto or exiting from the platform when in the lowered position. **(T-0)** When the distance between the access level and the floor of the platform in its access position exceeds inches (0.5 meters), the aerial platform shall be equipped with an access ladder. **(T-0)** The access system shall permit and, by proper placement of components, promote achievements of three-point contact while ascending or descending the access system. **(T-0)** The steps or rungs shall be divided equally over the distance between the first step or rung and the floor of the platform and shall not be more than 12 inches (0.30 meters) apart the height of the first step above the ground shall be a maximum of 20 inches (0.5 meters). **(T-0)** Each step or rung shall be at least 12.5 inches (0.32 meters) wide, at least 1.0 inches (25 millimeters) deep, and shall be slip resistant. **(T-0)** The front steps or rungs shall be at least 6 inches (0.15 meters) horizontally away from the supporting structure or any other component of the aerial platform. **(T-0)** The access ladder shall be symmetrical with the access opening. **(T-0)** Personnel ascending/descending ladders shall face the ladder and maintain a firm hold on the ladder. **(T-0)** Personnel ascending/descending stairs (between 50 and 70 degrees) shall face the direction of travel and use hand rails. **(T-0)**

16.6.11.4.2. Refer to [Chapter 7](#) for additional guidance on ladder safety.

16.6.11.5. 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 shall be secured to prevent collision with aircraft, vehicles or other equipment. **(T-1)** Designated flightline storage areas for mobile work platforms shall be determined by AGE flight commander and airfield manager and approved by the Maintenance Group Commander. **(T-1)** Refer to [Chapter 24](#) for further guidance.

16.6.11.6. Mobile work platforms shall be operationally inspected per the equipment TO or manufacturer's instructions and TO 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures*. **(T-0)** Maintenance work stands shall 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 and casters are locked, if so equipped. **(T-1)** Wheel will be locked either 90 or 180 degrees 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 in accordance with TO 00-25- 172, *Ground Servicing of Aircraft and Static Grounding/Bonding*. Platforms shall be locked when not in use to avoid rolling down slanted surfaces or being moved by wind. **(T-1)** Stands with defects shall be tagged as unserviceable. **(T-0) Note:** Some maintenance work stands may only have two operational brakes and no permanently installed jacks. Both brakes are required to be set. **Note:** A daily inspection is not required for days the stand is not used.

16.6.11.7. When mobile work platforms are being moved:

16.6.11.7.1. 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 16.6.3.8](#) and subparagraphs are followed.

16.6.11.7.2. Platforms to be towed shall be equipped with hitches designed for such purpose. **(T-0)**

16.6.11.7.3. The following rules apply when platforms are towed by vehicles:

16.6.11.7.3.1. Maximum towing speed for one 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 shall be reduced accordingly. **(T-1)**

16.6.11.7.3.2. No more than four type B1, B4, B5 and similar small stands may be towed as follows: two sets of two in tandem on a double hitch or two in tandem on a single hitch. Type B3, J7 and similar large stands shall be towed singly on a center mounted hitch. **(T-1)** Four-wheeled units shall not be towed behind two-wheeled units. **(T-1)** Large pieces of AGE, when towed in tandem, shall not block the driver's vision of last item being towed. **(T-1)**

16.6.11.7.3.3. Safety pins shall be used to secure pintle hooks and trailer hitches. **(T-1)**

16.6.11.8. Mobile work platforms used where static electricity is hazardous to the work operation, such as fuel cell repair or refueling vehicle maintenance, shall be grounded and equipped with static discharge plates for personnel to dissipate accumulated static electricity. **(T-0)**

16.6.11.9. Maintain mobile work platforms and ladder stands in accordance with appropriate 35-series TOs. **(T-1)**

16.7. Scaffolding. This section applies to all scaffolding used in the DAF, except rolling scaffolds (mobile towers), which are covered in [paragraph 16.6](#) 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 16.6](#) 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.

16.7.1. General Requirements.

16.7.1.1. Scaffolds shall be provided when work cannot be done safely from the ground or from solid construction and shall be erected, moved, dismantled or altered only under the supervision and direction of a competent person trained in these activities. **(T-0)** Such

work shall 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)**

16.7.1.2. The footing or anchorage for scaffolds shall be designed to support the maximum intended load without settling or displacement. **(T-0)** Unstable objects such as barrels, boxes, loose brick or concrete blocks shall not be used to support scaffolds or planks. **(T-0)**

16.7.2. Guarding requirements. All guarding for scaffolding shall meet the requirements specified in 29 CFR § 1910.27. **(T-0)**

16.7.3. Scaffolds and their components shall be capable of supporting at least four times the maximum intended load. **(T-0)**

16.7.4. Scaffolds shall not be altered or moved horizontally while in use or occupied. **(T-0)**

16.7.5. Scaffolds, their accessories and other devices prescribed in this chapter shall be maintained in good condition. **(T-0)** Scaffold parts shall be inspected by a competent person prior to use. **(T-0)** If any deficiencies are found, the scaffold shall not be used until repaired or replaced. **(T-0)**

16.7.6. A ladder or equivalent safe access shall be provided. **(T-0)**

16.7.7. Where swinging loads are being hoisted onto or near a scaffold, they shall have a tag line or equivalent measures to control the loads and prevent contact with the scaffold. **(T-0)**

16.7.8. Workers shall wear hard hats during erection, while working on maintenance and teardown of scaffolding. **(T-0)** Protective gloves are also recommended.

16.7.9. Clearance Between Scaffolds and Power Lines. Scaffolds shall not be erected, used, dismantled, altered or moved such that they or any conductive material handled on them might come close to exposed and energized power lines. **(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 work beginning on the erecting of scaffolding. **(T-0)**

16.7.10. Adverse weather conditions such as ice, snow, rain and wind can create a hazardous working surface. A plan shall be established addressing adverse weather conditions and measures to be taken to protect workers performing work under adverse weather conditions. **(T-1)** The following rules shall apply to work under adverse weather.

16.7.10.1. Personnel shall not work on scaffolds covered with ice or snow. **(T-0)** If the work surface remains slippery after ice or snow removal, it shall be sanded or otherwise treated to prevent workers from slipping. **(T-0)**

16.7.10.2. Personnel shall 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 workers. **(T-1)**

16.7.11. Tools, materials and debris shall not be allowed to accumulate in quantities that could cause a hazard. **(T-0)** When possible, containers shall be provided on scaffolds for storage of loose materials. **(T-0)** Supervisors shall ensure good housekeeping practices are followed to prevent tripping hazards. **(T-1)**

16.7.12. 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 shall be consulted for assistance in determining the proper type rope to use. **(T-0)**

16.7.13. Wire or fiber rope used for scaffold suspension shall support at least six (6) times the intended load. **(T-0)**

16.7.14. The use of shore scaffolds or lean-to scaffolds is prohibited.

16.7.15. Lumber sizes, when used in this publication, refer to nominal sizes except where otherwise stated.

16.7.16. Scaffolds shall be secured to permanent structures by anchor bolts, reveal bolts or other equivalent means. **(T-0)** Window cleaners' anchor bolts shall not be used. **(T-0)**

16.7.17. Special care shall be taken to protect scaffold members, including wire or fiber ropes, when using heat-producing processes. **(T-0)**

16.7.18. A covered storage area is recommended to protect scaffolding from damage and deterioration.

16.7.19. Wooden parts of scaffolding shall not be painted as paint can hide defects. **(T-0)** Clear varnish, lacquer, shellac or linseed oil shall be used when wood protection is needed. **(T-0)**

16.7.20. Individual workers shall not attempt to manually lift or move scaffold members which are excessively heavy, or because of their shape or size, cannot be safely handled. **(T-0)** In these cases, assistance shall be obtained from other workers or mechanical handling equipment shall be used. **(T-1)**

16.7.21. Hand tools used to assemble scaffolding shall be in good condition. **(T-0)** When powered hand tools are used, they shall be electrically grounded or of double insulated construction. **(T-0)**

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 and fire prevention signs and tags, and for 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, <i>Safety Color Code for Marking Physical Hazards</i>
Preventions signs and tags	29 CFR § 1910.145, <i>Specifications for Accident Prevention Signs and Tags</i>
Bulk petroleum products systems	MIL-STD-161H, <i>DoD Standard Practice: Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels</i>
Color code for pipelines, piping systems and compressed gas cylinders	MIL-STD-101C, <i>DoD Standard Practice: Color Code for Pipelines and for Compressed Gas Cylinders</i> ASME A13.1, <i>Scheme for the Identification of Piping Systems</i>
Signs design	UFC 3-120-01, <i>Design: Sign Standards</i>
Exit signs	NFPA 101, <i>Life Safety Code</i> UFC 3-600-01, <i>Fire Protection Engineering for Facilities</i>
Fire hazards signs	NFPA 704, <i>Standard System for the Identification of the Hazards of Materials for Emergency Response</i>
Electrical equipment labeling	UFC 3-560-01, <i>Operation and Maintenance: Electrical Safety</i>
Signs and symbols for explosive materials	DESR 6055.09_AFMAN 91-201, <i>Explosives Safety Standards</i>
Laser hazard warning signs	AFI 48-139, <i>Laser and Optical Radiation Protection Program</i>
Radio frequency radiation warning signs	AFI 48-109, <i>Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program</i>
Ionizing radiation warning signs	AFMAN 40-201, <i>Radioactive Materials (RAM) Management</i> AFMAN 48-148, <i>Ionizing Radiation Protection</i> 10 CFR § 20, <i>Standards for Protection Against Radiation</i>

Specific Area	Regulatory Guidance
Toxic and hazardous substances warning signs	29 CFR § 1910, Subpart Z – <i>Toxic and Hazardous Substances</i>
General environmental controls signs	29 CFR § 1910.145, <i>Specifications for Accident Prevention Signs and Tags</i>
Hazardous noise	29 CFR § 1910.95, <i>Occupational Noise Exposure</i>

17.2. Hazards and General Information.

17.2.1. Work Hazards. Preventive signs, tags, color coding, labeling or markings shall be used wherever a hazard is present in the workplace. **(T-0)** The following are examples of workplace hazards:

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 workers 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 shall be concise, accurate, easily read, contain sufficient information to be easily understood. **(T-0)**

17.2.2.3. Interior and other installation specific signs shall be designed in accordance with UFC 3-120-01, where applicable. **(T-1)** Where OSHA has specific requirements, they shall 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 shall ensure an adequate supply of safety signs and tags is available to workers. **(T-1)**

17.2.4. Other signs or tags prescribed by DAF directives for site-specific hazards shall 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. Workers shall immediately advise supervisors of unsafe conditions. **(T-0)**

17.2.5.2. Supervisors shall 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 Risk Assessment Codes with the installation Occupational Safety office, F&ES Flight and/or BE, as appropriate. **(T-1)**

17.2.5.2.2. The supervisor, or person in charge at the time, is responsible for issuing tags. If unavailable, the worker shall contact the installation Occupational Safety office, F&ES Flight or BE, as appropriate. **(T-1)**

17.3. Training.

17.3.1. All exposed affected employees shall be instructed in the classification and use of safety, health and fire prevention signs and tags, to include, when applicable, piping systems safety color coding, labeling and markings in accordance with 29 CFR § 1910.144 and 1910.145. **(T-0)** Supervisors shall ensure training is accomplished and that employees are knowledgeable of the requirements. **(T-0)**.

17.3.2. Retraining. Employees shall be retrained when changes in their job assignment occurs, such as a change in machinery, equipment or processes that present a new hazard, when changes in the workplace may result in a hazardous condition or 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 shall be uniform, properly worded and located, with a meaning immediately and clearly understood as an automatic warning, caution or notice to all personnel no matter where they work in accordance with 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 shall not be placed on moveable objects or adjacent to moveable objects like wheeled equipment, removable partitions, on doors, etc., which, if moved, will obscure the sign.

17.4.1.3. Signs shall have adequate illumination. If illumination is inadequate under emergency conditions, signs shall be equipped with emergency (battery operated) illumination, be luminescent or both. Consult the local CE facility design section for lighting guidance for specific locations.

17.4.1.4. Multi-lingual Signs. Whenever possible, use international signs and ensure all workers understand warnings. If additional languages are needed on safety signs, it is strongly encouraged to use symbols, in addition to words, to better communicate hazard information across language barriers.

17.4.1.5. Criteria for Color Coding. Safety color coding for warning signs and markers helps alert persons to the presence of hazards. Color schemes for tags should follow standard color schemes of signs. Color specifications in this publication are in accordance with 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 shall be follow and used in accordance with 29 CFR § 1910.145. **(T-0)**

17.4.2.2. AF Form 1118, *Notice of Hazard*, is considered a sign. AF Forms 1118 are issued only by Occupational Safety office, F&ES Flight and BE to permanently identify a hazardous condition that could result in serious injury, disability or death. **Note:** AF Form 979, *Danger Tag*, equivalent DoD or commercial Danger Tags may be used temporarily until an AF 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 AFI 91-202 for instructions on Risk Assessment Codes and preparing the AF 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*, and used by Continental United States (CONUS) installations F&ES Flights. The installation F&ES Flight can provide additional information on fire hazards of materials.

17.4.2.4. Signs and Symbols Used to Identify Explosive Materials. The AF and North Atlantic Treaty Organization (NATO) identifies items and substances assigned to United Nations dangerous goods Class I (explosives, munitions, propellants and pyrotechnics) according to the hazard they present in accordance with DESR 6055.09_AFMAN 91-201.

17.4.2.5. Electrical equipment labeling and placarding shall comply with UFC 3-560-01. **(T-0)**

17.4.2.6. Exit signs shall clearly identify the means of egress from facilities when required in accordance with 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 shall be designed in accordance with UFC 3-120-01. **(T-0)**

17.4.2.8. Instruction and identification signs, designed in accordance with UFC 3-120-01 shall be used to convey general instructions or identify PPE or systems. **(T-0)**

17.4.2.9. Laser hazard warning signs and labels shall conform to and be used in accordance with 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 shall be followed and used in accordance with AFI 48-109. **(T-1)**

17.4.2.11. Biological hazard signs shall conform to and be used in accordance with 29 CFR § 1910.145. **(T-0)**

17.4.2.12. Ionizing radiation warning signs, placards and forms shall conform to and be used in accordance with AFMAN 48-148 and AFMAN 40-201, *Radioactive Materials (RAM) Management*. **(T-1)** Ionizing radiation warning signs, placards and forms shall also meet the requirements of 29 CFR § 1926.53, *Ionizing Radiation*. **(T-0)** Electrical equipment labeling and placarding shall comply with UFC 3-560-01. **(T-1)**

17.4.2.13. Toxic and hazardous substances warning signs shall conform and be used in accordance with 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 workers of hazardous conditions, defective equipment, etc., including hazards that are out of the ordinary, unexpected or not readily apparent. Tags are not a complete warning method and shall only be used until a positive means can be used to eliminate the hazard. **(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 tags prescribed by this publication. Requirements unique to a particular tag appear in the tag’s instructions. All mishap prevention tags used to warn of specific hazards shall be standardized DAF forms with no variation in design of tags. **(T-1)**

17.5.1.1. Risk Assessment Codes (RAC) shall be assigned by installation Occupational Safety office, F&ES Flight or BE, as appropriate. **(T-1)** A RAC shall 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 in accordance with applicable TOs, AFIs 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, when maintained, shall 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 shall implement internal procedures to ensure coordination of tags between supervisors and installation Occupational Safety office, F&ES Flight and BE. **(T-1)**

17.5.1.5. Removal of Danger and Caution Tags. The supervisor, with coordination from the installation Occupational Safety office, F&ES Flight or BE, as appropriate, is responsible for removing the tag after the hazardous condition has been corrected. Maintenance logs, if maintained, shall be annotated that the hazardous condition has been corrected and tag removed. **(T-1)** The installation Occupational Safety office shall be notified during normal duty hours that the tag has been removed. **(T-1)** Notification shall not be later than the following duty day. **(T-1) Note:** Removal of danger tags prescribed by TOs or AFIs for routine aircraft or missile/munitions maintenance actions need not be coordinated with the installation Occupational Safety office, F&ES Flight or 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) shall meet requirements of AFI 91-202 and 29 CFR § 1910.145. **(T-0)** Tag text shall 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, *Out of Order Tag*, AF Form 982, *Do Not Start Tag*, equivalent DoD or commercial tag. **Note:** Risk Assessment Codes assigned by the installation Occupational Safety office, F&ES Flight or BE shall 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, shall only be used where an immediate hazard (RAC 1 through 3) exists and specific precautions are required to protect personnel or property or when required by TOs or other manuals. (T-1) A Danger tag shall be placed on damaged equipment and immediate arrangements made to take the equipment out of service until repaired. Tag wording shall read, “DO NOT USE THIS EQUIPMENT” or “DEFECTIVE EQUIPMENT, DO NOT USE.” (T-1)

17.5.2.2. Warning tags, including equivalent DoD and commercial warning tags, shall 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 unit supervisor or installation Occupational Safety office, F&ES Flight or 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, shall only be used where a hazard can damage equipment, or a potential hazard or unsafe practice presents a lesser threat of worker injury. (T-1)

17.5.2.4. AF Form 981, *Out of Order Tag*. Out of Order tags, including equivalent DoD and commercial tags, shall only be used to indicate a piece of equipment, machinery, utility or system is out of order and its use might be hazardous. (T-1) If repairable, a TO-prescribed green tag may be used in place of the Out of Order tag. Applicable equipment records, when available, shall annotated in addition to completing the Out of Order tag. The energy source shall be locked 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, shall only be used to alert personnel of hazards associated with restarting the equipment and only for a very short time until the energy isolating device can be locked out. (T-1) Do Not Start tag shall be placed in conspicuous locations or in a manner that they effectively block the starting mechanism should the equipment 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 installation Occupational Safety office, F&ES Flight or BE, as appropriate.

17.5.2.6. Biohazard tags, including equivalent DoD and commercial tags, shall identify the actual or potential presence of a biological hazard and to identify equipment, containers, rooms, experimental animals or combinations thereof that contain or are contaminated with hazardous biological agents. (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 shall be clearly distinguishable from an issued/assigned authorized lockout device. **Note:** If red band locks are used for LOTO, they shall not be used as an administrative device. The danger or equipment lockout tag shall 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 shall 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 shall 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) shall 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 shall 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 worker, the work center/shop supervisor or appointed employee shall remove the administrative device and the authorized worker shall place the authorized lockout/tagout device on the machinery/equipment in accordance with [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 shall not be substituted for elimination of hazards by safety engineering, but shall be used to supplement other established mishap prevention practices. **(T-0)**

17.7.2. A uniform system for identification of piping contents shall 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-161H, *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 shall be attached above or hung below cryogen piping by metal bands.
(T-0)

Chapter 18

HYDROCARBON 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 a 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 and Lubricants*, 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 shall be established in accordance with the installation Environmental Management office 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 shall meet the requirements of AFMAN 24-306 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 shall not be worn as outer garments when working with or around low flash point fuels. **(T-0)**

18.2.3.2.1. Flak vests shall 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 worker wearing a flak vest will always ground or bond him- or herself 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 worker will ground or bond him or herself frequently during all work phases. **(T-1)** **Note:** Commanders may authorize wear of body armor/flak vests and Gortex-type clothing in combat areas. **(T-2)** Outer garments shall not be removed or put on in the work area. **(T-0)** Matches or lighters shall 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. Workers should wait at least 30 seconds after flow stops so the static charge can dissipate.

18.2.4.2. Loading Racks and Fillstands. 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*, shall 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.

18.2.5. 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 confined spaces such as petroleum storage tanks.

18.2.7. Asphyxiation and Confined Space. Hydrocarbon fuel vapors will displace oxygen in enclosed spaces and pits and may cause death due to asphyxiation. Refer to **Chapter 23** for additional guidance.

18.2.8. Servicing aircraft with the wrong fuel or utilizing untrained fuel servicing personnel can be catastrophic. Fueling personnel shall ensure aircraft receive the proper fuel. **(T-0)**

18.2.8.1. All transient alert and maintenance control personnel shall state both the type of aircraft and the fuel desired when requesting support from the fuels service center. **(T-1)**

18.2.8.2. Refueling drivers shall verify, prior to commencing any refueling operation, that the type of aircraft to be serviced is the same type aircraft specified on the refueling dispatch log. **(T-1)**

18.2.8.3. Refueling personnel and the maintenance crew chief shall ensure the fuel in the servicing unit, as indicated on the unit, is the correct type of fuel required for the aircraft to be fueled, as indicated by the TO, aircraft decals or other positive means. **(T-1)** Similar precautions are required when refueling units are refilled from bulk sources.

18.2.9. First Aid. Personnel shall 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.

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 shall be trained in accordance with 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 particular 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 normally require a minimum of two persons who are knowledgeable of fuel safety and operational procedures. Refer to AFI 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 installation 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 the installation Environmental Management office 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 the Environmental Management office for appropriate markings and management.

18.5.5. Fuel spills can cause fires and create slipping hazards. **(T-0)** Spills shall 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 work day, unless instructed by TO, manufacturer's instructions or when allowed by the installation 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 (5) 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 the installation Environmental Management office for appropriate markings and management.

18.5.12. Never pour acids 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) shall be positioned in accordance with 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 shall continually monitor the equipment for sparks and other ignition sources, unusual noises and other indications of possible malfunctions. **(T-0)** Servicing shall be stopped immediately if the operator determines it is unsafe. **(T-0)** When using hydrant systems, all operating personnel shall 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 installation F&ES Flight.

18.6.5. Refer to TO 00-25-172 for fire guard designation during refueling and defueling operations.

18.6.6. A safety flask (liquid trap) is required between the vacuum pump and the filtration apparatus to prevent fires in laboratory fuel filtration equipment. This prevents fires caused by flammable liquid from being drawn into the vacuum pump. **(T-0)**

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 as determined by BE, in conjunction with the installation occupational safety Office. **(T-0)** Signs shall 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 installation Fuels Management Office shall develop emergency procedures and coordinate them with the installation F&ES Flight and Occupational Safety office. **(T-1)** These

procedures include, but are not limited to, evacuation, equipment shutdown and notification of the installation F&ES Flight. Emphasize techniques to extinguish clothing fires. (T-1)

18.7. Inspection.

18.7.1. Fuels Laboratory. Supervisors shall inspect their facilities and operations to identify and control or eliminate hazards before they cause a mishap. (T-0) Personnel shall be instructed to notify their supervisors of potential hazards. (T-0) Hazards shall be categorized according to potential severity and probability of occurrence in accordance with AFI 91-202. (T-1) Immediate action shall 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 shall be accomplished by the installation F&ES Flight, BE and Occupational Safety office. (T-1) BE shall conduct an occupational and environmental health risk assessment whenever there is reason to believe an exposure may be hazardous, as necessary. (T-1) Functional managers shall maintain copies of these inspection reports for a minimum of three (3) 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 AFI 91-202. (T-1) Items requiring special attention during daily, weekly or monthly internal inspections include: (T-1)

18.7.3.1. Inspect all electrical connections of equipment for loose or defective connections and frayed insulation. (T-1)

18.7.3.2. Visually inspect all ground wires for frays or loose connections. Check electrical continuity monthly with a resistance (ohm) meter. Inspections shall be documented on MAJCOM/FLDCOM or locally devised automated systems. (T-1)

18.7.3.3. Inspect electrical grounding of the fuels laboratory building monthly and electrical resistance annually. (T-1) Electrode resistance to ground shall 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 shall 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 shall be maintained per UFC 3-460-03, *Petroleum Fuels Systems Maintenance*.

18.8.1.2. Access. Where necessary, pit covers shall be altered or replaced to provide free and unobstructed access. (T-0) Fuels Management shall determine which pits are essential to the operation and control of the system. (T-2) Nonessential pits, or pits that can be made nonessential, shall be filled with sand to eliminate vapor hazards. (T-1) Essential pits shall be kept clean, dry and vapor-free. (T-0) Pit covers shall 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 shall be provided in accordance with American Conference of Government Industrial Hygienists and be consistent with BE's occupational and environmental health risk assessment. **(T-0)**

18.8.2.2. Entry into confined spaces will be in accordance with **Chapter 23**. Contact BE for specific ventilation requirements. **(T-1)**

18.8.3. Drainage. Gravity drains or pumps shall 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 the installation Environmental Management office. **(T-1)** Contact BE for an occupational and environmental health risk assessment.

18.8.4. Piping System Identification. Piping systems shall be color coded to aid in identifying the contents of piping in fuel storage areas. **(T-0)** Yellow shall be used as a primary warning for all flammable gases and liquids, and black and white shall be used for identification of contents. Refer to MIL-STD-161, *Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels*, and **Chapter 17** for additional guidance. **(T-1)**

18.8.5. Petroleum Storage Tank Entry. UFC 3-460-03 covers this subject in detail and shall be used as definitive guidance on all tank entry tasks. **(T-0)** Refer to **Chapter 23** for additional 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 shall be constructed and maintained in accordance with 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 drain pipe. **(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 in accordance with TO 00-25-172. **(T-0)** When a hose cart or hydrant servicing vehicle is used as a fillstand, the hose cart or hydrant servicing vehicle operator shall bond the hose cart or hydrant servicing vehicle to the hydrant outlet piping. **(T-0)** The refueling unit operator shall 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 fillstand using the grounding/bonding reel installed on the vehicle. **(T-0)**

18.9.8. Push the stop switch on the fillstand to ensure the transfer pump is not operating when the system does not have a deadman control installed. This ensures the loading arm or hose is not pressurized prior to connecting to the vehicle and will avoid a possible fuel spill. The operator shall 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. 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 shall 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 shall 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 shall be treated as above-ground fuels facilities and safeguarded accordingly. **(T-0)**

18.9.10.2. Fuel servicing equipment parking areas shall 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 in accordance with 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 in accordance with 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 shall 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 shall 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 shall be supervised. **(T-1)** Hydrant system pump houses shall be manned in accordance with TO 37-1-1. **(T-1)** The Fuel Servicing Equipment operator shall hold the remote control switch, magnet lanyard or deadman control throughout the refueling operation. **(T-1)** Before fuel delivery begins, aircraft fuel tank caps shall 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 shall help the hosecart/hydrant servicing vehicle operator stow the hoses. **(T-1)**

18.10.4.2. The operator shall 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 shall 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/cell is full or to the level dictated by the mission. **(T-0)**

18.10.6. Fueling From Drums. Refuel from drums in accordance with TO 00-25-172.

Note: Fueling from drums shall 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 shall 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 shall be in accordance with 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 re-entering. **(T-0)**

18.10.8.2. Support equipment and vehicles shall be serviced outdoors, with engines turned off and with parking brakes engaged. **(T-0)**

18.10.8.3. During refueling, operators shall ensure the nozzle of the fuel hose is in constant contact with the filler pipe of the support equipment, tank and/or vehicle fuel tank, to provide an electrical bond. **(T-0)**

18.10.8.4. Nozzles used at attended/unattended motor vehicle service stations and fleet fueling sites shall be listed in accordance with 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/unattended marine motor fuel dispensing facilities/sites shall be listed in accordance with 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 shall only be a manually operated nozzle. **(T-0)**

18.10.8.5. Nozzles used on mobile support refueling equipment shall be automatic-closing type hose nozzles without a latch open device. **(T-0)**

18.10.8.6. Emergency instructions shall also be conspicuously posted in the dispenser area. **(T-0)** The emergency instructions shall 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 (installation FES number) 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 shall 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 shall be listed or approved for the specific purpose. All compressed natural gas, liquefied natural gas and liquefied petroleum gas motor vehicle fuel dispensing shall be in an outdoor location. **(T-0)**

18.11. Fuel Laboratory Operations.

18.11.1. Design Requirements. Fuel laboratories shall be designed in accordance with 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. The installation BCE, F&ES Flight, Occupational Safety office and BE shall make an initial inspection to certify the acceptability of the fuels laboratory. **(T-0)**

18.11.2. Sampling and Analysis Safety. The installation Fuels Management Office shall 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 shall 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 shall 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 Environmental Management office 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 installation 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 shall 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 shall grasp a warm metal object such as a coin and touch it to the guardrail and ensure the coin contacts the guardrail’s metal surface. **(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-rong (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 shall 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 in accordance with **Chapter 9**. **(T-0)**

18.11.3.9. Ensure all facility and equipment electrical repairs meet NFPA 70, *National Electric Code*, requirements. **(T-0)**

18.11.3.10. Electrical receptacles in fuels laboratories shall be at least four (4) 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 Safety Data Sheet. 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 CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders*. Employees shall 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 shall 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 shall 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 in accordance with CGA C-13, *Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders*. **(T-0)** Requalification of cylinders, including DOT-8 cylinders will be in accordance with 49 CFR § 180.209, *Requirements for Requalification of Specification Cylinders*. **(T-0)**

19.2.1.2. Cylinders shall be hydrostatically tested in accordance with 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 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 in accordance with 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*, shall 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 (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 shall be used to move cylinders weighing more than 50 pounds. **(T-1)** The cylinder shall 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. Keep all cylinders in a vertical position at all times, 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 shall 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 shall 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 shall 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 shall 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 located in the lab or work area. **(T-0)** Spare or empty cylinders shall 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 shall be secured by a metal chain, straps, braces or other restraining devices to a solid fixture (wall, stanchion, etc.) to prevent cylinders from falling over. **(T-0)** Synthetic straps shall not be used to secure cylinders of flammable gases or oxygen. **(T-0)** While in storage, cylinder valve protection caps shall be firmly in place. **(T-0)**

19.3.1.1. Doors or gates for gas cylinder supply areas shall be locked. **(T-0)**

19.3.1.2. Enclosures for gas supply systems shall not be used for storage purposes other than for cylinders. **(T-0)**

19.3.1.3. Cylinders attached to a manifold shall also be secured to solid fixtures to prevent the cylinder from falling over. **(T-0)**

19.3.1.4. The enclosure shall be posted as a “No Smoking Area.” **(T-0)**

19.3.2. Do not store cylinders in locations where temperatures may exceed 125 °F (51.7° C) or near other sources of heat to prevent excessive pressures in the cylinders. **(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 shall not be used to secure cylinders of flammable gases or oxygen. **(T-0)**

19.3.2.4. Cylinders stored in the open shall 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 shall not be kept in unventilated enclosures. **(T-0)**

19.3.3. Cryogenic cylinders shall be fitted with stainless steel or other suitable plumbing only. **(T-0)**

19.3.4. Stored cylinders (either inside or outside) shall not obstruct exit routes or other traffic areas. **(T-0)**

19.3.5. All stored cylinders shall have their valves closed. **(T-0)** Valve protection caps shall always be in place and hand tight except when cylinders are in use or connected for use. **(T-0)**

19.3.6. Oxygen cylinders shall 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 shall be removed and the cylinders properly stored. **(T-0)**

19.3.7. Storage facilities shall 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 shall be grouped by type of gas and the groups arranged to take into account the gases contained. **(T-0)** Cylinders shall be prominently labeled in accordance with DOT regulations. **(T-0)**

19.4. Disposal and Shipping.

19.4.1. Disposal of Compressed Gas Cylinders. Disposal of compressed gas cylinders shall be accomplished in accordance with 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 shall be returned to the owner. **(T-0)** If the owner cannot be determined, cylinders shall be processed in accordance with DoDM 4160.21, Volume 1. **(T-0)**

19.4.1.2. Cylinders rejected for failure to pass hydrostatic testing or any other reason shall 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 shall be inspected for dents, bulges, oxidation pits or other damage. **(T-0)** Faulty cylinders shall be handled as required by the latest DOT regulations. **(T-0)** Cylinders shall be shipped by military airlift in accordance with 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, *Fire Prevention During Welding, Cutting and Other Hot Work*.

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. Workers 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 BE for an occupational and environmental health risk assessment 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 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. In close proximity of explosive hydrogen gas, which is formed when sulfuric acid comes in contact with 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 BE for an occupational and environmental health risk assessment.

20.2.8. Cylinders or welding sets in excess of 40 pounds total weight shall 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 shall 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*. **(T-1)** Place the cylinder in an upright manner well away from an ignition source 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 shall notify personnel of the danger before entering into the area. **(T-1)** These signs are intended to prevent personnel from entering into a danger zone while attempting to read the sign on the cylinder. Refer to [Chapter 17](#) for danger signs specifications. Immediately notify the installation 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., shall be used. **(T-0)** In locations where the acquisition of such apparatus is not feasible, contact the installation occupational safety office or 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 shall 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 shall be inspected and shall 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 shall not be used and shall be removed from service. **(T-0)** Gaseous systems and containers shall be color coded in accordance with 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 installation occupational safety office or 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 shall be certified in accordance with TO 00-25-252, *Intermediate and Depot Level Maintenance Instructions – Aeronautical Equipment Welding*. **(T-0)**

20.4.3. Commanders and supervisors shall ensure employees are trained in the requirements of the Air Force 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 shall 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 installation 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. Provide appropriate fall protection for welders and helpers when on elevated surfaces. 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**, Chapter **16** 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 installation F&ES Flight, Occupational Safety office and BE. **(T-1)** This shall 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 installation 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 installation Occupational Safety office, F&ES Flight and BE. **(T-1)**

20.5.1.4.6. Outdoor areas within six (6) feet of combustible structures or combustible exterior finish materials without approval by the installation 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 shall 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 shall be used to protect personnel from hazardous concentrations of airborne contaminants. **(T-0)** Consult BE and AFI 48-137 for additional guidance.

20.5.2.5. Workers with pacemakers and other electrically-active implanted medical devices must not be allowed to work in areas where the function of their device may be adversely affected by exposure to known non-ionizing radiation or electromagnetic fields. **(T-0) Note:** Workers with pacemakers and other electrically-active medical devices engaged in this type of work shall 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 (usually a member of the BE staff). **(T-1)** All personnel must comply with DAF requirements for handling and processing radioactive materials. 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 shall be used to eliminate any possible vapor accumulation by the proper venting or positioning of the container during the filling operation. Consult the installation Environmental Management office for disposal guidelines of purged materials. **(T-2)**

20.5.3.3. Purging with Air. Hazardous vapors may be displaced from inside containers by purging with air. A safe atmosphere shall be maintained by continuous ventilation. **(T-0)** Every precaution shall be taken to ensure all ignition sources have been removed from the vicinity since the concentration of vapor in the tank or container might reach the flammable range before a safe atmosphere is obtained. **(T-0)** The air mover shall be electrically bonded to the tank or container being cleaned. **(T-0)**

20.5.3.4. Inert with Gas. Inert gas may be used to displace flammable gas from the container. Adequate ventilation shall be maintained during the operation to ensure gas concentrations remain below hazardous levels. **(T-0)** Supervisors of this operation shall 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 shall 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 shall be provided and use the appropriate PPE to protect themselves from injury. **(T-0)** The appropriate protective clothing required for specific welding operations shall vary with the size, nature and location of the work to be performed. **(T-0)** Supervisor shall 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 shall meet the requirements found in 29 CFR § 1910.253, *Oxygen-Fuel Gas Welding and Cutting*. Both oxygen and acetylene cylinders are stored in accordance with TO 42B5-1-2.

20.7.2. Arc-Welding and Cutting. Arc-welding equipment shall 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, shall be grounded in accordance with 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 coming in contact 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 similar to 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 shall 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.

20.8. Hot Work Locations.

20.8.1. Permits. Daily hot work permits (AF Form 592, *Hot Work Permit*) are required where welding, cutting, brazing and other hot work are conducted excepted in [paragraph 20.8.1.1](#).

20.8.1.1. Approved Hot Work Industrial Shop/Area. A specific area shall be designated and approved by the installation F&ES Flight, Occupational Safety office and BE for welding and cutting operations. **(T-1)** It shall be of fire resistant or noncombustible construction appropriate for its hazard classification, free of combustible and flammable materials, and segregated from adjacent areas. **(T-0)** This area shall be exempt from requiring an AF Form 592 on a daily basis. **(T-1)**

20.8.1.2. Maintain a copy of the signed AF 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 shall 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 shall be inspected prior to each day's operation to ensure that no conditions have changed and requirements of the original permit are in effect. **(T-0)** The permit shall be signed and dated daily in Block 12 at the completion of each day's work until completion of operations or as required by local policy. **(T-1)** Only the tasks authorized by the original permit shall be accomplished. Additional tasks shall require a new permit to be issued. **(T-1)**

20.8.1.4. Outside Areas.

20.8.1.4.1. The welding operation shall be roped off or segregated by physical barrier whenever possible. **(T-1)** Placards reading “*WELDING OPERATIONS IN PROGRESS*” shall be prominently displayed for warning purposes. **(T-1)** Protective screens, when possible, shall be placed around welding operations. **(T-1)** When screens are not feasible, workers and other personnel adjacent to the welding areas shall be required to wear appropriate personal protective goggles. **(T-1)**

20.8.1.4.2. Authorization, including an AF Form 592, to perform welding, cutting or brazing shall be obtained from the installation F&ES Flight prior to the start of operations. **(T-1)** Coordinate with BE when welding, cutting or brazing operations involve hazardous task(s) that will require additional worker protection. **(T-1)**

20.8.1.4.3. MAJCOMs/FLDCOMs/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 shall 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 shall be signed and dated daily in Block 12 at the completion of each day’s work until completion of the operations or as required by local policy. **(T-1)** Only tasks authorized by the original permit shall be accomplished. **(T-1)** Additional tasks shall require a new permit to be issued. **(T-1)** The following procedures are applicable:

20.8.1.4.3.1. Personnel certified by the installation F&ES Flight may authorize welding, cutting and brazing operations, using AF Form 592 for this purpose. **(T-1)**

20.8.1.4.3.2. The installation F&ES Flight shall instruct and qualify welding shop supervisors and other selected personnel. **(T-1)** Upon completing the required training, the installation F&ES Flight shall certify the individuals in writing. **(T-1)** Upon certification, trained personnel shall be qualified to issue permits. **(T-1)**

20.8.2. Confined Spaces.

20.8.2.1. When a welder must enter and/or perform a welding, cutting or brazing operation in a confined space, the requirements for confined space entry in NFPA 51B, 29 CFR § 1910.146, *Permit-Required Confined Spaces*, 29 CFR § 1910.252, *Welding, Cutting and Brazing*, Chapter 23 of this instruction and AFI 48-137 shall be strictly adhered to. **(T-0)** An AF Form 592 shall be obtained from the installation F&ES Flight, with coordination by the installation Occupational Safety office and/or Bioenvironmental Engineering as applicable. **(T-0)** All welding, cutting or brazing equipment shall be inspected for leaks, abrasions or defective equipment prior to inserting into the confined space. **(T-1)** Unserviceable equipment shall not be authorized within the space. **(T-0)**

20.8.2.2. Hot work permits (AF Form 592) will not be issued until the requirements in NFPA 51B and 29 CFR § 1910.252 are met. **(T-0)** Consult with the installation F&ES Flight for additional guidance.

20.8.2.3. Where it is impossible to provide the necessary ventilation inside a confined space, Bioenvironmental Engineering shall determine the appropriate level of respiratory protection required. **(T-1)**

20.8.2.4. When a welder must enter a confined space through a manhole or other small opening, a mean shall be provided for quickly removing the welder in case of emergency. **(T-0)** When safety belts and lifelines are used for this purpose, they shall 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 shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect. **(T-0)** Refer to Chapter 23, 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. An AF Form 592 shall be issued prior to all aircraft welding operations. **(T-1)** Welding shall 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 shall 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 shall be prepared and attached to the form. **(T-1)** The welding supervisor shall ensure identified precautions and/or checklist items are followed. **(T-1)** The welding supervisor shall 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 shall 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 shall 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 worker shall conduct an atmosphere analysis with a combustible gas analyzer to assure that flammable vapors do not reach 20 percent of the lower explosive limit. **(T-1)** Such analysis shall be conducted prior to the start of welding and at least every 15 minutes during the welding operation. **(T-1)** For 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. National Fire Protection Association standards are normally available for review at the installation occupational safety office or installation 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, when possible, around welding operations. **(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 shall be as close to the weld area as possible, and clamps used on such ground leads shall 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 fire guard a 2A10B: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 shall include the availability of a Class D fire extinguisher. **(T-1)**

20.8.3.11. Aircraft welding operations performed in hangars shall conform to [Chapter 6](#) and NFPA 410. **(T-1)**

20.8.4. Vehicle Equipment Shops. Welding or cutting in vehicle maintenance activities shall only be conducted in areas approved by the installation F&ES Flight. **(T-1)** Maintenance shop supervision shall evaluate each welding or cutting task to determine if batteries or fuel tanks require removal and/or need to be made inert. **(T-1)**

20.9. Contractors. The contracting officer, in coordination with the Occupational Safety office and F&ES Flight, shall 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. An AF 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 installation F&ES Flight prior to starting welding operations. **Note:** BE assistance and coordination may be required, e.g., BE survey report, PPE listing/recommendation.

Table 20.1. How To Fill Out AF 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 SEG/BE/F&ES Flight & attach to the AF Form 1024, <i>Confined Space Entry Permit</i> .
Block 9.	PAI signature granting permission to execute work.
Block 10.	Operator/On-scene supervisor signature stating understanding of responsibilities under AFMAN 91-203 and National Fire Protection Association 51B.
Block 11.	Installation 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 in accordance with 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

Category	Hazardous Energy Sources
	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 shall:

21.2.1. Establish a hazardous energy control program. **(T-0)** When required, develop procedures for tagout only processes. **Note:** The employer shall demonstrate that the tagout program will provide a level of safety equivalent to that obtained by using a lockout program. **(T-0)**

21.2.2. Perform and document an annual hazardous energy control program self-inspection. **(T-1)** Refer to paragraphs [21.4.1](#) and [21.4.2](#) for additional guidance.

21.3. Training.

21.3.1. Authorized and affected employees as defined by OSHA will receive training in accordance with 29 CFR § 1910.147(c)(7). **(T-0)** Supervisors shall verify training for authorized and affected employees is accomplished. **(T-0)**

21.3.2. Retraining. Authorized employees and affected employees shall be retrained, e.g., change in their job assignments, a change in machinery, equipment or processes that present a new hazard, 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)**

21.3.3. Documentation. All related training shall be documented in accordance with AFI 91-202. **(T-1)**

21.4. Program Self-Inspections.

21.4.1. Shop hazardous energy control program periodic inspections shall be conducted by authorized employees, one acting as an inspector and one performing the maintenance/servicing activity, at least annually, to ensure compliance with all program elements. **(T-0)** Periodic inspections shall be designed to identify and correct any deviations or inadequacies observed. **(T-0)** The inspection shall be documented to include the date of the inspection and the unit representative conducting the inspection. **(T-0)** The organization shall certify that the periodic inspections have been performed. **(T-0)** The certification shall identify the machine or equipment on which the energy control procedures was being utilized, the date of the inspection, the employees included in the inspection, and the person performing the inspection. **(T-0)** An authorized employee other than the one(s) utilizing the energy control procedure shall conduct periodic inspections of the energy control procedure in accordance with 29 CFR 1910.147(c)(6)(i)(A). **(T-0)** The inspection shall include, as a minimum:

21.4.1.1. Identification of equipment and machinery for which the hazardous energy control program applies. **(T-0)**

21.4.1.2. A review of each employee's responsibilities under the program. **(T-0)**

21.4.1.3. Verification that training has been conducted is current and properly documented. **(T-0)**

21.4.1.4. A review of hazardous energy control procedures with authorized employees to include demonstration by the employee of the required practices. **(T-0)**

21.4.1.5. An out-brief to the shop or unit supervisor, as appropriate, and documented in the written report. **(T-0)**

21.4.2. A qualified occupational safety inspector shall review the annual self-inspection hazardous energy control report during the organization's safety assessment to ensure compliance. **(T-1)**

21.5. Authorized Lockout and Tagout Devices. Authorized lockout and tagout devices shall be used in accordance with 29 CFR § 1910.147(c)(5), 29 CFR § 1910.333(b)(2)(iii)(D), 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 equipment to that obtained by the use of a lock.

21.5.1. Be singularly keyed with only authorized employees retaining the key(s) to the lock(s) when in use. **(T-0)**

21.5.2. AF Form 983, *Danger – Equipment Lockout Tag*, or DoD tag or commercial equivalent tags, shall be used in conjunction with energy-isolating devices. **(T-1)** The functional manager or supervisor shall ensure an adequate supply of energy-isolating devices are available. **(T-1)**

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(a)(2). **(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). **Note:** NFPA 70E, Article 120.2, defines the two (2) forms of hazardous electrical energy controls permitted as simple lockout/tagout and complex lockout/tagout. For the simple lockout/tagout, the authorized person shall be in charge. For the complex lockout/tagout, the person in charge shall have overall responsibility. **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 shall:	
1. Preparation	Determine if written hazardous energy control procedures for the machinery/equipment are applicable to the task. (T-0) If so, the authorized employee shall 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.,

The authorized employee shall:	
	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 in accordance with 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.
2. Notification	Notify all affected employees of the impending shutdown and that they shall not touch hazardous energy control devices or attempt to restart the machinery/equipment until informed it is safe to resume normal operations. (T-0)
3. Shutdown	Verify it is safe to shut down the machinery/equipment. (T-0)
	The machinery/equipment shall 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 shall 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 shall be installed. (T-1)
	Tags shall indicate date, time, reason and name of the authorized employee installing device. (T-0)
	To prevent inadvertent or accidental detachment, tags shall 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 in accordance with paragraph 21.6.1.
6. Verification	Once the system is locked/tagged out, all potentially hazardous stored or residual energy shall 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 shall 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

The authorized employee shall:	
	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 shall 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 shall ensure the energy is tested by a qualified person. (T-0)
	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.
7. Keep Authorized Hazardous Energy Control Devices in Place	The LOTO device shall remain in place until work on the machinery/equipment is complete. (T-0)
	When circumstances require testing, adjustment or repositioning of machinery/equipment, it may be necessary to temporarily remove LOTO devices before work is complete in order to verify functionality. The following sequence of actions shall 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 machinery/equipment area and ensure 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.
	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)
8. Before Restoring Machinery/Equipment to Service	The authorized employee will ensure the steps in Figure 21.2 are followed in order. (T-0) Note: When the authorized employee is unavailable, follow 29 CFR § 1910.147(e)(3). (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 shall:
	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. Removal of Additional Devices	Remove any additional devices applied in accordance with hazardous energy control application. (Figure 21.1). (T-0)
	Remove all safety grounding devices. (T-0)
	Verify the work for which hazardous energy control was applied is complete and it's safe to reenergize the machinery/equipment.
3. Removal of all LOTO Devices	Each LOTO device shall be removed only by the authorized employee who applied it. (T-0) When the authorized employee who applied the device is not available to remove it, their supervisor may remove the device in accordance with 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 shall 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 lockout/tagout will be in accordance with 29 CFR § 1910.147(f)(3) and its subordinate paragraphs. **(T-0)**

21.6.2. Group Hazardous Energy Control Verification Procedure. Group hazardous energy control procedures will be developed to ensure authorized employees walk through the affected work area to verify isolation at each LOTO device. **(T-0)** After verification, each authorized employee participating in the group LOTO shall affix their personal LOTO devices to the group LOTO box prior to performing servicing/maintenance. **(T-0)** If there is a potential for the release or re-accumulation of hazardous energy, verification of isolation must be continued. **(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)**

21.6.3. 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.

21.6.4. Shift Changes. Specific, written procedures shall 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 in accordance with NFPA 70E, *Electrical Safety in the Workplace*, Article 120, hazardous energy control program shall meet the requirements of this chapter and procedures listed below.

21.7.1. Simple Lockout/Tagout Procedure. All lockout/tagout 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 shall be considered to be a simple lockout/tagout. **(T-0)** Simple lockout/tagout procedures shall not be required to be written for each application. Each authorized employee shall be responsible for their own lockout/tagout. **(T-0)**

21.7.2. Complex Lockout/Tagout.

21.7.2.1. A complex lockout/tagout procedure shall 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 lockout/tagout procedures shall require a written plan of execution in accordance with 29 CFR § 1910.147 and identifies the person(s) in charge. **(T-0)**

21.7.2.3. The complex lockout/tagout procedure shall 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 shall be held accountable for safe execution of the complex lockout/tagout. **(T-0)**

21.7.2.4. Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox or comparable mechanism when he or she begins work and shall 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 lockout/tagout plans shall identify the method to account for all persons who might be exposed to electrical hazards in the course of the lockout/tagout. **(T-0)**

21.8. Contractors. Interaction with contractors will be in accordance with DoDI 6055.01, AFI 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 addresses criteria for storage, use and handling of flammable and combustible liquids and gases, and implements 29 CFR § 1910.106, *Flammable Liquids*, and NFPA 30. Refer to 29 CFR § 1910.101, *Compressed Gases (General Requirements)*, and NFPA 55 for additional guidance. Use of these gases shall 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 require careful handling at all times. 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) shall 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 AFI 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 safety data sheet(s) and/or contact the installation Occupational Safety office, F&ES Flight or BE when in doubt or for additional guidance. **Note:** Water-reactive materials shall not be stored where fire protection sprinklers are in place. **(T-1)** These materials shall 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 shall be avoided, when possible. **(T-0)** Open flames, heaters, equipment not properly grounded and non-explosion proof electrical equipment shall 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 shall 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 in accordance with 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 shall include, as a minimum, information on the need for and use of approved PPE, maintenance and care of PPE, review of safety data sheets, 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 shall 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 shall be approved for the work performed and shall be maintained in satisfactory condition. (T-0) Refer to [Chapter 14](#) for additional requirements.

22.4.2. Functional Managers and/or Supervisors shall ensure PPE is available and appropriately worn when handling flammable or combustible liquids. (T-0)

22.4.3. DAF personnel shall 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 shall be provided to dispose promptly and safely of leakage or spills. (T-0) Refer to the appropriate safety data sheets for spill clean-up procedures and PPE required.

22.5.1. Leaking containers shall be removed to a safe location outside the building, and the contents transferred to an undamaged container in accordance with guidance from the installation F&ES Flight and Environmental Management office. (T-1)

22.5.2. Functional Managers and/or Supervisors shall 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 shall be developed for flammable and combustible liquid warehouses, laboratory and storage buildings. (T-0) These plans shall be

maintained in the installation F&ES Flight and on vehicles designated by the fire chief. **(T-1)** Refer to AFI 32-2001, *Fire and Emergency Services Program*, for additional information. The plans include the hazardous materials contained in installation facilities, their locations and emergency procedures to be followed.

22.6.2. 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 shall not have an opening into any portion of a building used by the public. **(T-0)** At least one clear 3-foot wide aisle shall be maintained in all inside storage areas. **(T-0)** Containers in excess of 30-gallon capacity shall not be stacked. **(T-0)** Dispensing shall be in accordance with [paragraph 22.7.1.3](#) for Class I flammable liquids. **(T-1)** All other dispensing shall 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 shall 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 shall be located within 30 feet of any Class I or Class II liquid storage area outside of a storage room but inside a building. **(T-0)**

22.6.2.3. Installed fire suppression systems shall be approved in accordance with UFC 3-600-01. **(T-1)** Additionally, consult the installation F&ES Flight for further guidance.

22.6.3. Storage Inside Buildings.

22.6.3.1. Storage shall not physically obstruct a means of egress from the building or area and not be placed in such a manner that a fire would prevent safe egress from the area. **(T-0)**

22.6.3.2. If a flammable and combustible liquids storage building is used, it shall be one-story and devoted principally to handling and storing of flammable or combustible liquids. **(T-0)** The building shall 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 shall be located outside of, but not more than 10 feet from, the door opening into any room used for storage of flammable or combustible liquids. **(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 shall 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 shall be approved in accordance with UFC 3-600-01. **(T-0)** Contact the installation F&ES Flight for further guidance.

22.6.4.3. Welding, cutting or brazing shall be accomplished in accordance with [Chapter 20](#). **(T-1)** Refer to 29 CFR § 1910.252, *Welding, Cutting and Brazing*, for additional guidance.

22.6.5. All laboratories shall have fire protection appropriate for their fire hazard classification. **(T-0)** Fire protection shall include, as a minimum, portable fire extinguishers, an alarm system and an evacuation and emergency 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 shall 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 shall be suitable for general purpose use. **(T-0)**

22.7.1.3. Containers and portable tanks used for Class I liquids shall be electrically grounded and bonded during liquid transfer. **(T-0)** Positive measures shall be taken to eliminate any source of ignition: open flames, electrical, smoking, cutting and welding, hot surfaces, static, mechanical sparks, radiant heat or spontaneous ignition sources. **(T-0)**

22.7.2. Ventilation. Liquid storage areas where dispensing is conducted shall 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 shall be separated from other similar operations by 25-feet or by construction with a fire resistance of at least one (1) hour. **(T-0)** Drainage or other means shall be provided to control spills. **(T-0)** Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapors at or below 10 percent lower explosive limit (LEL). **(T-0)** Mechanical ventilation shall 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 shall be taken from a point near a wall on one side of the room and within one (1) foot of the floor with one or more make-up inlets located on the opposite side of the room within one (1) foot of the floor. **(T-0)** The location of both the exhaust and inlet air openings shall be arranged to provide air movement across all portions of the floor to prevent accumulation of flammable vapors. **(T-0)** Exhaust from the room shall 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 shall provide for a complete change of air within the room at least six (6) times per hour. **(T-0)** If a mechanical exhausting system is used, it shall be controlled by a switch located outside the door. **(T-0)** The ventilating equipment and any lighting fixtures shall be operated by the same switch. **(T-0)** The switch shall be illuminated or an electric warning pilot light shall be adjacent to the switch if flammable liquids are dispensed within the room. **(T-0)** The mechanical ventilation system for dispensing areas shall be equipped with an airflow switch or equally reliable method interlocked to sound an audible alarm upon failure of the ventilation system. **(T-0)**

Note: Coordinate with the installation BE to assist in the proper selection of a ventilation system.

22.7.2.3. Ventilation ducts and airflow requirements shall 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 shall 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 in accordance with 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 shall 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 shall 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 shall apply:

22.7.3.3.1. If the cabinet is vented, for whatever reasons, the cabinet inlet shall be vented outdoors in a manner that will not compromise performance of the cabinet. **(T-0)**

22.7.3.3.2. If the cabinet is not required to be vented, the vent opening, as applicable, shall be sealed with bungs supplied with the cabinet or specified by the manufacturer of the cabinet. **(T-0)**

22.7.3.4. Storage cabinets that meet at least one of the following sets of requirements shall be acceptable for the storage of liquids. Storage cabinets designated and constructed to limit the internal temperature at the center of the cabinet and 1 inch (2.5 centimeter [cm]) from the top of the cabinet to not more than 325° F (162.8° C), when subjected to a 10-minute fire test that simulates the fire exposure of the standard time-temperature curve specified in ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, shall be acceptable. **(T-0)** All joints and seams shall remain tight and the door shall 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 shall 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 shall have noncombustible liquid-tight raised sills or ramps at least four (4) inches in height or, as an alternative, the floor in the storage area shall be at least four (4) inches lower than the surrounding floor. **(T-0)** Rooms shall 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*, shall be used. **(T-0)** Where other portions of the building or other properties are exposed, windows shall 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 shall not be stored or handled within a building having a basement or pit where flammable vapors can travel, unless such area is provided with ventilation that will prevent the accumulation of flammable vapors. **(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 shall comply with NFPA 30. **(T-1)** Refer to 29 CFR § 1910.106 for additional information. **(T-0)**

22.7.5.1. Storage shall not physically obstruct a means of egress from the building or area and not be placed in such a manner that a fire would prevent safe egress from the area. **(T-0)**

22.7.5.2. Water reactive materials shall 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 shall be in accordance with 29 CFR § 1910.106, Table H-14. **(T-0)** Buildings or portions of such buildings utilized for flammable and/or combustible storage shall be isolated by standard fire walls approved for the type and quantity of liquids being stored. **(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 shall 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 shall comply with 29 CFR § 1910.106, Table H-14 and Table H-15. **(T-0)**

22.7.5.6. Stacked containers of flammable liquids shall be separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls. **(T-0)** Refer to [paragraph 22.6.2](#) for guidance on stacking containers.

22.7.5.7. Portable tanks stored over one tier high shall be designed to nest securely, without dunnage. **(T-0)** Adequate materials handling equipment shall be available to handle tanks safely at the upper tier level. **(T-0)**

22.7.5.8. No stack shall be closer than three (3) feet to the nearest beam, chord, girder or other construction member and shall be at least three (3) feet below sprinkler deflector or discharge orifice of water spray or other installed fire protection systems. **(T-0)**

22.7.5.9. Aisles at least three (3) feet wide shall 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 in accordance with [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 shall be graded to divert possible spills away from buildings or other facilities or shall be surrounded by a curb at least six (6) inches high. **(T-0)** When curbs are used, provisions shall be made for draining accumulations of ground or rainwater or spills of flammable or combustible liquids. **(T-0)** Drains shall terminate at a safe location and shall be accessible and operate under fire conditions. **(T-0)**

22.7.7. Incidental Storage of Flammable Liquids in Industrial Areas. Incidental storage shall be authorized only after the following requirements are met: (Reference NFPA 30.)

22.7.7.1. Incidental storage shall be in industrial areas only. **(T-0)**

22.7.7.2. Storage shall be in metal cabinets stenciled, “FLAMMABLE—KEEP FIRE AWAY” (metal wall lockers meet this requirement). **(T-0)**

22.7.7.3. Storage shall be limited to 1 gallon (4 liters) of Class I or 10 gallons (40 Liters) of Class II and Class III liquids, not to exceed 10 gallons (40 liters) total per cabinet, in closed containers. **(T-0)** Storage shall 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 shall be limited to one cabinet. **(T-1)**

22.7.7.4. The installation F&ES Flight shall be consulted prior to establishing incidental storage areas in industrial shops. **(T-1)**

22.7.8. Laboratories. Many laboratory operations require special control flammable and combustible liquids to protect personnel and equipment. Two types of laboratories are covered

by this section: general laboratories and health-related laboratories. Refer to NFPA 30 for additional guidance.

22.7.8.1. A list of working supplies and operating instructions on handling flammable and combustible liquids shall be published. **(T-0)** The aggregate total outside of storage cabinets in any laboratory shall not exceed 10 gallons. **(T-0)** All quantities of flammable and combustible liquids in one laboratory in excess of 10 gallons shall be stored in an approved storage cabinet or in an approved storage room. **(T-0)** Flammable or combustible liquids shall not be stored or transferred from one vessel to another in any exit way, corridor or passageway leading to an exit. **(T-0)** A minimum of one approved storage room shall be available within any building housing a laboratory which regularly maintains a reserve storage capacity in excess of 300 gallons. **(T-0)** Refer to NFPA 45 for additional guidance.

22.7.8.2. Flammable or combustible liquids shall not be brought into a laboratory, receiving area, storage area or storage facility unless design, construction and fire protection requirements are suitable for the hazard and quantity involved. **(T-0)** Container types and maximum capacities shall 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 shall 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 shall be limited to quantities needed for display and normal merchandising purposes, not to exceed two (2) gallons per square foot of gross floor area. **(T-0)** The gross floor area used for computing the maximum quantity permitted is that portion of the store actually being used for merchandising flammable and combustible liquids. Refer to NFPA 30 for additional guidance.

22.7.9.1. Storage of Class IA liquids shall be prohibited in basement display areas and limited to one (1) gallon per square foot on any other floor. **(T-0)** In areas not protected, storage of Class IB, IC and II liquids on other than the ground floor shall be limited to one (1) gallon per square foot of gross floor area. **(T-0)** Protected shall mean protected with automatic sprinklers installed in accordance with 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 shall 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 shall not be stacked more than three (3) feet or two (2) containers high, whichever is greater. **(T-0)**

22.7.9.4. Shelving shall be capable of supporting the load and containers on shelves must be arranged so they are not easily knocked off the shelves to the floor. **(T-0)**

22.7.9.5. Storage shall be in accordance with 29 CFR § 1910.106, Table H-14. **(T-0)** Buildings or portions of such buildings utilized for flammable and/or combustible storage shall be isolated by standard fire walls approved for the type and quantity of liquids being

stored. **(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 shall be a blank wall having a fire-resistance of at least two 2 hours. **(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 shall comply with 29 CFR § 1910.106, Table H-14. **(T-0)**

22.7.9.8. Stacked containers of flammable liquids shall be separated by pallets or dunnage, where necessary, to provide stability and to prevent excessive stress on container walls. **(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 shall be serviced after use and prior to extended off-season storage. **(T-0)**

22.7.10.1.1. Equipment shall be stored in accordance with manufacturer's instructions. **(T-0)**

22.7.10.1.2. Storage facilities shall be protected against tampering or unauthorized entry and area around the facility shall be kept free of weeds, debris and other combustibles. **(T-0)**

22.7.10.1.3. Workplace storage facilities shall be inspected monthly by supervisor and/or building custodian. **(T-1)** The supervisor and/or building custodian shall document each inspection. **(T-1)**

22.7.10.2. Gasoline powered equipment shall not be stored in military family housing living areas, including basements, unless the storage room or area has walls and is separated from the living area by an un-pierced 1-hour rated fire-resistant partition and ceiling. **(T-1)** All storage areas must be inspected (one-time inspection) and approved by the installation F&ES Flight. **(T-1)** Subsequent inspections shall be accomplished in accordance with manufacturer's inspection and on an as required basis as determined by the installation F&ES Flight. **(T-1)**

22.7.10.3. Custodians of dormitories, multiple living quarters, assembly, institutional, military exchange, commissary and warehouse facilities shall store small gasoline powered equipment in an enclosed 1-hour fire-rated storage room. **(T-1)** Boiler rooms and other utility rooms shall 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 is limited to 10 gallons or less of Class I and II liquids and 20 gallons or less of Class III liquids stored in an approved storage

container or in safety cans. Refer to 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 (3) dwelling units with attached or detached garages.

22.8. Handling and Dispensing.

22.8.1. Containers. Containers and portable tanks shall 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 shall 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 shall be in accordance with 29 CFR § 1910.106, Table H-12. **(T-0)**

22.8.1.2. Flammable liquids shall 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 shall be prohibited in office occupancies, except when required for maintenance and operation of buildings and equipment. **(T-0)** Such storage shall be the smallest quantity required, in approved self-closing metal containers stored in a storage cabinet or in safety cans or an inside storage room not having a door that opens into that portion of the building used by personnel. **(T-0)** Maximum quantities shall meet the requirements of the storage cabinet, container or room in accordance with [paragraph 22.7.3](#) and NFPA 30, Table 9.6.1. **(T-1)**

22.8.2. Storage Inside Building.

22.8.2.1. Containers shall remain tightly sealed except when transferred, poured or applied. **(T-0)** Workers shall 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 shall be protected from heat sources to prevent the contents expanding and pressurizing the container, which could rupture the container. **(T-0)** Open flame or smoking shall 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 shall 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 shall be conducted in outside areas free from ignition sources. **(T-0)** Fuel tanks shall 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 shall not refuel a running engine or one that is hot from recent use. They shall allow a minimum of five (5) minutes cooling off time before starting refueling operations. **(T-1)**

22.8.5.3. Fueling and/or refueling operations shall be accomplished using a safety can with pouring spout or an appropriate sized funnel. **(T-1)** Care shall be taken not to spill fuel onto hot surfaces. **(T-0)** Spilled fuel shall be cleaned up before attempts are made to start equipment. **(T-0)**

22.8.5.4. Equipment shall 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, munitions maintenance facilities, fire stations, shops and maintenance facilities. However, this equipment shall not be stored in hangars, nose docks, corrosion control, fuel cell repair or missile assembly and repair facilities. **(T-1)** When stored, the equipment shall 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 shall be drawn from or transferred into vessels, containers or portable tanks within a building only through a closed piping system, from safety cans, by means of a device through the top, or from a container or portable tanks by gravity through an approved self-closing valve. **(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 shall be used for transporting and dispensing flammable liquids in quantities of five (5) gallons or less. **(T-0)**

22.8.6.2. Flammable liquids shall be kept in covered containers when not actually in use. **(T-0)**

22.8.6.3. Means shall 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 shall 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° F shall be red in color with additional clearly visible identification in the form of a yellow band around the container and the contents conspicuously stenciled or painted in black. **(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 National Fire Protection Association 30 for additional guidance.

22.8.6.6. Disposal. Consult the installation Environmental Management office for proper guidance regarding disposal of any excess or unneeded hazardous materials. Also refer to AFMAN 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. Units that have personnel who enter confined spaces will comply with 29 CFR § 1910.146, 29 CFR § 1926, Subpart AA, this chapter, and other applicable standards. **(T-0)** Industries excepted in 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 consider 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:** Examples of confined spaces include, but are not limited to, aircraft fuel cells, silos, tanks, pits, manholes, vaults, storage bins, etc. **Note:** All three (3) 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 (2) 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 a 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 a space 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 damage.

23.2.3. Serious physical damage 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 damage 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	<ul style="list-style-type: none"> • 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 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 or which could result in an exposure or does in excess of its occupational and environmental exposure limit
Serious Physical	<ul style="list-style-type: none"> • 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

23.4. Responsibilities.

23.4.1. Major Commands (MAJCOMs), Field Commands (FLDCOMs), Direct Reporting Units (DRUs) and Field Operating Agencies (FOAs) with a safety staff shall:

23.4.1.1. Ensure program oversight through a variety of 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 shall include the number and type of confined spaces, 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, as required. **(T-1)**

23.4.1.4. Approve installation safety office developed train-the-trainer materials. **(T-1)**

23.4.2. The installation 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. This representative shall: **Note:** It is the responsibility of the occupational safety manager (OSM) to assign a representative.

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 safety certifies the representative's competency in the program. **(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, shall include organization, classification, data supporting the classification and 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 the installation 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 installation OSM, when appointed to represent the tenant unit on the CSPT, to show competency in the confined space program. **(T-1)**

23.4.4. Installation fire chief shall identify, in writing, to the OSM the appointed Fire Emergency Services (FES) 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 Bioenvironmental Engineer (BE) shall 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 shall:

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 the workplace is evaluated for permit and non-permit required confined spaces. **(T-1)** Require the designated representative to compile an inventory of the identified confined spaces in the organization and provide a copy to the installation CSPT. **(T-1)** In addition to items listed in [paragraph 23.4.2.2.3](#), the inventory shall include, at a minimum, the number of spaces (quantity), type (with every entry point uniquely identified and listed) and exact location (e.g., grid coordinates, Global Positioning Satellite coordinates, if available, highlighted maps, if necessary). **(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. Require that all exposed personnel are informed of the identified permit-required spaces. **(T-0)**

23.4.6.4. Ensure a written confined space program, developed and approved by the CSPT, is implemented IAW 29 CFR § 1910.136 and this chapter. **(T-0)** Master Entry Plan(s), when required, shall be routed through 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)**

23.4.6.5. 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) shall:

23.4.7.1. Coordinate between each shop in the organization who enters confined spaces and the commander. **(T-1)** Ensure required equipment needed to conduct safe entry into a permit-required space is purchased and properly maintained. **(T-0)**

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 confined spaces with all information required in [paragraph 23.4.5.2](#) and submit the confined space inventory to the commander for review prior to submission to the installation occupational safety office. **(T-1)** Initially, annually and as changes occur, review the confined spaces inventory and immediately incorporate any newly identified confined spaces and/or changes to existing classification of the confined spaces inventory when discovered during (re)evaluation and (re)classification by the CSPT. **(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) shall 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 spaces found in [paragraph 23.10.1.1](#). **(T-1)**

23.4.7.6. Develop, with the assistance of each shop supervisor, a written confined space program, if required, 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 spaces under their organizational control to contractors working in permit-required spaces. **(T-1)** Notification to the installation occupational safety office ensures the CSPT members can be made aware of all permit-required 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. **(T-1)**

23.4.8.2. Issue entry permits consistent with the organizational written confined space program or the Master Entry Plan, when applicable. **(T-1)**

23.4.8.3. 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 operations. **(T-1)**

23.4.8.4. Ensure workers are aware that work on energized electrical equipment is prohibited unless approved by the installation base civil engineer (BCE) in accordance with AFMAN 32-1065, *Grounding and Electrical Systems*. **(T-1)**

23.4.8.5. With assistance from Occupational Safety, 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 space, leaking valve or pipe in the space, etc. **(T-0)**

23.4.8.6. Ensure all members of the rescue team are trained and current in cardiopulmonary resuscitation (CPR) for permit-required confined space entry operations. **(T-1)**

23.4.8.7. Ensure DAF workers enter a permit-required confined space only after an AF Form 1024, *Confined Spaces Entry Permit*, or other entry permit, approved by the CSPT that meets the minimum documentation requirements, has been completed. **(T-0)**

23.4.8.8. 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)**

23.4.8.9. Request assistance from the CSPT, as needed, to ensure all program requirements are met. **(T-1)**

23.4.8.10. Be trained according to [paragraph 23.10](#). **(T-1)**

23.4.9. Confined space attendants will perform duties in accordance with 29 CFR § 1926.1209, *Duties of Attendants*, and be trained according to [paragraph 23.10](#). **(T-0)**

23.4.10. Confined space entrants will perform duties in accordance with 29 CFR § 1926.1208, *Duties of Authorized Entrants*, and be trained according to [paragraph 23.10](#). **(T-0)**

23.4.11. Rescue teams will perform duties in accordance with 29 CFR § 1926.1211, *Rescue and Emergency Services*. **(T-0)**

23.4.12. The Confined Space Program Team (CSPT) shall:

23.4.12.1. Assist commanders and/or functional managers in the development and administration of their organizational confined space program. **(T-1)**

23.4.12.2. When notified, test and evaluate identified confined spaces to classify them. **(T-0)** **Note:** Obvious hazardous spaces, e.g., sanitary sewer manholes, may automatically be classified as permit-required without the need for initial testing only to designate the confined space classification. 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-space entry operations. **(T-0)**

23.4.12.3. Validate that the organization, who maintains the confined space, has ensured all exposed personnel are informed of the permit-required 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 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. When requested by the unit, assist in the development of the Master Entry Plan. **(T-1)** Evaluate and approve Master Entry Plans that meet requirements in [paragraph 23.7.2](#). **(T-1)**

23.4.12.7. Review and approve all entry permits not contained in a Master Entry Plan. **(T-1)**

23.4.12.8. Meet annually to conduct a review of the installation Confined Space Program. **(T-1)** Include all approved written confined space programs, Master Entry Plans, training plans, rescue team evaluations/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)**

23.4.12.9. 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)**

23.4.12.10. Allow the installation 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-1)**

23.4.12.11. 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)**

23.4.12.12. Convene after a confined space mishap to ensure all hazards are identified to protect other members and to collect any quantifiable data for the mishap investigation. **(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 shall be done by the installation 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 shall 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 shall 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 is also acceptable.

23.5.1.4.2. Monitoring equipment that requires calibration, but cannot be calibrated by TMDE, shall be sent to the manufacturer for calibration. **(T-1)**

23.5.1.5. The user shall be required to field check and span gas test equipment in accordance with the manufacturer's instructions immediately before testing the confined space. **(T-0)** Workers will not use equipment that cannot be calibrated or which fails the

field check or span gas test, until it is repaired and the calibration and/or field check is successfully accomplished. (T-0)

23.5.2. When workers perform hot riveting, welding, cutting or burning, or heating operations within a confined space, they will obtain an AF Form 592, *Hot Work Permit*, from the installation F&ES Flight. (T-0) Refer to **Chapter 20** for additional information. If hazards may be introduced into the confined space by the hot work, BE shall be contacted to evaluate the potential hazards and recommend ventilation procedures. (T-1) Workers will inspect, test, operate and maintain welding and cutting equipment such as hoses, connections, torches, etc., in accordance with provisions of **Chapter 20**, applicable TOs and manufacturer's instructions. (T-0)

23.5.3. Entry into telecommunications only controlled spaces are 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. A knowledgeable BE and occupational safety representative shall be present at all times to serve as consultants to the entry supervisor. (T-1)

23.6.3. An experienced on-site supervisor shall be present. (T-0)

23.6.4. Personnel will be equipped with respirators in accordance with 29 CFR § 1910.134, *Respiratory Protection*. (T-0) **Note:** Additional guidance can be found in AFI 48-137.

23.7. Master Entry Plan. This part of the written confined space program serves as approval for recurring entries into permit-required 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 month or more frequently.

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-0)**
- 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)**
- 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 shall 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 in accordance with 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, e.g., hazardous energy control, ventilation, that will eliminate or isolate identified hazards for safe entry. **(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 Bioenvironmental Engineering (BE) office is the subject matter expert for determining appropriate PPE. BE surveys or assessments shall be used 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. **(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 Master Entry Plan. **(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, installation F&ES Flight) to be used for permit-required confined space entries. **(T-0)**
 - 23.7.2.13.3.1. Identify how rescue services will be notified to ensure prompt response. **(T-0)**
 - 23.7.2.13.3.2. Entry shall 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 shall 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 in accordance with TO 1-1-3. (T-1)

23.7.2.13.3.4. Specify the method that will be used for reliable summoning of the rescue team, e.g., telephone, radio, and ensure it is operable, on hand and easily accessible. (T-0)

23.7.2.14. Ensure the inspection, testing, maintenance and documentation of safety and rescue equipment is accompanied in accordance with **Chapter 14**, TO 00-25-245, *Operations Instructions – Testing and Inspection Procedures for Personnel Safety and Rescue Equipment*, 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)(5). (T-0)

23.7.2.16. Procedure 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 and after evaluation and testing prove they do not contain hazards and do not have any reasonable probability to become hazardous. (T-0) Permit spaces can be reclassified as non-permit spaces where the hazards in the space can be effectively isolated or eliminated from the space. (T-0)

23.8.1. Entries into a permit-required space for the purpose of reclassifying the space will follow permit-required entry requirements while conducting those activities until the permit-space hazards are completely isolated or eliminated. (T-0)

23.8.2. Confined spaces classified as non-permit required will be assessed by the shop supervisor to determine if work to be conducted could or will introduce hazard(s) that will change its classification, e.g., welding, sanding, use of chemicals. (T-0)

23.8.2.1. Similar confined spaces that will have the same types of work conducted in them may be combined. (T-1)

23.8.2.2. Results will be provided to the CSPT for review and concurrence. (T-1)

23.8.2.3. Work differing from that identified in the formal risk assessment will be identified to the installation 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 required spaces will have atmospheres tested prior to entry when conditions or operations change after the space was originally classified. (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)**

23.9. MAJCOM/FLDCOM Mandatory Aircraft Confined Spaces. Refer to AFSEC SharePoint® (<https://usaf.dps.mil/teams/AFSEC-SEG/pages/seghomev2.aspx>) for the most current listing.

23.10. Training.

23.10.1. General Information. Each organization shall develop a structured and effective training program, to include a hands-on portion that establishes safe work practices and techniques. **(T-1)** A computer-based training (CBT), titled Confined Space Series General Worker: Entrant, Attendant and Supervisor Course, the OSHA Course 2264, Permit-Required Confined Space Entry, or other MAJCOM-approved CBTs are available for personnel who have not attended a formal training course. Each MAJCOM may develop and present training using methods (PowerPoint presentations, training plans, etc.) other than CBT, if approved by the installation occupational safety office and BE. This will allow for type specific training for each weapons system. Personnel assigned duties as entry supervisors, attendants and entrants will complete general permit-required confined space program hands-on training in addition to AFCEC's CBT, 367 TRSS's "The Griffin" Confined Space CBT (Course code: A1AKU00TVT0002), or OSHA Course 2264, Permit-Required Confined Space Entry.

23.10.1.1. Commanders and functional managers only need to take the CBT on Advanced Distributed Learning Service for awareness understanding, unless acting as the commander's designated representative.

23.10.1.2. The Occupational Safety, 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.

23.10.1.2.2. Any additional training required by the MAJCOM/FLDCOM/DRU/FOA safety office, OSM, installation F&ES Flight and BE.

23.10.2. Commander's designated representative(s) and/or supervisor will be trained with initial, train-the-trainer and unit specific training. **(T-1)** They shall ensure training is provided to those with active roles in the confined space program on initial training and unit-specific procedures. **(T-0)** Training will ensure that personnel receive classroom and hands-on training to develop proficiency in their expected duties. **(T-0)**

23.10.2.1. Personnel required to test the atmospheric conditions in a confined space shall be trained using manufacturer's instructions or other information to develop effective training. **(T-0)** Supervisors shall contact the BE representative for assistance in developing training. **(T-1)** If unable to support this requirement, the BE representative will assist in identifying a training resource. **(T-1)**

23.10.2.2. 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 shall also meet the training requirements of an entrant. **(T-0)**

23.10.2.2.1. Annual training on the use, calibration and care of atmosphere testing and monitoring equipment will be conducted to maintain proficiency. **(T-1)**

23.10.2.2.2. 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. Supervisors shall 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 representative(s) for assistance in developing the training. **(T-1)** The F&ES Flight representative(s) 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. Students in this training shall be required to experience entry into simulated or actual confined spaces that represent common hazards and procedures found on the installation. Training objectives must focus on providing a clear understanding of how a confined space program shall be developed and implemented. **(T-1)**

23.10.4.2. 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.

23.10.4.3. The MAJCOM/SEG or FLDCOM/SEG will approve the train-the-trainer course materials and provide MAJCOM/FLDCOM specific requirements. **(T-1)**

23.10.5. Documentation of training will have name of student, name of trainer and dates of training.

23.11. Instructions for Completing the AF Form 1024, *Confined Spaces Entry Permit*. The following guidance shall be used to complete the AF 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, SEG, 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, along with 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)** Enter the name of each entrant and the time of each individual's entry and exit in the Entry Time Log. **(T-0)** If the entry supervisor(s) will enter the permit-required space, list them as entrants. **(T-0)** Attach an additional separate sheet if needed to list additional entrants. **Note:** Attendants and entrants are not required to sign or initial next to their names.

23.11.8. Section 8 – Fire Emergency Services (FES) Flight or equivalent. Identify and notify emergency response personnel. **(T-0)** Include POC name, contact information (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. SEG, 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 the time of each individual's 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 DoDI 6055.01 and AFI 91-202. **(T-0)** Required communication of confined spaces will be conducted to comply with 29 CFR § 1926.1203(h). **(T-0)** The details of responsibilities for the contractor and the DAF will be specified in contracts. **(T-0)** BE shall not test or monitor a confined space for a contracted confined space operation. **(T-0)** Rescue services for contractors will not be provided by the installation F&ES Flight without specific written approval by the installation fire chief. **(T-1)**

23.12.2. 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)**

23.12.3. BE representative will assist entry supervisor in the interpretation of air monitoring results when requested. **(T-1)**

23.12.4. BE representative serves as the OPR for the installation respiratory program in accordance with 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 installation respiratory protection program. **(T-1)**

23.12.5. BE will provide appropriate atmospheric testing and monitoring in isolated cases where trained unit personnel and/or equipment are not available. **(T-1)**

23.12.6. BE will provide appropriate atmospheric testing and monitoring for Immediately Dangerous to Life and Health (IDLH) conditions during permit-required confined space operations. **(T-1)**

23.12.7. BE will evaluate potential worker exposure related to confined spaces in accordance with AFI 48-145. **(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 AFI 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 shall follow guidance addressed within as well as guidance in AFI 91-202, aircraft-specific procedural TOs and other TOs and safety standards and local written operating instructions (OIs) applicable to their areas of responsibility. **(T-1)**

24.2.2. Fire Prevention. Aircraft servicing and maintenance facilities shall conform to DAF design criteria or equivalent DAF-approved engineering guidance to minimize fire and explosion hazards. **(T-1)** Contractor aircraft maintenance facilities shall conform to this publication and National Fire Codes. **(T-0)** Refer to [Chapter 6](#) for additional guidance on fire prevention guidance.

24.2.3. Cardiopulmonary Resuscitation (CPR)/Self-Aid Buddy Care (SABC). Aircraft maintenance and support shop employees exposed to electrical hazards from energized aircraft electrical systems, aircraft components or aircraft equipment shall be provided CPR and SABC training. **(T-1)** This includes personnel who act as safety observers. Installation unit maintenance commanders and supervisors may identify other job tasks that require CPR/SABC training based on hazards associated with tasks performed. Unit CPR instructors shall meet training requirements described in [paragraph 1.9](#) All personnel requiring CPR/SABC training shall remain current. **(T-0)**

24.2.4. Lifting Devices. Engines and other heavy parts shall be handled with hoists, approved hoisting slings and similar equipment. **(T-1)** Safe load capacities shall be stenciled on all hoists and strictly observed by operating personnel. **(T-0)** Personnel shall not work under suspended loads. **(T-0)** Inspect hoisting equipment in accordance with [Chapter 12](#), technical orders (TOs), and/or the manufacturer's instructions. Defective hoists shall be locked and/or tagged out of service and shall remain out of service until repairs are complete in accordance with [Chapter 21](#). **(T-0)** Weight testing of all lifting devices shall be in accordance with [Chapter 12](#) and/or applicable TOs. **(T-1)**

24.2.5. Compressed Air.

24.2.5.1. Compressed air shall not be used for cleaning purposes in accordance with 29 CFR § 1910.242(b), *Hand and Portable Powered Tools and Other Hand-Held Equipment*. **(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 systems or components, e.g., aircraft tires, air bottles or landing gear struts, mechanics shall:

24.2.5.2.1. Inspect all chucks and valve stems for serviceability to ensure safe servicing. (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 in accordance with TO and local installation 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 shall:

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 air lines 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 drain pipe and valve shall 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, shall be opened and receiver completely drained daily to prevent accumulation of excess fluids. (T-1) Refer to [paragraph 2.4.8.8](#) for additional guidance.

24.2.6. Oxygen and Nitrogen (Liquid and Gaseous). Refer to [Chapter 26](#) for additional guidance.

24.2.6.1. Personnel Training and Safety. Only fully trained and qualified personnel shall operate oxygen and nitrogen equipment or service aircraft systems. (T-0) A trainee may service only if directly supervised by a qualified supervisor or operator. (T-1) Personnel engaged in oxygen handling and servicing operations shall strictly adhere to pertinent safety standards and TOs. (T-0)

24.2.6.2. Mobile Servicing Units or Bottles. Mobile servicing units or bottles used to service aircraft or components shall be carefully positioned and not left unattended after hook-up or during servicing operations. (T-1)

24.2.6.3. Aircraft oxygen systems (both gaseous and liquid) shall be emptied/drained prior to entering a major maintenance cycle at either an Air Logistics Center, Contract Repair Facility or Contract/Depot Field team location. (T-1) Safeguards shall 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 shall ensure employees comply with requirements in **Chapter 23**, when entering confined spaces. Personnel will not enter confined spaces without training. **(T-0)**

24.2.9. Red Ball. Maintenance personnel shall not deviate from authorized maintenance procedures or violate any flightline requirements, e.g., flightline speed limits or safety requirements, during Red Ball events. **(T-1)**

24.2.9.1. TOs, tools, rags, parts, unused supplies and checklists shall be accounted for before the aircraft is allowed to taxi/takeoff. **(T-1)**

24.2.9.2. Emphasis will be placed on foreign object damage (FOD) awareness/prevention during this critical maintenance operation. **(T-1)**

24.2.9.3. If aircraft engines are operating, a safety observer (maintenance or aircrew member) shall maintain interphone communications or remain in full view of the flight crew and be positioned to maintain overall surveillance of the aircraft and personnel performing maintenance. **(T-1)**

24.2.9.4. Weapons loaded aircraft shall be safed in accordance with applicable Mission Design Series (MDS) and/or weapons specific technical data. **(T-1)**

24.3. Flightline Potentially Hazardous Areas and Operations.

24.3.1. Flammable Fuel Vapor Areas. Supervisors shall ensure all personnel are aware of potentially flammable fuel vapor areas and the restriction against ignition sources in these areas. **(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 shall receive specialized training emphasizing hazards associated with these operations. **(T-0)** Refer to DESR 6055.09_AFMAN 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/approved equipment shall be turned off or removed from the area during refueling operations and fuel cell/tank work, unless permitted by TO 1-1-3. **(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, shall 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. If separation is not possible, receptacles in the immediate area of the fueling or defueling

operations shall be de-energized using administrative devices in accordance with [Chapter 17](#), (T-1)

24.3.3. Aircraft Maintenance Operations. MAJCOMs/FLDCOMs/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 shall be explosion-proof or intrinsically safe and shall comply with NFPA 70 or shall be approved by competent authority, e.g., HQ AFSEC, 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. Equipment not meeting this requirement may be temporarily approved by the installation fire chief prior to the use of the equipment. Approval shall be documented in writing, stating the area, nature, duration and the reason for the exception. (T-1) If the working environment has been tested and contains flammable fuel vapors, all maintenance activities shall be stopped until the hazardous condition is eliminated and a safe work environment restored. (T-0) Equipment in an area with a high potential for flammable fuel vapor release and that can be automatically energized when unattended shall be considered for explosion-proof or intrinsically-safe design. (T-0)

24.3.3.2. Tobacco. In accordance with 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 installation F&ES Flight, in coordination with the Maintenance Group commander or equivalent, Airfield Manager and/or the functional manager.

24.3.3.3. Aircraft Fuels Management and Servicing. Fuel system maintenance and servicing operations shall be in accordance with [Chapter 18](#), TO 00-25-172 and other applicable TOs. (T-1). Aircraft fuel cell and integral tank inspections and repairs shall be in accordance with TO 1-1-3. (T-1)

24.3.3.4. Welding on Aircraft. Welding on aircraft shall be done outside of hangars, whenever possible. (T-1) An AF Form 592, *Hot Work Permit*, shall be issued prior to aircraft welding operations. (T-1) Welding shall only be performed on aircraft system components in accordance with applicable aircraft technical data and [Chapter 20](#). (T-1) Welding operations in hangars shall meet the requirements of NFPA 410, *Standard on Aircraft Hangars*, Chapter 6. (T-1) Refer to American Conference of Governmental Industrial Hygienists' *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for industrial ventilation requirements during welding on aircraft.

24.3.3.5. Fire Extinguishers. Suitable fire extinguishers shall 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](#) for additional information.

24.3.3.6. Nondestructive Inspection (NDI). NDI operations involving ionizing radiation (normally X-ray operations) shall be conducted in accordance with TO 33B-1-1. (T-1) The

installation Radiation Safety Officer shall 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. Refer to AFI 48-127 for 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 shall wear heat-resistant gloves to prevent burns when working around hot exhaust or tail pipes. **(T-1)**

24.4.1. Head Apparel. Head apparel without chinstraps will not be worn in an engine intake danger zone, as defined by the specific aircraft TO, while engines are operating. For further details see AFI 21- 101.

24.4.1.1. Bump Caps. If bump caps are the chosen PPE for use after conducting a hazard assessment in accordance with paragraphs **14.3.1** and **14.3.2**, follow the guidance in **paragraph 14.3.3**.

24.4.1.2. Metal, plastic or leather hair fasteners and wigs shall 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** shall be used when aircraft or equipment TOs do not provide specific PPE guidance. **(T-1)**. When in doubt, consult the installation occupational safety office and 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 shall be provided and worn when there is a reasonable possibility of foot injuries. **(T-0)**. Removable shoe cleats may be worn on the flightline under the following conditions: 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 shall define the type(s) of footwear to be worn, the conditions and locations where such footwear may be worn, and procedures/controls to prevent cleats/spikes/studs becoming a FOD hazard. **(T-1)** Cleats will not be worn while working on or inside aircraft. 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.

24.4.3. Jet Intakes. Mechanics entering jet intake sections shall wear appropriate PPE. **(T-0)** A pocket-less, zipper-less, button-less bunny-suit labeled, "Intakes Only," and cloth over-booties or stocking feet (Boots may be worn if not restricted for use by TO/MAJCOM/FLDCOM and are authorized by MXG). Boots, if worn, must be inspected and FOD removed from boots prior to installing cloth over-booties. **(T-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 shall have procedures in place to control use. **(T-1)**

24.4.4. LOX/LN₂ Transfers. When transferring LOX/LN₂, personnel shall wear PPE (all items shall be clean and free of grease, oil and fuel) as identified in the task-specific JHA, OI and/or job safety training outline (JSTO). Protective footwear, which fit closely around the top, with rubber soles and heels. **(T-0) Note:** A leather boot approximately eight (8) inches in height with close fitting top and rubber soles and heel is recommended, since LOX spills normally subject one's foot area to a freeze burn exposure hazard. This type footwear when equipped with a hard protective toe area is a 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. **(T-0)**

24.5. Aircraft Parking Requirements.

24.5.1. Specific parking locations shall be designated for each aircraft in accordance with DAFMAN 32-1084, *Standard Facility Requirements*. **(T-1)** Generally, distances between parked aircraft, wingtip to wingtip, shall 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_AFMAN 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 shall be used to warn 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 shall be used. **(T-1)** A ground observer shall remain with the aircraft until moved to a safe location. **(T-1)**.

24.5.3. Wheel Chocking. Aircraft wheel chocks shall 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, workstands, loose aircraft parts and materials not actually required for work in progress or planned, shall be moved from the aircraft parking area to designated storage locations. **(T-1)** Equipment stored outside buildings shall be tied down and/or chocked or brakes applied to prevent movement by wind or engine blast. **(T-**

1) Mobile work platforms and stands shall 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 shall be determined by the Aerospace Ground Equipment (AGE) flight commander and airfield manager and approved by the Maintenance Group Commander or equivalent in coordination with the installation 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 shall 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 shall be placed directly over ground mooring points, or as close as possible. **(T-1)**

24.5.7. Aircraft Emergency Removal. Emergency procedures shall be developed to remove endangered aircraft in the event of fire, adverse weather or other emergency situations on the flightline or in hangars. **(T-1)** Refer to [paragraph 24.14.10](#).

24.5.8. C-130 Aircraft. Personnel will not enter the plane of rotation of the propellers except by walking around the outside (number 1 or number 4) propeller arcs. **Exception:** If bleed air is not supplied to the aircraft, personnel may enter the plane of rotation for preflight inspections and maintenance actions.

24.6. Adverse Weather Conditions.

24.6.1. Specific weather thresholds and notification procedures will be documented in the installation weather support document. **(T-1)** Aircraft shall 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 shall be developed to include an evacuation plan and hangaring of installation and transient aircraft. **(T-1)** The option to evacuate is the installation commander's decision in coordination with the appropriate MAJCOM/FLDCOM. Refer to [Chapter 3](#) for additional guidance on weather safety.

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 shall be given priority over heavy aircraft for parking inside hangars. **(T-1)** Aircraft parked outside shall be faced into the wind and tied down. **(T-1)** Wing spoilers shall be used when necessary to reduce airfoil lift. **(T-1)** Transient aircraft shall be parked inside hangars, if space permits, or tied down as directed by the Maintenance Group Commander or equivalent. **(T-1)**

24.6.2.3. When to Tow Aircraft. Light aircraft in docks or extending outside hangars shall be towed clear and parked in accordance with applicable aircraft TOs when winds exceed 30 knots (sustained or gusts). **(T-1)** Medium or heavy aircraft in docks or extending outside hangars shall be towed clear and parked in accordance with 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, workstands, loose aircraft parts, flightline fire extinguishers and materials not in use shall be removed from aircraft parking areas and stored in a safe area. **(T-1)** Equipment remaining outside shall be secured against wind movement. **(T-1)**

24.6.2.5. Personnel. Activities other than those required to safeguard aircraft shall be suspended and avoided when winds reach velocities of 40 knots or greater. **(T-1)**

24.6.3. High Profile Vehicles (Example: 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 Personnel will adhere to locally established high wind safety precautions, plans, and checklists developed by each functional area and observed along with the guidance presented. Criteria for advisories varies from state to state; local procedures shall consider these factors.	Ensure all aircraft precautionary actions are taken in accordance with applicable TOs, Directives and Publications.	In addition to high wind precautions secure all materials and maintenance equipment.	In addition to high wind precautions, have all nonessential personnel move to shelter or remain in their duty section. 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 shall 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 shall seek shelter or remain inside their duty sections.
	Ensure all protective covers are installed on aircraft.	Aircraft should be triple chocked and laced.	For winds in excess of 70 knots, moor aircraft in accordance with applicable TOs; clear ramp.
		Secure all equipment.	Consider evacuation of aircraft.

Note: This table shall be used as a guide in tying down, hangaring or evacuating aircraft.

Note: Installation commander is the governing authority on the evacuation of installation aircraft.

24.7. Towing and Taxiing Aircraft.

24.7.1. Towing Operations. Refer to AFI 21-101, AFMAN 11-218 and specific aircraft TO for vehicle operator's aircraft towing and taxiing. When connecting a tow bar to the tow vehicle, employees shall stand clear until the backing tow vehicle is in close proximity to the tow bar. **(T-1)** When connecting a tow vehicle to the aircraft, employees shall watch for any sudden tow vehicle movement. **(T-1)** Avoid backing aircraft when possible. MAJCOMs/FLDCOMs may authorize movement of aircraft into hardened aircraft shelters while the aircraft engines are operating, provided a System Safety Engineering Analysis has been conducted. A System Safety Engineering Analysis shall be conducted for each type or

generation shelter and type of aircraft to be moved into the shelter. **(T-1) Note:** Technical data takes precedence over this publication when differences exist in towing procedures.

24.7.2. **Qualified Personnel.** Newly assigned aircraft maintenance personnel shall pass a proficiency test on the types of aircraft towed after completing supervised on-the-job training (OJT). **(T-1)** Wing and tail walkers shall be familiar with all published towing procedures for the aircraft being towed but do not require annual proficiency training if their duties are restricted to these positions during towing operations. **(T-1)** Tow team supervisors shall clearly define duties and responsibilities at the time of the pre-tow briefing. **(T-1)**

24.7.3. **Workers Riding or Walking.** Personnel shall 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 shall brief this information prior to towing. **(T-1)**

24.7.4. **Night Crew Signals.** Refer to AFMAN 11-218 for night crew signaling practices. **Note:** Many units have established local policy on night crew signaling procedures. Local policy shall be written in accordance with the tenets of AFMAN 11-218. **(T-1)**

24.7.5. **Control Tower Clearance.** The tow team supervisor shall obtain control tower clearance before towing aircraft on or across a taxiway or runway, maintain radio contact with tower and inform the tower when tow is complete. **(T-1)** The primary means of communication shall be the aircraft radio, but, if not feasible, a radio-equipped escort vehicle, in direct radio contact with the control tower, shall accompany the aircraft throughout the towing operation. **(T-1)**

24.7.6. **Chocks.** Chocks shall be maintained near the tow vehicle or aircraft for emergency use throughout the towing operation and shall be properly placed before the tow vehicle is unhooked. **(T-1)** Chocks or other support equipment shall not be placed on or hung from any part of the aircraft exterior during towing or repositioning operations. **(T-1)** Conduct a risk management assessment of proposed tow operation based on current runway and taxiway condition readings from local Airfield Management.

24.7.7. **Tow Bars.**

24.7.7.1. Only authorized equipment in good condition shall be used in towing operations. **(T-1)** Before moving any aircraft, the tow vehicle, tow bars and connections, and other associated equipment shall be inspected for defects by the tow team supervisor. **(T-1)**

24.7.7.2. **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 (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 shall brief tow bar failure contingencies to the entire tow team prior to commencing towing operations. **(T-1)**

24.7.8. **Towing Vehicle Inspections.** Tow vehicle operators shall inspect all towing equipment to ensure it is serviceable and functioning properly before starting any tow operation. **(T-1)** Inspection shall be documented on AF Form 1800, *Operator's Inspection Guide and Trouble*

Report. The tow team supervisor is responsible for the entire towing operation and shall ensure the tow vehicle is free of defects or extraneous material that may interfere with safe operation before the tow bar is hooked to the aircraft. **(T-1)** Tow vehicles with safety defects shall be removed from service until repaired. **(T-1)**

24.7.9. Engine Operation. As a general rule, aircraft shall not be towed with engines operating. However, civilian contract air carrier jet engine transport aircraft may be towed or pushed short distances, e.g., pushing away from hangar or terminal gate, with engines operating in accordance with Federal Aviation Administration-approved procedures in operations and maintenance handbooks. Copies of these procedures shall be carried on the aircraft. **(T-1)** Air Force aircraft may only be pushed back with engines running during non-routine or abnormal operational requirements using push-back procedures supported by engineering analysis and the aircraft Dash 1 TO.

24.7.10. Taxiing Operations. Refer to AFMAN 11-218 for additional guidance. A marshaller shall be used. **(T-1)** Personnel shall remain clear of taxiing aircraft until the aircraft has come to a complete stop. **(T-1)** Aircraft shall not be taxied without clearance. Radio contact shall be maintained with the control tower throughout taxi operations. **(T-1)** Taxi speeds in uncongested areas shall be reasonable, with aircraft and personnel safety the determining factors. **(T-1)** Follow guidance in Dash 1 handbooks for taxi operations under varying wind conditions. Personnel, vehicles and towed aircraft shall 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 crew members 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 actually impeding it.

24.8. Aircraft Jacking Operations.

24.8.1. Jacks shall be:

24.8.1.1. Operated, maintained, inspected and tested in accordance with 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. Workers shall follow specific aircraft TO jacking procedures. **(T-1)** Non-essential workstands and equipment shall be removed from under the aircraft before jacking. If the aircraft weight-and-balance condition has been affected by removing heavy items, weight shall be added to reestablish the proper center of gravity before jacking. **(T-1)** Workers shall not remain in aircraft being raised or lowered, unless directed by TO (e.g., to observe leveling instruments). TO prescribed jack pads, jack pad fittings and correct jack screw adapters and extensions shall be installed prior to jacking. **(T-1)** Chocks shall 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, shall 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 shall not pass under, climb or walk on any portion of the aircraft when the entire aircraft is supported by jacks, except to support jacking activities or when operationally necessary to perform maintenance. The area around jacked aircraft shall be secured and warning signs posted. **(T-1)** Personnel not directly involved in jacking operations or performing maintenance on jacked aircraft shall 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, shall not be changed or removed on jacked aircraft with landing gear clear of the ramp or floor except in accordance with aircraft TOs.

24.8.6. 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 shall be removed from the ramp. **(T-1)** Refer to [Chapter 6](#) for additional guidance.

24.9. Aircraft Engine Operations.

24.9.1. Follow local OIs, 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 shall wear, at a minimum, hearing protection as prescribed by BE. **(T-1)** Eye protection shall 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. The ignition switch for reciprocating or electric start engines shall be in the OFF position when engines are not operating and the master battery switch shall be turned off when no longer required. **(T-1)** 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 shall not stand in line with the stripe that designates the plane of propeller operation. Radio contact with the control tower shall be maintained during engine operation or taxiing or with job control during engine runs when the control tower is not operating. **(T-1)** Maintenance Operations Center (MOC) shall be prepared to request F&ES Flight or medical services assistance as needed. **(T-1)**

24.9.2. Aircraft Chocks. When aircraft engines are in operation, chocks shall 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) shall be positioned by the fire bottle(s) as required by the aircraft TO prior to starting aircraft engines. **(T-1)** This individual shall remain stand by in readiness until all engines are operating and fire danger is past, 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 shall have a ground observer in position on interphone to monitor and report any problems, e.g., fire, fuel leaks, aircraft movement, and shall remain in position until released by the individual operating the engine. **(T-1)**

24.9.3.2. Aircraft without interphone capability shall have a fire guard stationed to observe the engine start process. **(T-1)** After start, 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/exhaust during ground operation. **Exception:** Aero Club or similar aircraft used by Civil Air Patrol (CAP-USAF) 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. Rotary Wing Aircraft.

24.9.4.1. The collective pitch stick shall be locked in the full low position during engine run-up by ground workers. **(T-1)** Personnel and equipment shall be kept clear of rotary wing aircraft at least a distance equal to its length, to prevent injury and damage if a quick excessive throttle start swings the tail. **(T-1)**

24.9.4.2. Main rotor blades shall be tracked only with an experienced pilot at the controls. **(T-1)** Engine run-up shall not be attempted by fewer employees than specified in specific aircraft TOs. Personnel shall exercise caution when approaching the plane of rotation of main rotor blades because they droop at decreased speeds. **(T-1)**

24.9.4.3. All personnel shall remain in full view of the pilot or helicopter operator and keep a crouched position approaching or leaving a helicopter with rotating blades. **(T-1)** Personnel shall 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.

24.9.4.4. Personnel shall use extreme caution to stay clear of main and stabilizing rotors when visibility is reduced by dust or other conditions. **(T-1)** Protective goggles shall be worn by all personnel and other precautions taken as needed to minimize problems from reduced visibility. **(T-0)**

24.9.4.5. Adequate precautions shall 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 shall 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 may cause extensive engine damage. Unless required by TO, crewmembers, maintainers and other personnel shall not approach closer than 5 feet from the side or rear or 25 feet from the front of engine intake ducts of running engines. Personnel may approach multi-engine aircraft, e.g., F-15, from the opposite direction of the running engine, but shall use extreme caution to prevent ingestion. **(T-1)** All objects shall be removed from in front of or within intake ducts prior to starting engines. **(T-1)** Visiting personnel or observers shall be briefed on removing hats and carrying objects near jet engines. **(T-1)**

24.10.3. Exhaust Blast. Jet engine exhaust blast is hazardous to personnel and property. Local procedures shall be established to prevent personnel, vehicles and aircraft passing behind engines operating above idle speed or through hazardous jet blast areas in accordance with applicable aircraft TOs. **(T-1)** A ground or flight crewmember shall be stationed alongside the operating engine to warn personnel and traffic to remain clear at least 25 feet in front and 200 feet to the rear of the aircraft, depending on the aircraft involved or as prescribed in accordance with applicable aircraft TOs and handbooks. **(T-1)** A blast fence shall be installed where needed to protect personnel and equipment from exhaust blast. **(T-1)** Tools, spare parts and other objects shall 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 shall have aircraft cockpit and flight deck familiarization training prior to entry in accordance with AFI 21-101. **(T-1) Exception:** C-17 Aircraft, Flotation Equipment Deployment Systems – Electro-Environmental workers 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)** Care shall be exercised 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)**

24.10.5. Sharp Edges. Some jet aircraft control surfaces have sharp edges. Personnel shall use caution when working on or near these edges. (T-1) During prolonged maintenance periods, sharp edges or corners of aircraft parts or equipment shall have suitable protective covers, where practical, or tape placed over them and red streamers attached to indicate the danger area. (T-1)

24.10.6. Entering Tail Pipe. In accordance with [Chapter 23](#), based on the determination of the Confined Space Program Team, employees will evaluate the condition of tail pipes prior to entering, e.g., to inspect engine turbine wheel assembly. (T-1) This evaluation will include an atmospheric test prior to entry. (T-1) If the tail pipe was deemed to be a permit-required confined space, appropriate measures shall be taken before entry in accordance with [Chapter 23](#), including use of a BE-approved respirator. (T-1) If the space was deemed non-permit required, the space shall be checked to ensure the space is safe to enter prior to any work being started in the tail pipe. (T-1)

24.10.7. Handling Hydrazine. Firefighting and transient maintenance personnel may be exposed to hydrazine. Employees shall be trained in accordance with [Chapter 14](#) of this manual, and AFI 90-821 and TO 00-25-172. (T-0) Training shall be documented in accordance with AFI 91-202. (T-1)

24.11. Aircraft Cleaning.

24.11.1. General Requirements. Aircraft shall be cleaned in accordance with MDS-specific TOs. (T-1) To prevent falls, employees shall not climb or walk on wet aircraft surfaces. (T-1) Separate elevated work platforms and long-handle brushes shall be used to the maximum extent possible. (T-1) If absolutely necessary to walk on aircraft TO-designated areas during washing, extreme care shall be exercised, and locally designed systems, such as sky-lines (horizontal life lines) and personal fall arrest systems, shall be used. (T-1) Refer to [paragraph 24.16](#) Workers will wear PPE identified by BE to include, but not limited to, chemical-splash goggles, when using brightening agents, caustics, acids, phenolic compounds or other chemicals. Only authorized cleaning agents shall be used. (T-0) Appropriate footwear shall be worn to prevent falls from wet surfaces. (T-0) Refer to [Chapter 14](#) for additional PPE guidance. Refer to AFI 90-821 for hazard communication requirements.

24.11.2. Aircraft Cleaning Operations.

24.11.2.1. Cleaning Parts. Parts shall 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 shall be considered hazardous and performed in a facility or area compatible with the solvents. (T-1)

24.11.2.2. Flammable liquids shall be kept in approved containers, marked to identify contents and stored in buildings/areas specifically approved by the installation F&ES Flight. (T-1) Refer to [Chapter 22](#) for additional guidance.

24.11.2.3. Wiping cloths, oily waste and other combustible materials shall be disposed of in accordance with [paragraph 24.11.2.2](#). (T-1)

24.11.2.4. Proper ventilation shall be maintained and proper protective clothing used when working with solvents. **(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 shall water be used. Employees using flammable solvents shall be trained and proficient in extinguisher use. **(T-0)** Extinguishers shall be sized for possible fires. **(T-1)** A gallon of spilled solvent can cover 25 to 50 square feet, but a small extinguisher may only extinguish 2 square feet. The F&ES Flight shall be consulted to ensure extinguishers with proper capacity are obtained. **(T-1)** Employees shall 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 shall 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 workers shall use tire dollies or mechanical devices when mounting, servicing or removing heavy aircraft tires. **(T-0)** Tire cages shall be used when inflating tires in the shop to prevent injury to employees. **(T-0)** Extreme caution shall be used to avoid over-inflating tires. **(T-1)** Only qualified precision measurement equipment laboratory (PMEL) personnel will adjust and/or calibrate tire inflation equipment. **(T-1)**

24.12.2. The supervisor shall ensure each employee demonstrates and maintains the ability to service aircraft wheels safely. **(T-0)** An employee is considered qualified and trained after completing the installation or unit's training program. The supervisor shall 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 AFMAN 24-306, AFI 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 shall be marked with reflective materials to the maximum extent 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 shall be marked with reflective materials. **(T-1)**

24.13.3. Speed Limits. No vehicle (including motorcycles, mopeds, bicycle or tricycles) shall be operated at a speed in excess of that deemed reasonable and prudent for existing traffic, road and weather condition. **(T-2)** Emergency vehicles will not automatically assume the right of way. **(T-2)** Installation 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. All vehicles, to include wheeled AGE equipment being towed, except emergency and alert vehicles responding to an alert or emergency, shall stop prior to entering the flightline and accomplish an FOD check. **(T-1)** 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 prevented by local procedures, traffic flow on aircraft parking ramps shall be parallel to the noses of parked aircraft with the driver's side toward the aircraft. **(T-1)** Vehicles shall 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 shall not be backed or parked within 25 feet of any aircraft, unless authorized for operations such as loading or unloading, servicing or towing. A spotter shall be posted when backing a vehicle towards an aircraft. **(T-1)** Prepositioned wheel chocks shall 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 shall 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 shall be turned off; keys left in the ignition; and the gear lever put in reverse gear for manual transmissions, and in 'park' for automatic transmissions. **(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)** Only alert and emergency vehicles responding to an alert or emergency are exempt from these requirements. In accordance with 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 installation/delta 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. To conduct a rolling FOD check, the vehicle operator MUST enter 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 shall not be parked or driven less than 25 feet in front or 200 feet behind aircraft with running engines, unless prescribed in applicable aircraft handbooks. Vehicles parked next to aircraft shall be clear of wingtips and clearly visible to personnel in cockpit. **(T-1)**

24.13.6. Passengers in Vehicle. Passengers shall 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 shall 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 a large number of injuries and the practice of riding in the bed of these type vehicles is highly discouraged.

24.13.7. Restricted Visibility or Night Operations. Flashing or parking lights shall be used at night when vehicles are temporarily parked on any part of the aircraft ramp. **(T-1)** **(Note:** Due to possible battery and alternator concerns, MAJCOMs/FLDCOMs may substitute this requirement by adding portable flashing lights.) This does not apply to vehicles parked in a designated parking area. Refueling and explosive loaded (laden) vehicles shall not be operated when visibility is less than 300 feet unless directed by wing/delta or installation commander. PMVs and flightline vehicles, except emergency and alert vehicles, shall not be operated on the flightline with visibility less than 100 feet. A walking guide with a flashing or luminescent wand shall be used during emergency movement of alert vehicles when visibility is under 50 feet. **(T-1)** Vehicle operators shall 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 AFI 13-213 for information.

24.13.9. *Follow Me* Vehicles. *Follow Me* vehicles for guiding aircraft shall be equipped with signs, easily visible at night, reading “*Stop*” and “*Follow Me*”. **(T-1)** They shall 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 marshaler, 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 shall not be used as *Follow Me* vehicles. **(T-1)**

24.13.10. Forklift and Hi-Lift Truck Operations Around Aircraft.

24.13.10.1. A spotter shall assist operators in determining safe clearances when maneuvering close to aircraft. **(T-1)** Bumper blocks or vehicle chocks placed on ramps shall be used to prevent backing into aircraft. **(T-1)** Spotters shall assist operators when necessary to back the vehicle. **(T-1)** The driver and spotter shall be able to communicate at all times. **(T-1)** The spotter shall 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 shall 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 shall 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 shall be driven in reverse as the operator’s field of vision is less obstructed. **(T-1)** Forks of parked forklifts shall be lowered flat on the ground to prevent injury to personnel working or walking in the area. **(T-1)** Parked and unattended forklifts shall 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 (2) persons will operate this piece of equipment. **(T-1)** 1-inch by 12-inch shoring or equivalent protection shall be used to prevent floor damage when moving extremely heavy loads inside aircraft. **(T-1)** Care shall be taken to avoid damaging aircraft ceilings and sidewalls. **(T-1)**

24.13.12. Tractor Operations. All tractor-trailer combinations shall 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 shall be displayed on these vehicles. **(T-1)** Passengers shall not be allowed to ride on tractors unless adequate seats are installed. **(T-1)** No more than four (4) trailers, loaded or empty, shall be pulled by any tractor. **(T-1)** To avoid jackknifing, trailer trains shall be arranged with the most heavily loaded trailer next to the towing vehicle, the next heaviest second in line, etc. **(T-1)** **Exception:** Six A/M- 3H-6 palletized cargo trailers may be moved behind one prime mover.

24.13.13. Deicing Operations. Conduct deicing operations in accordance with TO 42C-1-2, *Anti-icing, Deicing and Defrosting of Parked Aircraft*, and aircraft-specific deicing TO guidance. Only licensed drivers shall operate deicing trucks. **(T-1)**

24.14. Aircraft Hangar Operations.

24.14.1. Hangaring Aircraft. The Maintenance Group Commander or equivalent shall ensure detailed local operating procedures for hangaring aircraft, including safety precautions, are prepared and coordinated with the installation Occupational Safety office and F&ES Flight. **(T-1)** Include installation Weapons Safety Office coordination if hangaring weapons-loaded aircraft.

24.14.2. Aircraft Hangar, Shelter and Dock Facility Guidance. The installation Occupational Safety office, F&ES Flight and BE will evaluate facilities, equipment, processes, etc., and provide recommendations to ensure safety, fire and health hazards are properly mitigated and/or controlled, and complied with required standards, codes, etc. **(T-1)**

24.14.2.1. Fixed electrical equipment approved for Class I, Division 1 locations may be used in Class I, Division 2 locations of the same class and compatibility group. Equipment not meeting these guidelines shall be de-energized or disabled and locked out until special operations are complete and hazardous conditions permanently eliminated. **(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 shall be assigned an risk assessment code by the installation occupational safety office. **(T-1)** A JHA shall be performed and appropriate controls put in place until doors are compliant. **(T-1)** Establish a clear zone, e.g., five (5) feet if space allows, around all hazardous areas. **(T-1)**

24.14.2.4. Safety signs shall be printed in English and the predominant language of non-English reading employees. **(T-1)** Established symbols should also be considered. Employees unable to read posted signs shall be informed of hazardous areas and instructions printed on the signs. **(T-1)** **Note:** For overseas installations with host-nation employees, the maintenance group or squadron commander should consider a training class on safety signs and symbols for host-nation employees.

24.14.3. Training. Employees who routinely work in hangars or require access through hangar doors shall receive Hangar Door Awareness Training, both an initial training program and

annual refresher course. **(T-1)** Courses shall include, at a minimum, door hazards, emergency procedures (including manual door operation) and safe operation. **(T-1)**

24.14.4. Operating Condition. Hangar doors shall be maintained in safe working condition. **(T-1)** Door paths shall be free of obstructions with door tracks and track-ways in good condition and free of debris. **(T-1)** A visual inspection shall be made prior to operation and discrepancies corrected before operation. **(T-1)** Hangar doors shall be on a preventative maintenance schedule and only qualified employees shall perform hangar door maintenance. **(T-1)**

24.14.5. Alarm/Warning Lights. To prevent confusion, powered hangar doors shall have an alarm device with a sound distinguishable from the facility fire alarm and audible above normal noise levels. **(T-1)** The warning device shall automatically signal at least 5 seconds before any door section movement, continuously while the door is operated and shall reset immediately after movement stops. **(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)**

24.14.6. Operational Checkout of Doors and Safety Features. Facility managers shall conduct monthly inspections of hangar door operational and safety features. **(T-1)** CE and Airfield Management shall be notified immediately of any discrepancies. **(T-1)**

24.14.7. Roll-up Hangar Doors. See [paragraph 2.7](#) for roll up door requirements.

24.14.8. 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, *Standard on Aircraft Hangars*, for additional guidance.

24.14.9. Heaters. Combustion heaters installed in aircraft shall not be operated in a hangar. Portable engine and cabin heaters shall be removed and stored immediately after each use or when no longer required. **(T-1)** Engine and shelter heaters shall be placed as far from the aircraft as ducting permits. **(T-1)** No portable heater shall be left operating unattended. **(T-1)** Only heaters approved for operation inside hangars and that do not give off unacceptable levels of carbon monoxide (CO) shall be used. **(T-1)** Heaters and the processes for which they are used shall be evaluated by BE to ensure adequate ventilation is provided and that health threats (e.g., CO) are effectively controlled (e.g., CO alarms are installed) to prevent harmful exposures. **(T-1)**

24.14.10. Aircraft Emergency Removal. The aircraft maintenance officer, designated by the Maintenance Group Commander or equivalent, shall establish emergency procedures to remove aircraft from hangars in case of fire, severe weather or other hazards. **(T-1)** Workers shall 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 shall be attached to the aircraft when in-progress work permits. **(T-1)**

24.14.11. Aircraft shall only be fueled or defueled in facilities approved through a System Safety Engineering Analysis to the current weapons system and facility configuration in accordance with instructions in TO 00-25-172. **(T-1)** Documentation of System Safety Engineering Analysis, 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 shall be maintained by the installation. (T-1) Aircraft fueling and fueling operations in aircraft fuel system maintenance (fuel cell repair) facilities is not allowed unless the facility is fully 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.

24.15.1.1. Machine Safeguarding and Shop Layout. Refer to [Chapter 11](#) and [Chapter 7](#) for additional guidance.

24.15.1.2. Tool Safety. Use of personally owned hand and power tools shall be prohibited. (T-1) Refer to TO 32-1-101 and TO 32-1-2, *Use of Hand Tools (International Business Machines)*, and [paragraph 24.15.8](#) for battery-powered tool use.

24.15.1.3. Compressed 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 shall be evaluated, the level of risk established and controls incorporated where necessary. (T-1) AFI 48-145 provides guidance for these evaluations.

24.15.2. Aircraft Electrical System Maintenance. Electrical systems shall be de-energized whenever possible. (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*, shall 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. If de-energized, approved procedures shall be strictly followed. (T-0)

24.15.2.1. For on-equipment aircraft maintenance, the AFTO Form 492, *MX Warning Tag*, shall be used to flag a condition that could cause damage or injury if ignored. (T-1) Warning tags shall be used during maintenance actions as required by applicable technical data and/or local procedures. (T-1) Refer to AFI 21-101 for additional guidance. Do not use the AF Form 979, *Danger Tag*, for on-equipment aircraft maintenance. The AF Form 979 shall only be used when an immediate hazard exists and specific precautions are required to protect personnel or property or as required by TOs, instructions or other directed requirements. (T-1) Tags shall be placed on damaged equipment to be taken out of service and sent to the repair shop. To reduce the probability of internal electrical shorts, aircraft wiring, including wire bundles, shall be secured to prevent scraping and chafing. (T-1) Electrical components shall be bench-tested in a properly designed shop. (T-1) Testing of electrical systems or equipment while installed on the aircraft shall be held to a minimum. (T-1)

24.15.2.2. If a circuit breaker opens (pops) during maintenance on the aircraft, the popped circuit breaker shall 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. A popped fuel system circuit breaker shall not be reset without following specific guidance in aircraft system TOs. (T-1)

Electrical components and systems shall 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 shall be familiar with OIs for equipment they use, including emergency shutdown, other precautionary measures and use of fire extinguishers. (T-1) Operators shall review maintenance records and inspect equipment for leaks, damage or malfunction before operation. (T-1) AGE equipment shall not be left unattended while running, unless specifically designed for unattended operation. (T-1) Contact the installation AGE Maintenance Shop for further guidance. **Warning:** Danger Area. Personnel shall not climb inside combustion powered AGE (e.g., light carts) as the enclosure may contain fatal levels of carbon monoxide. (T-1)

24.15.5. Communication and Navigation Equipment Repair. Repair communication and electronic equipment on an approved shop bench in accordance with 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 *Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program*, for additional information.

24.15.6. Flight Control Systems. Unexpected movement of flight controls may cause severe injuries. Maintenance personnel shall be trained and aware of dangers with flight control system operation. (T-1) Flight control operation shall be directed orally by interphone or after visual assurance from a person outside the aircraft that flight control surfaces and movement areas are clear. (T-1) All maintenance activities shall be coordinated and a warning tag applied to the flight controls to prevent movement when employees are exposed to potential injury. (T-1) Local procedures shall be developed to address work shift changes when tags must remain in place or be reapplied. (T-1)

24.15.7. Aircraft Hydraulic Systems. Employees shall ensure pressures are relieved prior to disassembling any hydraulic lines or system components. (T-1) Control(s) that could injure personnel or damage equipment shall be tagged out in accordance with TO procedures and/or local procedures while maintenance activities are in progress. (T-1) Proper PPE, such as goggles, shall be worn. (T-0) Hydraulic spills shall be cleaned up immediately to prevent slips and falls. (T-1)

24.15.8. Explosives. Storing, handling and using explosives shall be in accordance with specific TOs and DESR 6055.09_AFMAN 91-201. (T-1)

24.16. Fall Protection Requirements. Maintenance group commanders or designated representative must ensure safe DAF maintenance operations. (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. When deployed operations preclude proper use of fall protection, a JHA may be used to address the limitations and list the actions required to mitigate the risks of falling. The use of chemical gear during chemical, biological, radiological, nuclear and explosive (CBRNE) operations is a good example of a military-unique operation. **Note:** Refer to AFMAN 10-2503, *Operations in a Chemical, Biological, Radiological, and Nuclear Environment*, for additional guidance. These terms are defined as follows:

24.16.1. Military-Unique. Refer to [paragraph 1.7.1](#).

24.16.2. Nonmilitary-Unique. Refer to [paragraph 1.7.2](#).

24.16.3. Given the diversity and complexity of DAF operations, it is impossible to address every situation in this guidance. However, the intent is reasonably clear and commanders have the authority to make final determinations regarding military uniqueness. Decisions that are based upon sound risk management principles, and the DoD guidance provided, are very likely to be defensible and correct. Supervisors working with the local safety staff are in the best position to recommend decisions that optimally balance safety and mission accomplishment.

24.16.4. While the DAF must comply with OSHA requirements to the maximum extent practical, there may be operations where, due to facility or equipment design, or operational requirements, active or passive means of fall protection are not feasible. **(T-1)** In such cases, the best level of fall protection available, within existing operational limitations, shall be provided. **(T-0)** Where adequate lead time is available or for repetitive operations, a fall hazard survey shall be conducted and documented in accordance with [paragraph 13.4](#) **(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.

24.16.5. Types of Fall Protection. Fall hazards from aircraft walking and working surfaces are controlled through application of Risk Management, at command and local levels, to determine which fall protection method offers optimal employee safety for the tasks performed. The maximum use of maintenance stands and work platforms, whenever possible, will reduce the exposure and risk. Whenever it becomes necessary to perform required tasks where a worker can fall four (4) feet or more, fall protection will be used. **(T-0)**

24.16.5.1. Passive. Passive fall protection is the most preferred means of protecting workers from falls. Passive systems need not be directly connected to the 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)**

24.16.5.2. Active. Active fall protection, such as positioning devices, fall restraint systems, ladder climbing devices and personal fall arrest systems, require the employee to wear a full body harness and components and attach himself/herself to an anchorage or lifeline. Positioning devices and fall restraint systems prevent an employee from falling off unprotected sides and edges by restricting the employee's range of movement while a

personal fall arrest system allows an employee to fall off unprotected sides and edges, but the personal fall arrest system and components absorb the energy forces during a fall, reducing the potential for injury.

24.16.5.2.1. Personal fall arrest systems (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 paragraph [13.8](#) 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 of time can be fatal. Supervisors shall ensure employees using a personal fall arrest system can be properly rescued or can rescue themselves should a fall occur. **(T-0)** Availability of rescue personnel, ladders or other rescue equipment shall be determined prior to using a fall arrest system. **(T-0)**

24.16.5.2.2. 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 mass from reaching the fall hazard. When exposed to a fall hazard, a personal fall arrest system must also be used. **(T-0)** Refer to [paragraph 24.16.5.2.1](#) for additional guidance.

24.16.6. 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 DAF personnel or resources are not subjected to hazards, the Installation Occupational Safety office, F&ES Flight, Airfield Management and BE shall review requirement documents prior to submission to Contracting office to ensure contracts and activities of contractors performing a task or service for the DAF. **(T-1)** Appropriate safety, fire and health requirements shall be included in contract specifications. **(T-1)** This is normally accomplished by including appropriate Federal Acquisition Regulation (FAR) provisions or clauses in the contract. Installation Occupational Safety office, F&ES Flight, Airfield Management and BE shall assist the contracting officer and using organization establish appropriate requirements. **(T-1)** If a contractor procedure or condition requires correction, action shall 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 shall call a pre-construction conference before the contractor begins construction on an DAF installation. **(T-1)** Installation Occupational Safety office, Flight Safety Office, F&ES Flight, Airfield Management, BE, the using organization, CE, contractor representatives and other affected agencies, as appropriate, shall be present. **(T-1)** The Contracting Officer shall 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 installation personnel and activities. During requirement development, requiring activity coordination with the installation Occupational Safety office, F&ES Flight, Airfield Management, BE, contract representatives, using organization and other affected organizations, as appropriate, is necessary to assure appropriate safety, fire prevention and health requirements are included in the contract. Prior to contract renewal, Occupational Safety office, F&ES Flight, Airfield Management, 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. Civil Engineering (CE) units are typically involved in numerous planning, maintenance and fire prevention activities that have a high risk for mishaps. Safe management of the work force, inclusion of safety features (most economical during the identification, planning or design phases) and the correction of facility and grounds hazards are instrumental in preventing mishaps. Training, safe work practices, correct 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 damages can occur when electrical, gas and steam lines are broken during digging operations. Ensure AF 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, produces carbon monoxide. Employee exposure to carbon monoxide may be excessive if such operations are conducted in low ceiling, enclosed or poorly ventilated areas. Ensure proper ventilation is available at all times. **(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 shall be in accordance with 29 CFR § 1910.1001, *Asbestos*. **(T-0)** Employees shall not be exposed to unsafe levels of airborne asbestos. **(T-0)** Consult BE prior to all planned asbestos projects. Immediately notify installation BE and BCE if asbestos is suspected or confirmed during a project. Employees shall not resume work until receiving proper guidance from BE. **(T-1)** Refer to AFMAN 48-146, 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 AFI 32-2001, <i>Fire and Emergency Services Program</i> UFC 3-600-01, <i>Fire Protection Engineering for Facilities</i> UFC 3-601-02, <i>Operations and Maintenance: Inspections, Testing, and Maintenance of Fire Protection Systems</i> National Fire Protection Association (NFPA) standards, as applicable
Electrical	Chapter 8 UFC 3-560-01, <i>Operation and Maintenance: Electrical Safety</i> 29 CFR § 1910, Subpart S – <i>Electrical</i> NFPA 70E, <i>Standard for Electrical Safety in the Workplace</i>
Fall Protection	Chapter 13 Chapter 24 29 CFR § 1910, Subpart D – <i>Walking-Working Surfaces</i> 29 CFR § 1910.140, <i>Personal Fall Protection Systems</i>
Machinery and Tools	Chapter 11 TO 32-1-101, <i>Use and Care of Hand Tools and Measuring Tools</i>

Subject	Reference
	29 CFR § 1910, Subpart O – <i>Machinery and Machine Guarding</i> 29 CFR § 1910, Subpart P – <i>Hand and Portable Powered Tools and Other Hand-Held Equipment</i>
Materials Handling Equipment	Chapter 12 29 CFR § 1910, Subpart N – <i>Materials Handling and Storage</i> 29 CFR § 1926, Subpart CC – <i>Cranes and Derricks in Construction</i>
Personal Protective Equipment	Chapter 14 AFI 90-821, <i>Hazard Communication (HAZCOM) Program</i> * 29 CFR § 1910, Subpart I – <i>Personal Protective Equipment</i> **
Hot Work	Chapter 20 AFI 32-2001, <i>Fire and Emergency Services Program</i> AFI 90-821, <i>Hazard Communication (HAZCOM) Program</i> 29 CFR § 1910, Subpart Q – <i>Welding, Cutting and Brazing</i>
Hazardous Energy Control	Chapter 21 AFMAN 32-1065, <i>Grounding and Electrical Systems</i> NFPA 70E, <i>Standard For Electrical Safety in the Workplace</i>
Flammables and Combustibles	Chapter 22 29 CFR § 1910, Subpart H – <i>Hazardous Materials</i> 29 CFR § 1910.106, <i>Flammable Liquids</i> 29 CFR § 1910.119, <i>Process Safety Management of Highly Hazardous Chemicals</i> 29 CFR § 1910.120, <i>Hazardous Waste Operations and Emergency Response</i> 29 CFR § 1910.134, <i>Respiratory Protection</i> 29 CFR § 1926.152, <i>Flammable Liquids</i> NFPA 30, <i>Flammable and Combustible Liquid Code</i>
Confined Spaces	Chapter 23 AFI 23-201, <i>Fuels Management</i> AFI 90-821, <i>Hazard Communications Programs</i> TO 1-1-3, <i>Inspection and Repair of Aircraft Integral Tanks and Fuel Cells</i> 29 CFR § 1910.146, <i>Permit-Required Confined Spaces</i> 29 CFR § 1926, Subpart AA – <i>Confined Spaces in Construction</i>
Training Systems	Chapter 15 AFI 16-1007, <i>Management of Air Force Operational Training Systems</i> UFC 3-600-01, <i>Fire Protection Engineering for Facilities</i> UFC 3-601-02, <i>Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems</i>
<p>* Note: Specific AFI, AFMANs or TOs may include PPE for specific operations.</p> <p>** Note: Specific OSHA standards may include PPE for specified operations conducive to that standard.</p>	

25.2. Supervisory Responsibilities. Supervisors will comply with the requirements of AFI 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)**

25.2.2. Supervisors shall 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, but are not limited to, (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 Job Hazard Analysis (JHA). **Note:** Use of PPE is the least preferred method.

25.2.3. The supervisor shall frequently inspect job sites, work methods, materials and equipment used. **(T-0)** Any unsafe equipment or material shall be tagged and rendered inoperative or physically removed from the workplace. **(T-0)**

25.2.4. The supervisor shall permit only qualified personnel to operate equipment and machinery according to safe work practices. **(T-0)** Refer to AFI 90-802, *Risk Management*, for additional risk management information.

25.2.5. Ensure industrial shops and sites have a basic first aid kit, or suitable substitute that is approved by the installation 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 shall 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 shall never be used to blow debris from a person. **(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 shall be familiar with compressor operating and maintenance instructions. **(T-0)**

25.3.3. The following are requirements for air compressors:

25.3.3.1. Air compressors shall be maintained strictly in accordance with manufacturer's instructions or applicable TO. **(T-1)**

25.3.3.2. The compressed air tank shall be drained in accordance with manufacturer's instructions to prevent moisture build up. **(T-1)**

25.3.3.3. Air tanks shall be protected by adequate safety relief valves. **(T-0)** These valves shall 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 shall be maintained in good operating condition. (T-0)

25.3.3.5. The maximum working pressure of compressed air lines shall be identified in psi. (T-1) Pipeline outlets shall be tagged or marked showing maximum working pressure immediately adjacent to the outlet. (T-0)

25.3.4. Air supply lines shall be protected from damage by vehicles, tools and equipment. (T-0) They shall be inspected regularly and maintained in good condition. (T-1) Air supply lines shall be marked or tagged to identify the maximum psi on the lines. (T-0)

25.3.5. Compressed Air Systems. Plumbing employees shall be trained and authorized to inspect, maintain or install compressed air systems. (T-1)

25.4. Shoring and Trenching. The walls and faces of excavations and trenches over five (5) feet in depth, where employees may be exposed to danger of a cave-in, shall 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 (5) feet deep with hazardous soil conditions shall 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 CE maintenance, repair or construction operations and presents a hazard to personnel in the area (residents, other employees or passers-by), care shall be taken to warn these personnel and other engineering employees of the potential hazard. (T-0)

25.5.1. Appropriate barriers shall 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) shall 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 shall 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 shall be trained in traffic control procedures. (T-1)

25.6. Sanitation.

25.6.1. Shop supervisors shall ensure shop personnel use the protective clothing and equipment that will protect them from hazards of the work they perform. (T-0) The employee

is responsible for keeping their PPE clean, serviceable, sanitary and in a state of good repair at all times, and use the proper equipment, when required.

25.6.2. Employees shall keep their hands and face clean, change clothes when they are contaminated with solvents, lubricants or fuels and keep their hands and soiled objects from contacting their skin, eyes or mouth. **(T-0)** No food or drink shall be brought into or consumed in areas exposed to toxic materials, chemicals or industrial shop contaminants. **(T-0)** After exposure to any contaminant, shop personnel shall wash their hands before eating or smoking. **(T-0)** Safe drinking water shall be provided in or reasonably near all shops. **(T-0)** Waste food from the lunch area shall 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 shall be kept clean and in a sanitary condition. **(T-0)**

25.6.3. Shop personnel required to wear protective clothing shall be provided with change rooms equipped with clothing lockers having separate storage facilities for clean and soiled clothing. **(T-0)** Shower facilities shall be provided when necessary to remove contamination from skin. **(T-0)**

25.6.4. Clothing used daily and issued by the shop shall be cleaned and stored in shop lockers or fenced areas within the building. **(T-0)** Employees shall 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 shall be suitable to weather conditions and work being done. **(T-1)** Highly combustible garments or coveralls made of a synthetic material such as nylon shall not be worn in or around high-temperature equipment or operations such as boiler operations, hot-tar roofing, welding or any other work with open-flame devices. **(T-0)** Refer to AFMAN 32-1065 for additional guidance.

25.8. Equipment Operations and Pavements. Training outlines for operator qualifications shall be tailored to the particular equipment and shall 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 competent person following the manufacturers or sellers recommendation. **(T-0)** AFMAN 24-306 contain general requirements applicable to construction equipment. All required PPE shall be used. **(T-0)**

25.8.1. Joint Seal Kettle-Melter.

25.8.1.1. Kettles shall not be operated without installation F&ES Flight approval. **(T-1)** A permit shall be obtained at least two (2) working days prior to the placement of the tar kettle. **(T-1)**

25.8.1.2. Serious burns can result from improper operation. Clothing that is loose fitting shall be worn. **(T-1)** Pants will completely cover the legs to below the tops of shoes. **(T-1)** Shirts shall be long sleeved. **(T-1)** Loose-fitting gloves shall be worn. **(T-1)**

25.8.1.3. Safety-toe shoes and a face shield shall be worn. **(T-0)** The operator and personnel handling the heated kettle product will wear face shields and gloves. **(T-0)** All tripping hazards shall be removed from the vicinity of the worksite. **(T-1)**

25.8.1.4. Containers shall not be overfilled and shall be allowed sufficient room for the bitumen (tar) to slosh without spilling when the container is moved. **(T-1)**

25.8.1.5. Appropriate number and type of fire extinguishers shall be kept near the kettle. **(T-1)**

25.8.1.6. When adding bituminous or joint sealant materials to the kettle, the product shall be eased into the kettle to prevent splashing of heated materials on the operator. **(T-1)** The kettle shall 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 shall 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 shall 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 shall 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 shall 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 shall be worn during operation. **(T-0)** A firm grasp will be maintained on the tool. **(T-1)** It shall be kept aligned with the hole to prevent binding. **(T-1)** The tool shall 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, and by using required PPE. Prior to commencement of work, ensure personnel are not exposed to asbestos or lead-based paint. **(T-1)** Contact installation Environmental Management office and BE for asbestos and lead verification. **(T-1)** If lead or asbestos is identified or suspected, contact BE for an Occupational and Environmental Health Risk Assessment. **(T-1)**

25.9.2. General Carpentry.

25.9.2.1. Employees shall 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 shall be completely shut down and all energy sources locked or tagged in the de-energized position according to instructions in **Chapter 21**. **(T-0)** Supervisors shall ensure periodic inspections are accomplished on all shop equipment in accordance with appropriate technical data or manufacturer's recommendations. **(T-1)** Chips or dust shall never be removed from machinery by hand. **(T-1)** Machine guards and safeties shall 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 and 29 CFR §§ 1910, Subpart O – *Machinery and Machine Guarding*, and Subpart P – *Hand and Portable Powered Tools and Other Hand-Held Equipment*, and 29 CFR § 1926 Subpart I – *Tools – Hand and Power*, for both carpentry and structural maintenance work methods or tools. (T-0)

25.9.3. Ventilation Systems.

25.9.3.1. Only essential safety, fire prevention and occupational health requirements are addressed in this publication. Contact BE for specific guidance, including information on flow rate requirements. Ventilation and exhaust systems shall be installed and maintained in accordance with the manufacturer's instructions. (T-1)

25.9.3.2. Refuse. Refuse shall be removed daily in all operations not required to have an exhaust system or where the refuse cannot be handled by an exhaust system. (T-1)

25.9.4. Storage and Handling of Lumber. Refer to 29 CFR § 1910.265(c)(27), *Lumber Piling and Storage*, for additional guidance.

25.9.5. Roofing Operations. Refer to AFI 32-1001 for additional 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*, and ANSI/ASSP A10.9, *Safety Requirements for Concrete and Masonry Work*, for additional guidance.

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 shall be provided and located separately from the office areas and breakroom. (T-0)

25.11. Plumbing Maintenance. Plumbing maintenance normally includes the installation, preventive 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 confined space entry procedures and requirements.

25.11.1. Personal Protective Equipment. Ventilated lockers for clothing and shower facilities shall be provided and located separately from the office areas and breakroom. (T-0) Refer to Chapter 14 for additional PPE guidance.

25.11.2. Hot Operations.

25.11.2.1. Torches and Furnaces. Work and storage areas for this equipment shall be well ventilated. (T-0) Where flammable or explosive vapors or dust may be present, torches and furnaces shall not be used until the atmosphere has been tested and the sources of such vapors or dust removed. (T-1) Refer to Chapter 20, Chapter 18, 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 solders used have 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 shall be checked. (T-1) Where required because of toxic fumes, a respirator or adequate ventilation shall 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 been evaluated, contact BE for an occupational and environmental health risk assessment.

25.11.2.2.2. Electric soldering irons shall be grounded unless of double-insulation construction. (T-1) All soldering irons shall be placed in suitable non-combustible receptacles when not in use. (T-1)

25.11.2.2.3. When required, an AF Form 592, *Hot Work Permit*, shall 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 shall be familiar with the properties of gases in the systems they maintain. (T-1) Personnel entering the area shall be suited with PPE and respiratory protective devices. (T-1) Consult with installation occupational safety office and BE with questions pertaining to PPE. Refer to [Chapter 14](#) for additional guidance.

25.11.4. Tunnels, Pits and Sumps. Where shop personnel are required to work in utility tunnels, pits and sumps, the atmospheric conditions shall be checked for explosive atmosphere or oxygen deficiency before allowing employees to enter. (T-0) Personnel shall be suited with proper protective equipment and respiratory protective devices, when required, while performing maintenance to underground utilities. (T-0) Consult with the installation occupational safety office and BE on questions pertaining to PPE and proper air quality testing. Refer to [Chapter 14](#) for additional guidance on PPE. All tunnels, pits or sumps known to be contaminated shall be tagged or otherwise identified for work crews. (T-1) Spaces determined to be permit required confined spaces shall be entered under all provisions addressed in accordance with [Chapter 23](#). (T-0) When manhole covers are removed, barriers shall be installed to prevent injury to personnel not associated with the work in progress. (T-0)

25.12. Refrigeration and Air Conditioning Maintenance. Refer to AFMAN 32-7002 for additional guidance.

25.13. Heating Systems and Central Heating Plant Maintenance. Refer to AFMAN 32-1068, *Heating Systems and Unfired Pressure Vessels*, for additional guidance.

25.14. Water and Wastewater Treatment. Refer to AFMAN 32-1067, *Water and Fuel Systems*, and AFMAN 32-7002 for additional 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 absorption of toxic and hazardous chemicals through the skin and respiratory system. 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, confined space hazards (e.g., oxygen deficiency). Particular attention shall be given to prevent exposure to hazardous noise levels since the effects of over-exposure are not always apparent immediately or in the near future. **(T-1)** Potential physical and health hazards can be effectively controlled by following guidance in this chapter, by proper work procedures and controls, and by using protective equipment and clothing. Refer to [Chapter 14](#), 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 shall be trained in accordance with 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 safety data sheets (SDSs) for proper handling, storage, dispensing and transporting of cryogenic liquids. Information contained within this chapter provides general guidance applicable to most cryogenic liquids.

26.1.1. Physical Hazards.

26.1.1.1. Liquid nitrogen (LN₂) and liquid oxygen (LOX) hazards are primarily associated with phase change and low temperature effects of cryogenics. A tremendous volume increase occurs when either liquids undergoes a phase change from liquid to gas. When LN₂ vaporizes, each cubic foot of liquid expands to 695 cubic feet of nitrogen gas. For LOX, the expansion ratio is 860 to 1. Containment of cryogenics may create a tremendous pressure increase if liquid to gas conversion occurs, so a sealed container can become a bomb. Expansion on ratio of LN₂ can displace oxygen in a confined space, causing an asphyxiation hazard. Expansion of LOX can cause oxygen enrichment, producing fire and explosion hazards. See [paragraph 26.1.3](#) for additional information.

26.1.1.2. The cold temperature of LN₂ (-320° F) and LOX (-297° F) can alter the strength, ductility, thermal expansion, thermal conductivity and heat capacity of materials. Mild carbon steels become brittle and failure-prone when exposed to cryogenics. However, properly treated metals such as austenitic steels, nickel, aluminum, copper and a number of alloys are safe for low temperature work.

26.1.1.3. LN₂ can liquefy oxygen from the air it contacts. Therefore, an open container of LN₂ will slowly condense air causing a LOX concentration buildup within the LN₂. The presence of LOX within LN₂ 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 shall 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 in accordance with local procedures. Refer to TO 42B-5-1-2 for general safety guidance and requirements for compressed gases.

26.1.1.5. Liquid Hydrogen (LH₂). Hydrogen's flammability range is very wide (between 4 percent and 75 percent in air), compared to other fuels. Under optimal combustion condition (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 -423° F, a temperature that can cause cryogenic burns or lung damage. Detection sensors and PPE are critical when dealing with a potential LH₂ leak or spill. Refer to 29 CFR § 1910.103, *Hydrogen*, for additional 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° C (-260° F) and maximum transport pressure is set at around 25 kPa (4 psi).

26.1.2. Physiological Hazards.

26.1.2.1. Evaporation of LN₂ in a poorly ventilated or unventilated enclosure may reduce the oxygen content of the air and produce asphyxiation and death. Because the brain requires the most oxygen, a reduction in available oxygen will first affect the mental processes. A slight impairment of the ability to concentrate and think clearly is an early symptom, which then progresses to a loss of consciousness. Unconsciousness can occur in seconds in atmospheres with very high concentrations of nitrogen. Recovery in fresh air is rapid and complete if exposure to high concentrations of nitrogen is short. Prolonged exposure can cause death.

26.1.2.2. The extremely cold temperature of LN₂ 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 LN₂ and LOX and will freeze to the skin on contact. Flesh can be badly burned and severely torn in an attempt to free it, which must be done immediately since the results of prolonged skin contact are worse.

26.1.2.3. LH₂ 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. LH₂ 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. Approach suspected leak area with caution. Before entering area, especially confined areas, check atmosphere with an appropriate device. Self-contained breathing apparatus and PPE may be required by rescue workers. Remove all sources of ignition if without risk. Reduce gas with fog or fine water spray. Shut off flow if without risk. Ventilate area or move container to a well-ventilated area.

26.1.2.4. LNG is normally stored and transported in liquid form at a temperature of approximately -162°C (-260° F). If this cooled liquid is released from a storage facility, pipeline or LNG transport ship, then 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 (with some ethane) 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 come in contact with hydrocarbon materials when leaked or spilled, including all areas where LOX might flow after a spill. If spilled onto asphalt, LOX will seep into cracks and form shock-sensitive compounds which can explode violently upon impact. **(T-0)** 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 LN₂ and LOX production and storage cause skin irritation or burns, and can be absorbed through the skin. It may also cause liver damage and poisonous if taken internally.

26.1.5. Spill Hazards. LN₂ 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 LN₂ and LOX.

26.2.1.1. Liquid Nitrogen. LN₂ is a colorless, odorless, nonflammable, nontoxic and chemically inactive water-like fluid with a boiling point of -320° Fahrenheit (F). LN₂, less dense than water, weighs approximately 6.7 pounds per gallon. The expansion ratio for LN₂ (from LN₂ to gaseous nitrogen) is 695 to 1 at normal temperature and pressure. The critical temperature of LN₂ is -233° F at 493 pounds per square inch absolute. At temperatures higher than this, LN₂ 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. Liquid oxygen is attracted to an electromagnet much like iron and will combine readily with other substances to actively support combustion.

26.2.2. Production of LN₂ and LOX. LN₂ and LOX storage tanks are constructed with an inner cylinder supported in an outer vacuum insulated jacket to reduce radiation and convection heat transfer. The evacuated space between the inner and outer vessels contains a highly efficient

insulating material, which reduces boil off of the LN_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 located in a cabinet at the front end of the tank. Storage tanks are manufactured in various sizes and shall be designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code. **(T-0)** Safety relief valves shall be installed so moisture cannot collect, freeze and interfere with proper operation of the valves. **(T-0)** Frangible disks shall 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. Production 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 similar to, 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 to be used in heating and cooking as well as electrically 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.

26.2.4. Generating Plants. DAF LN_2 and LOX plants can typically produce one and one-half to five tons of liquid oxygen per day (24 hours). These plants produce four products: liquid and gaseous nitrogen, and liquid and gaseous oxygen. LN_2 and LOX are generated from atmospheric air through five basic steps: compression, purification, refrigeration, expansion and distillation.

26.2.5. High Pressure. Pressures approaching 4,000 pounds per square inch (psi) may be found in production facilities. To prevent personnel injury and property damage from whipping of failed lines, all high-pressure lines shall be secured with brackets, braces or other suitable tie-down devices. **(T-0)**

26.2.6. Contamination. Atmospheric contamination during production runs may introduce impurities into the cryogens. To avoid this hazard, the following operations are not permitted during production:

26.2.6.1. Painting.

26.2.6.2. Welding, cutting and other hot work.

26.2.6.3. Solvent use.

26.2.6.4. Any operation generating toxic and noxious gases or vapors.

26.3. Cryogenic Facility Siting.

26.3.1. Safe Distance Criteria. The special hazards associated with LN₂ and LOX require care be exercised in siting these facilities. Production or storage facilities of 100 gallons or more shall conform to the following minimum separation distances. **(T-0)** Refer to UFC 3-600-01 and TO 00-25-172. In accordance with DESR 6055.09_AFMAN 91-201, if the cryogen is used as a propellant and/or fuel, the most stringent distance shall apply.

26.3.1.1. Stationary Cryogenic Containers, Cylinders and Tanks. Stationary containers located outdoors shall be separated from exposure hazards in accordance with 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 shall be separated from exposure hazards. **(T-0)**

26.3.2. Facility Requirements.

26.3.2.1. Security fencing and lighting shall be in accordance with AFI 23-201. **(T-0)**

26.3.2.2. LOX production and storage facilities shall be permanently placarded to indicate “OXYGEN—NO SMOKING—NO OPEN FLAMES” or an equivalent warning. **(T-0)**

26.3.2.3. Notify the installation BCE prior to installation, modification or repair of utility services (water, electricity, sewage, telephone).

26.3.2.4. Joint sealer shall 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 area around the LN₂ and LOX plant itself (where spills are most likely to occur) shall be concrete. **(T-1)** Refer to AFI 23-201 for additional guidance.

26.3.2.5. A paved road shall be provided to and from the facility for delivery, maintenance and emergency vehicles. **(T-1)** Refer to AFI 23-201 for additional guidance.

26.3.2.6. Generator plants shall be permanently grounded. **(T-1)** Storage and servicing tanks shall have adequate grounding points. **(T-1)** Refer to AFI 23-201 for additional guidance.

26.3.2.7. Generating plants shall be sited to minimize airborne contamination of the local area. **(T-1)**

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 LN₂ and LOX production and storage. BE's occupational and environmental health risk assessment recommends appropriate controls.

26.4.2. Noise. Noise levels in generating plants can reach high levels, particularly during defrost, start-up and shutdown operations. AFI 48-127 addresses program responsibilities, designation of hazardous noise-producing equipment and hazardous noise areas, required PPE and required medical examinations for workers exposed to hazardous noise. If process not already evaluated, contact BE for an occupational and environmental health risk assessment.

26.4.3. First Aid Medical Treatment for Cryogenic Burns. Remove the victim from exposure immediately and transport to the nearest emergency room as soon as possible. Identify

exposure to LN₂ or LOX. Keep the victim warm and dry by wrapping exposed areas in a blanket. No attempt to re-warm frozen body parts shall be made until the victim is under proper medical care. **(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 shall 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 shall be done only by medical services personnel. **(T-1)**

26.5. Safety Precautions When Working With LN₂, LOX, LH₂ and LNG.

26.5.1. PPE for LN₂ or LOX. PPE is of two distinct types — cryogenic and chemical protection; and may not be interchangeable. Local procedures shall be developed to prevent hydrocarbon or chemical contaminated PPE from being used during cryogen transfers.

26.5.1.1. Personnel handling or transferring LN₂ or LOX shall follow PPE requirements in [Chapter 14](#). **(T-0)** Non-absorbent long sleeves shall extend to the gloves. **(T-0)** Cuffless trousers shall be worn outside leather boots or over high-top leather shoes to shed spilled liquid. **(T-0)** BE-approved foot protection shall have no mesh sides or air holes and will be tightly laced to prevent spilled cryogen seeping inside. **(T-0)** Only tightly woven materials shall be worn during LN₂ or LOX operations. **(T-0)** A face shield, eye protection (safety goggles or safety glasses with side shields) and apron (leather or other BE-approved) shall be worn. **(T-0)**

26.5.1.2. When transferring LN₂/LOX, personnel shall wear protective footwear, which fit closely around the top, with rubber soles and heels. **(T-0)** Boots, shoes or other BE-approved foot protection shall 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 (8) inches in height with close fitting top and rubber soles and heel is recommended, since LOX spills normally subject one's foot area to a freeze burn exposure hazard. This type footwear when equipped with a hard protective toe area is generally classified as a safety shoe or boot.

26.5.1.3. LN₂ and LOX both saturate clothing. Such contact holds the LN₂/LOX against the skin and may be more hazardous than a direct splash. Contaminated clothing will be removed, hung up and air dried for one hour. **(T-1)**

26.5.1.4. Due to its cold temperatures, LH₂ is a hazard for cold burns. Also, because of its flammability, LH₂ should be kept away from heat or flames, unless ignition is intended.

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 percent to 15 percent), 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 LN₂ 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. LN₂, 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. Elemental hydrogen as a liquid is biologically inert and its only human health hazard as a vapor is displacement of oxygen, resulting in asphyxiation.

26.5.5. LOX/LN₂ Transfers.

26.5.5.1. When transferring LOX, personnel shall wear the following PPE (all items shall 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 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 in accordance with [paragraph 26.5.1.2](#) or other BE-approved foot protection. **(T-0)**

26.5.5.2. When transferring LN₂, personnel shall wear the following protective clothing and equipment (all items shall be clean and free of grease, oil and fuel):

26.5.5.2.1. Head covering. (T-0)

26.5.5.2.2. Eye protection (goggles). (T-0)

26.5.5.2.3. Face shield. (T-0)

26.5.5.2.4. Gloves (loose fitting), leather, welder's gauntlet cuff, medium with gloves, cloth, work, cotton knit, medium as an insert; or Gloves (loose fitting), leather with glove inserts, wool. (T-0)

26.5.5.2.5. Apron. (T-0)

26.5.5.2.6. One of the following: jacket, long sleeve shirt or coveralls (Refer to TO 00-25-172 for guidance on coveralls). (T-0)

26.5.5.2.7. Cuff-less trousers. (T-0)

26.5.5.2.8. Foot protection in accordance with [paragraph 26.5.1.2](#) or other BE-approved foot protection. (T-0)

26.5.6. Oxygen Carts. Oxygen carts shall be kept clean and free of moisture, oil and grease. (T-1) Oxygen carts shall 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 shall not be parked in direct sunlight. Liquid oxygen (LOX) carts containing LOX shall not be parked in hangars, nose docks or shelters unless designed or modified for this purpose. LOX carts shall be transported with vent valve closed and parked with vent valve open. (T-1) In accordance with TO 00-25-172, cylinders should be isolated from any incompatible or combustible material storage by a barrier of noncombustible material at least 5 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 25 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. Workers shall wear only approved clothing and shall 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 LN₂. Although inert, LN₂ is colder than LOX. It liquefies oxygen from the surrounding air and, therefore, an open container of LN₂ will slowly condense

oxygen from the air causing a LOX concentration buildup within the LN₂. When the LN₂ is pale blue in color, there is LOX present in the mixture. The LOX contamination can cause unexpected chemical reactions with other materials.

26.6.6. Consult the installation F&ES Flight on fire protection and compatible firefighting agents for LN₂ and LOX production and storage facilities. Nitrogen is a fire suppressant but oxygen supports combustion. In an oxygen supported fire, stop the oxygen flow if possible. Use large quantities of water, preferably in the form of a spray, to cool the burning material. If electrical equipment is involved in the fire, ensure electrical power is turned off before applying water. **(T-1)** LOX is a vigorous oxidizing agent and supports combustion of many materials not flammable in air. A LOX fire cannot be extinguished with carbon dioxide (CO₂), dry chemical or foam. Unless the LOX flow can be stopped or the combustible materials isolated from the LOX, such fires are difficult if not impossible to extinguish.

26.6.7. Always maintain a clear and unobstructed access to and from LN₂ 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 conditions of pressure and temperature. These include oil, grease, asphalt, kerosene, cloth, paint, tar and dirt, and anything which may contain oil or grease. If LOX is spilled on asphalt or surfaces contaminated with combustibles (for example, oil-soaked concrete or gravel), do not walk on or roll equipment over the area of the spill. Keep sources of ignition away for at least 15 minutes after all frost has disappeared.

26.6.9. LH₂ leaking from a fuel tank, evaporates quickly because of its low boiling point, rising in the atmosphere due to its low density in comparison to normal air. Products of burning LH₂ 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. LN₂ and LOX production plants and tank support equipment may require electrical service up to 480 volts alternating current. Use extreme care when working around any electrical connections, panels, motors or other energized components. Moving fluids, drive belts, removal of clothing and almost any form of friction can generate a static charge. Ground LN₂ and LOX plant components and storage tanks at all times. 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 shall 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 shall be kept meticulously clean and properly stored. **(T-1)**

26.8.3. Store LH₂ in accordance with manufacturer's instructions and/or Air Force 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 suggested in the safety data sheet (SDS) to avoid 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. Be sure that all electrical equipment used in the area is UL-listed Class I, Division I, Group D hazardous locations. 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 LN₂ or LOX.

26.9.1. Due to the catastrophic consequences of mixing LN₂ and LOX in storage tanks and carts, workers shall exercise care in verifying the correct product is transferred to the correct storage tank or cart. **(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. Only fittings designed specifically for LOX or LN₂ equipment will be used; workers will never fabricate or use ones that are compatible with both LOX or LN₂ equipment. **(T-1)**

26.9.2. At least two workers, fully knowledgeable in DAF safety criteria and operational procedures shall be within normal voice or eye contact when generating or transferring cryogenic fluids. **(T-1)** This also applies to maintenance actions on cryotainers or plants when cryogenic fluids are present in the system. Personnel requirements for aircraft servicing operations shall be in accordance with TO 00-25-172. **(T-1)**

26.9.3. All transfers of LN₂ and LOX shall 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 shall be developed for this contingency. **(T-1)**

26.10. Common Cryogenic Liquids, Their Properties and Precautions.

26.10.1. While LOX and LN₂ are widely used cryogenics, other cryogenics are also used within the DAF, such as LH₂ and LNG. As with LOX and LN₂, 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. **(T-1)** Common cryogenic liquids include nitrogen, helium, hydrogen, argon, methane, oxygen and carbon monoxide.

26.10.2. Although liquefied carbon dioxide (CO₂) does not meet the definition for a cryogen, at -57° C it is very cold, can burn exposed skin and shall be treated as a cryogen. **(T-1)**

26.10.3. Workers shall read the SDS and safety precautions for all cryogenics 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 cryogenics, 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. BE's occupational and environmental health risk assessment 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 cryogenics enter the gloves. Supervisors shall review chemical SDSs as well as contact BE for proper PPE. **(T-0)**

26.10.4.3.1. Wear a long sleeve shirt and cuffless pants. **(T-0)** Pants should be worn over the tops of boots. **(T-0)**

26.10.4.3.2. Wear foot protection in accordance with [paragraph 26.5.1.2](#) or other BE-approved foot protection.

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 cryogenics. **(T-0)** Unapproved materials such as plastic, rubber, wrought iron and carbon steel will become brittle and shatter. (Chemical ensemble vinyl overboots shall not be worn while handling cryogenics, except when threat of chemical/biological threat exists, as determined by the organization commander.)

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. **Note:** Follow manufacturer's instructions and SDSs for proper handling, storage, dispensing and transporting of cryogenic liquids. Information contained within this chapter provides general guidelines applicable to most cryogenic liquids.

26.10.5.1. Special precautions shall be taken to prevent spills while dispensing or transporting cryogenics 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 cryogenics shall:

26.10.5.1.1. Wear proper PPE when dispensing or transferring cryogenic liquids. **(T-0)**

26.10.5.1.2. Cool the secondary container by adding a little cryogenic liquid first, when obtaining liquid from a large dispensing dewar or cylinder. **(T-1)** Dispense slowly to mitigate thermal stress and prevent excess 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. When using cryogenics, personnel shall use at least two (2) personnel to transport cryogenic liquids indoors. **(T-1)** Use handcarts equipped with brakes to move large dewars and cylinders. **(T-1)** **Note:** 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)** **Note:** One person transporting LOX and LN₂ carts to the flightline is acceptable as long as carts are equipped with a pintle hook and towed behind a vehicle.

26.10.5.2.2. Personnel shall always use care when handling equipment. **(T-1)** Damage to dewars could cause loss of vacuum, increased evaporation or leaks.

26.10.5.2.3. Personnel shall wear PPE and hold the dewar as far away from the face as possible when carrying a dewar. **(T-0)** Containers that cannot be easily and safely carried shall be placed on a stable wheeled base designed for the dewar. **(T-0)**

26.10.6. Storage of Cryogenic Liquids. Gas from a cryogenic liquid storage unit left open to the atmosphere or a catastrophic failure of a storage unit could create an oxygen deficient atmosphere. To reduce the likelihood of this occurring, users shall ensure:

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. Dewars are stored in well-ventilated rooms with a minimum of six (6) air changes per hour. **(T-1)** If the ventilation rate is unknown, contact BE to evaluate the storage area as the installation of oxygen detection systems and alarms for cryogenic liquid storage areas may be required based on location, ventilation and quantity of material stored.

26.10.6.3. Cryogenic liquids are not 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 are well ventilated. **(T-0)** Consult BE for recommended continuous oxygen monitoring equipment. All new installations shall be designed with an oxygen monitoring system and alarm. **(T-0)**

26.10.6.7. Cryogenic dewars are not be stored in hallways, unventilated closets, environmental rooms or stairwells. **(T-0)**

26.10.7. Special Precautions for Liquid Oxygen and Flammable Cryogenic Liquids. Flammable cryogenic liquids like methane, hydrogen and carbon monoxide are hazardous. While oxygen does not burn, it supports and accelerates combustion rates of other materials and may form explosive mixtures with other combustibles. Prior to using flammable cryogenics and oxygen:

26.10.7.1. The supervisor shall contact 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. The supervisor 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 very 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. **(T-1)**

26.10.7.6. Ensure a valve operation is performed very 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 the installation F&ES Flight and BE immediately if ice blockages occur.

26.10.8.2. If a spill occurs, immediately exit the area and contact the installation 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 shall only be retrieved by personnel using a self-contained breathing apparatus. **(T-1)** Once the person is removed 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. Workers shall 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, particulates and vapors. Inhalation of mists and vapors from paints, solvents, thinners, cleaning chemicals, strippers and epoxies can be injurious depending upon the agent's toxic characteristics and the amount and method of exposure. Three of the more toxic pigment ingredients are lead, antimony and chromates. Their use shall be avoided. **(T-0)** In addition, paints containing epoxy or polyurethanes can cause respiratory sensitization. Respiratory sensitization results from an allergic reaction to a given substance. This sensitivity develops during the induction period, which may be a few days to a few months. After sensitivity is established, exposure to even a small amount of the sensitizing material can produce a severe reaction. Refer to **Chapter 2** of this instruction, 29 CFR § 1910.107, *Spray Finishing Using Flammable and Combustible Materials*, AFI 90-821, and BE workplace evaluations for additional guidance and information.

27.2. Safety.

27.2.1. Equipment used in painting operations is hazardous. Therefore, functional managers shall ensure spray painting operations are closely supervised and equipment is in serviceable condition. **(T-0)**

27.2.2. Other Equipment. Painter's ladders, scaffolds, lifelines and other equipment shall be inspected prior to use to ensure all equipment is in a safe condition. **(T-0)** Refer to **Chapter 7**, **Chapter 14**, and **Chapter 22** for additional guidance and information. Powered industrial trucks, man lifts and other aerospace ground equipment shall meet the requirements of 29 CFR § 1910.178, *Powered Industrial Trucks*, for Class I, Division I locations. **(T-0)**

27.2.3. Paint Mixing. Paint or dope mixing shall be performed in designated areas, which will be adequately ventilated rooms constructed of fire-resistant materials. **(T-0)** The mixing of paint may be accomplished out of doors with approval of the installation Environmental Management office. Otherwise, paint shall only be mixed in a covered, dust-controlled area and shall not exceed local air emission standards. **(T-0)** All sources of ignition shall be prohibited in mixing areas. **(T-0)** All electrical fixtures or equipment within 20 feet of designated paint preparation areas shall meet the requirements of NFPA 70 for Class 1, Division 1 locations. **(T-0)** Mixing rooms shall 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 shall be cleaned up promptly. **(T-0)** Work clothing shall be stored in metal lockers that are vented at top and bottom. **(T-0)** Street clothing and protective clothing shall be kept in separate lockers. **(T-0)** Paint rooms, booths, etc., shall be kept clean with equipment stored in a proper and orderly manner. Rags or waste soiled with sprayed materials shall be deposited in approved self-closing metal waste containers immediately after use. **(T-0)** In accordance with 29 CFR § 1910.107(g)(3), *Residue Disposal*, the contents of waste containers shall be disposed of at the end of each shift or at least once daily. **(T-0)** Contact the installation Environmental

Management office for waste disposal guidance. Paint stored in workshops shall be kept in tightly covered metal containers and meet the requirements of **Chapter 22**. (T-0)

27.2.5. Personal Protective Equipment. Personnel engaged in painting and paint removal shall wear protective clothing, respiratory devices (if required) and appropriate face, eye and hand protection. (T-0) Clothing shall 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 shall be kept clean and, when not in use, shall be hung in ventilated metal lockers. (T-0) Refer to **Chapter 14** for additional guidance.

27.2.6. Eye Protection. Personnel using abrasive techniques to prepare surfaces for painting shall wear suitable eye protection to protect their eyes from chips and flying particles. (T-0) Eye protection and rubber gloves shall be worn when using acids, lye or noxious cleaning materials. (T-0) Refer to **Chapter 14** for additional guidance.

27.2.7. Respiratory Protection. BE's occupational and environmental health risk assessment determines respiratory protection. 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 shall not be used without approval of the installation Radiation Safety Officer (usually the BE or assigned to BE). (T-0) Refer to AFMAN 40-201 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 BE's occupational and environmental health risk assessment for additional guidance.

27.3.3. Personal Hygiene. In accordance with 29 CFR § 1910.134(g)(1)(i)(A), personnel required to wear tight fitting respiratory protection shall be clean shaven so facial hair will not interfere with the face-piece seal of the respirator. (T-0) Employees shall keep hands and faces clean, clothes shall be changed when contaminated, and hands and soiled objects shall be kept out of the mouth. (T-0) No food or drink shall be brought into or consumed in paint and dope shops. (T-0) Employees shall 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 shall be disposed of in accordance with AFMAN 32-7002, and as specified and approved by the installation BCE. (T-0)

27.4. Fire Prevention.

27.4.1. Fire Prevention. Some 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 dilutants are very flammable. Other paints, under certain conditions, will burn violently. These

paints, for control purposes, are classified as flammable, unless specifically stated by the manufacture as being combustible.

27.4.3. Paint Remover. Paint removers are corrosive and are considered flammable or combustible based on their flash point. They may contain volatile ingredients and the residue after evaporation may also be flammable or combustible.

27.4.4. Solvents. Solvent materials used for residual cleanup, after the initial removal, will have a flashpoint of 140° F or above. Cleaning operations using flammable or combustible solvents shall be conducted inside spray areas with ventilating equipment operating. **(T-0)**

27.4.5. Methyl Ethyl Ketone. Methyl ethyl ketone used as a solvent wipe-down on aircraft just prior to painting. 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 extreme caution to ensure there are no ignition sources in the area and ventilation is adequate to remove flammable vapors. Employees shall use approved respiratory protection in accordance with AFI 48-137 and minimize skin contact. **(T-1)**

27.4.6. Storage. Paints and solvents shall be stored in accordance with **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 shall 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 shall 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 shall be emptied or removed to an approved location outside the shop for pickup and disposal. **(T-0)** Contact the installation Environmental Management office 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 shall 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 shall 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 shall be provided with mechanical ventilation capable of confining, controlling and/or removing vapors, mists and combustible residues, dusts and deposits. **(T-0)** Mechanical ventilation shall be kept in operation whenever spray operations are conducted and for a sufficient time thereafter to allow ventilation of vapors from drying coated objects or material and residues. **(T-0)** An adequate supply of makeup air, e.g., fresh outside air flowing through a building via ventilating (heating or cooling) equipment, shall be provided. **(T-0)** BE shall be consulted for questions concerning makeup air requirements. **(T-0)** Ventilation and exhaust systems shall be installed and conform to the provisions of this chapter

and NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Particulate Solids*. **(T-0)** Refer to American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance.

27.5.2. Exhaust and Ventilation Units. The rotating elements of the exhaust fan shall be of nonferrous materials or the fan shall be constructed so that a shift of the impeller or shaft shall not permit two ferrous parts to rub or strike together. **(T-0)** There shall be ample clearance between the rotating element and fan casing to avoid a fire caused by friction. **(T-0)** Necessary allowances shall be made for ordinary expansion and loading, and to prevent contact between moving parts and the duct or fan housing. **(T-0)** Fan blades shall be mounted on a shaft rigid enough to maintain alignment when the fan is operating under full load. **(T-0)** All bearings shall be of the self-lubricating type or shall be lubricated from a point outside the duct and, preferably, shall be located outside the duct and the booth. **(T-0)** Refer to NFPA 30 and NFPA 91 for additional guidance.

27.5.3. Exhaust Ducts. Exhaust ducts shall be protected against mechanical damage, properly supported and shall normally have a separation of at least 18 inches from combustible materials. **(T-0)** Ducts shall be periodically inspected for accumulation of paint deposits and shall be cleaned as needed. **(T-0)**

27.5.4. Exhaust. Exhaust air from spray operations shall be directed so it shall not contaminate makeup air introduced into the spraying area or other ventilation intakes. **(T-0)** Unless the spray booth exhaust is from a water wash spray booth, the terminal discharge point shall be at least 6 feet from any combustible exterior wall or roof and will not discharge within 25 feet of any combustible construction or unprotected opening in any noncombustible exterior wall. **(T-0)**

27.5.5. Drying. Freshly sprayed articles shall 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 shall 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 shall be placed outside of booths or ducts. **(T-0)** Drive belts shall 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. Minimum safety, fire prevention and occupational health requirements pertaining to ventilation are addressed in this chapter. Ventilation and exhaust systems details, including information on flow-rate requirements, and the design of ventilation and exhaust systems are in the most current edition of the ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. BE will determine what, if any, periodic testing of ventilation systems is required. **(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. Storage in process areas shall be no more than three (3) approved flammable liquids storage cabinets in any single process area without the approval of the authority having jurisdiction. **(T-0)** Storage shall be listed or designed and constructed to meet the requirements of NFPA 30. **(T-0)** Any single cabinet shall contain no more than 120

gallons (454 liters) of Class I, Class II or Class IIIA liquids, of which no more than 60 gallons (227 liters) shall be Class I and Class II liquids. **(T-0)** Bulk storage of these liquids shall 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-base 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 shall be in original closed containers, approved portable tanks, approved safety cans or by a properly arranged system of piping. **(T-0)** Containers shall be marked in accordance with AFI 90-821. Open or glass containers shall 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, shall be done only in a mixing room or in a spraying area. **(T-0)** The ventilating system shall be in operation. **(T-0)** Precautions shall be taken to prevent liquid spillage. **(T-0)**

27.6.4. Grounding. Whenever flammable or combustible liquids are transferred from one container to another, both containers shall be effectively bonded and grounded. **(T-0)** Piping systems used to transfer fluids shall also be properly bonded and grounded. **(T-0)**

27.7. Electrical.

27.7.1. Electrical Wiring. Electrical wiring and equipment shall 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 shall be of a non-spark-producing design. **(T-0)** This equipment shall 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 shall be considered non-hazardous except for the space within three (3) 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, shall be totally enclosed to prevent hot particles from falling should breakage occur, and shall be protected from mechanical damage by guards or by location. **(T-0)** Portable electric lamps shall 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 shall be electrically grounded in an effective and permanent manner. **(T-0)**

27.7.5. Heaters. If a heater is used to heat the liquid being sprayed, it shall be low-pressure steam, low-pressure hot water or electricity. **(T-0)** If electric, it shall be approved and listed for the specific location in which it is used. **(T-0)** Heaters shall not be located in spray booths or other locations subject to the accumulation of combustible residue. **(T-0)** Agitators, if used,

shall be driven by compressed air, water, low-pressure steam or electricity. (T-0) If powered by an electric motor, the motor shall 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 shall be located in separate one-story buildings with fire-resistant floors, walls and ceilings. (T-1) They may be located in specially constructed rooms if separated from other operations by fire-resistant walls. Paint and dope shops shall be provided with automatic sprinkler protection. (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 shall be located in the paint and dope shop. In industrial facilities, spray-finishing operations shall be located and protected to minimize possible damage to other property by fire or by extinguishing agents. (T-1) All spray booths shall be installed and conform to the requirements in NFPA 33, the BE occupational and environmental health risk assessment and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. (T-1)

27.8.3. Prohibited Locations. Spray-finishing operations shall not be conducted in an administrative, educational or public assembly facility, unless in a room specifically designed for the purpose, protected with an automatic sprinkler system and separated vertically and horizontally from such occupancies by not less than 2-hour fire-resistance construction. (T-0)

27.9. Paint Spray Booths.

27.9.1. Construction. ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and 29 CFR § 1910.107(b), *Spray Booths*, provides direction on the construction of paint booths.

27.9.2. Exhaust Filters.

27.9.2.1. Filter pads and filter rolls shall be inspected after each painting operation and replaced when necessary or from a tracking log based on the number of hours in use. (T-0) Consult the manufacturer's instructions or the installation Environmental Management office for the proper replacement interval.

27.9.2.2. Automatic-advance roll filters shall 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 shall be made of noncombustible materials. (T-0)

27.9.2.4. Both filter pads and rolls shall be changed when changing coating materials if the two materials are susceptible to spontaneous combustion when in contact with each other. (T-0)

27.9.2.5. Discarded filter pads and rolls shall be removed from the area daily unless water-filled metal containers are provided to hold them immersed until disposal. (T-0)

27.9.3. Baffle Plates. Baffle plates, if used, shall be made of noncombustible material and readily removable or accessible on both sides for cleaning. (T-0) Such plates shall be grounded. (T-0)

27.9.4. Extinguishers. The appropriate type and size portable fire extinguishers shall be located within the work area in accordance with NFPA 10 and the installation F&ES Flight. **(T-0)** Refer to **Chapter 6** for additional guidance.

27.9.5. Floor Covering. The floor of paint spray booths shall be covered with a noncombustible mat, removable for cleaning or disposal. **(T-0)** If an overspray covering is not feasible, consult the installation occupational safety office for additional guidance.

27.9.6. Flame-Producing Devices. Using or carrying of matches, lighters or other spark or flame-producing devices in or adjacent to paint spray booths is prohibited.

27.9.7. Containers. Containers supplying spray nozzles shall be a closed type or provided with metal covers, which shall be kept closed. **(T-0)** Original shipping containers shall not be subjected to air pressure above atmospheric for supplying spray nozzles. **(T-0)** Containers under pressure exceeding atmospheric pressure shall be designed and approved for such use, shall be provided with a visible pressure gauge and shall be provided with both a relief valve and a shutoff valve. **(T-0)**

27.9.8. Hoses and Couplings. Pressure hoses and couplings shall be regularly inspected for condition and shall be replaced, as needed. **(T-0)** When positive displacement pumps are used, a relief valve shall 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 shall 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 shall not be directed toward a fellow employee. **(T-0)**

27.10.2. Air Hoses. All hoses shall be checked prior to each shift to ensure they are properly connected to both their pipe outlets and the equipment to be used. **(T-0)** Air hoses shall not be connected to a pipe outlet unless the loose end is secured, since a loose hose connected to a compressed air outlet will whip. **(T-0)** Hose couplings shall 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 extreme wear, deterioration, leakage or weakness shall 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 shall be equipped with an ASME-rated air tank, a visible pressure gauge on the tank, a pressure reducer with its own gauge, a guard fully enclosing the drive belt and pulleys and a pressure-limiting switch to shut down the compressor when the system's working pressure has been reached. **(T-0)** The equipment shall be securely mounted on a wheeled carriage for portability. **(T-1)** For interior painting,

where the compressor shall be located inside the facility, only electric motor-driven equipment shall be used. **(T-0)**

27.10.4.3. Overpressure Protection. When separate paint pressure tanks are used, they shall be equipped with a gauge and a relief valve to prevent overpressure. **(T-0)** Hoses shall 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 shall be implemented by all organizations using this equipment. **(T-1)**

27.10.5.2. Compressors, hoses, paint pressure tanks and spray guns shall be stored in areas designated and approved by the installation F&ES Flight. **(T-1)**

27.10.5.3. All paint pressure tanks and spray guns shall be cleaned after use and before the equipment is stored. **(T-1)** If solvents are used in the cleaning process, provisions of [Chapter 22](#) shall be followed. **(T-1)**

27.10.5.4. Respiratory Protection. If process not already evaluated, contact BE for an occupational and environmental health risk assessment. Respiratory protective devices shall 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 shall have its own ventilation system. **(T-1)** If spray booth ventilation systems are utilized, the oven vent shall enter the system downstream from filters and baffles. **(T-1)** In addition, an interlock shall be installed which will automatically start the blower when the oven is turned on and automatically shut down the oven if the blower stops operating, either by accident or intentionally. **(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 shall be isolated and adequate fire prevention measures taken. (T-1) Solvents used for cleaning operations shall have flashpoints at or above 100° F. (T-1) The aircraft shall be properly grounded and all sources of ignition removed from the area. (T-0) All electrical devices and equipment shall be of an approved explosion-proof type. (T-0) Except when essential to perform concurrent operations, all aircraft electrical systems shall be de-energized during cleaning, painting and paint removal. (T-0) Smoking shall be prohibited. (T-0) To prevent the accumulation of static charges, all materials or objects shall be effectively grounded. (T-0) Refer to [Chapter 6](#) for additional guidance.

27.12.3. Ventilation. Ventilation shall be provided and BE shall periodically check the adequacy of ventilation in accordance with [paragraph 27.5.7](#). (T-1)

27.12.4. Housekeeping. All spraying areas shall be kept free from the accumulation of deposits of combustible residues. (T-0) Cleaning shall be conducted daily. (T-1) Scraping tools shall be non-sparking. (T-0) Roof trusses, light fixtures and other overhead equipment shall be checked for accumulation of over-spray at least annually. (T-1) Rags or waste soiled with sprayed materials shall be deposited in approved self-closing metal waste containers immediately after use. (T-0) in accordance with AFMAN 32-7002 and 29 CFR § 1910.107(g)(3), the contents of waste containers shall be disposed of at the end of each shift or at least once daily. (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 shall 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 shall not be used near any open flames. (T-0) In accordance with [Chapters 6](#) and [22](#), smoking shall be prohibited within 50 feet of painting operations. (T-1)

27.13.2. These paints are toxic and shall only be used in ventilated spray booths in accordance with ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. (T-1)

27.13.3. Personal Protective Equipment. Paint shop personnel shall wear PPE as identified in BE's occupational and environmental health risk assessment. (T-0) While painting, personnel shall wear gloves to guard against skin irritation, and shall wear any other necessary PPE needed to complete the task. (T-1) Refer to [Chapter 14](#) for additional guidance.

27.13.4. Drying. Radio and radar equipment that has been spray painted, shall be placed in the open air for several hours or, if possible, for a full day. (T-1) This will prevent vapors from off gassing during the drying process and from being ignited by sparks generated when the equipment is put into operation. Emery paper or steel wool shall not be used on radio or radar equipment until the vapors have totally dissipated.

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 being attached 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 shall be checked regularly with particular attention given to automatic sprinkler heads. **(T-0)** Sprinklers protecting spraying areas shall be kept free from deposits by frequent or, if necessary, daily cleaning. **(T-0)** Portable fire extinguishers shall be available for use. Refer to [Chapter 6](#) for additional guidance. **(T-0)**

27.14.3. Daily Inspection. Spraying equipment, including spray gun tips, shall be checked daily. **(T-0)** The entire electrostatic unit shall also be checked daily, including the electrical terminals, electrodes and insulators. **(T-0)** On humid days, condensation shall be carefully removed from insulators. **(T-0)** The conveyor system shall be checked for jerky operation, loose hooks or other defects that could permit swinging of the units being painted. **(T-0)** Moisture shall be removed from the compressed air storage tanks. Refer to the manufacturer's operating instructions or [Chapter 25](#) for drainage requirements. **(T-0)**

27.14.4. Insulators. The insulators on electrodes and conductors shall 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 shall be turned off and the nozzle shall be grounded to discharge any static charge remaining in the system. **(T-0)** Maintenance shall 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 shall be allowed to permit any remaining electrical charge to drain off. **(T-0)** Only approved spark-resistant tools shall be used during cleaning operations, unless other type 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, shall be grounded to prevent static build-up. **(T-0)** Manual grounding wires shall be available and employees shall be familiar with their use. **(T-0)** Grounding shall be in accordance with AFMAN 32-1065. Items being painted in an interior spray booth shall be bonded or grounded to lessen 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 shall be electrically connected to ground so the operator, in normal operating position, is in contact with the handle by a resistance of not more than 1 megohm to ground. **(T-0)**

27.14.8. Personnel. Only properly trained, qualified and physically-fit persons shall be permitted to work around electrostatic apparatus. **(T-0)** Medical examinations shall be scheduled with base medical services, as needed. **(T-0)**

27.14.9. Warning Signs. Signs shall be conspicuously posted, designating the process zone as dangerous and indicating the necessity for grounding personnel entering the spray area. A red *ON* light shall be installed to the interlocked power transformer circuit. **(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 on most jobs. **Warning:** Never point an airless spray gun at any part of the body.

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.

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 by the grip and remove the fingers from the trigger. This shall prevent the gun from being activated if the operator's hold shall inadvertently tighten due to slipping or stumbling. **Note:** Guns shall be equipped with trigger guards and a safety lock. **(T-0)** The lock shall be positioned to prevent operation, except when the gun is actually in use. **(T-0)**

27.15.2.4. Ensure all hoses connections and fittings are tight and not leaking. **Note:** The fluid hose shall be designed to withstand the high pressure of the system. **(T-0)** The hose, gun and pressure vessel, if so equipped, shall be equipped with special fittings that are not interchangeable with low pressure fittings or any other fittings. **(T-0)**

27.15.2.5. Employees will inspect hoses prior to use to ensure they have no weak or worn spots. **(T-0)** Make certain the hoses do not contact moving parts of machinery, lie over or around sharp edges and corners, or come into contact with objects that would damage them. **(T-0)** Check for deterioration caused by exposure to chemicals and ordinary wear and tear. **Warning:** High-pressure leaks from hoses or connections may also cause hypodermic injection of paint. Injected paint may be life threatening and requires immediate medical treatment.

27.15.2.6. Cleaning. Consult the manufacturer's operating instructions for cleaning procedures. **(T-0)** Never pass a finger over the gun orifice to clean it, as this can result in hypodermic injection of paint into the finger. Injected paint may be life threatening and requires immediate medical treatment.

27.15.2.7. Ground the object being sprayed, as well as the spray gun, to prevent accumulating of static electricity. A static electricity discharge may ignite vapors in the confined atmosphere. Fluid hoses with a ground wire will prevent the accumulation of a static charge if the airless unit is grounded and the object being sprayed is also grounded. Periodic continuity checks shall be performed to ensure hose grounding is intact. **(T-0)**

27.15.2.8. Operators shall wear eye protection and gloves to guard against accidental contact with the spray. **(T-0)** Also, BE-approved respiratory protective equipment shall be worn if exhaust ventilation is inadequate or not available. **(T-0)**

27.16. Aerosol Cans of Spray Paint.

27.16.1. Availability. Pressurized cans of general purpose spray lacquers or enamels are available through the General Services Administration and commercial supply systems.

27.16.2. Precautions. The same general safety and health precautions apply to spray painting from pressurized cans as to spray painting by other means.

27.16.3. Storage. Cans of spray paint shall be considered flammable materials and stored in accordance with criteria in **Chapter 22**. **(T-0)** Office desks shall not be used to store cans of spray paint. **(T-0)** Office storerooms shall not be used to store cans of spray paint, unless the storage area has been approved by the installation F&ES Flight. **(T-0)**

27.16.4. Disposal.

27.16.4.1. Dispose of empty and malfunctioning cans in accordance with AFMAN 32-7002, 29 CFR § 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. **(T-0)** Contact the installation Environmental Management office for local guidance.

27.16.4.2. Wiping rags and other hazardous waste materials shall be disposed of in self-closing metal containers labeled to indicate the contents and in accordance with the procedures established by the installation Environmental Management office, AFMAN 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, wiping rags and other hazardous waste materials in office waste receptacles. **(T-0)**

27.16.4.3. PPE. The same general rules governing the use of PPE apply to painting with pressurized cans. Refer to other sections of this chapter and **Chapter 14** for additional guidance.

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 shall be approved types. **(T-0)** The maximum surface temperature of equipment in the coating area shall not exceed 150° F. **(T-0)** The high voltage circuits shall be designed to not produce a spark of sufficient intensity to ignite any powder-air mixtures or result in an appreciable shock

hazard upon contact with a grounded object, under normal operating conditions. **(T-0)** Transformers, power packs, control apparatus and all other electrical portions of the equipment, with the exception of the charging electrodes and their connections to the power supply, shall be located outside the powder coating area. **(T-0)**

27.17.3. Ventilation. Forced exhaust ventilation is mandatory to maintain a safe atmosphere. **(T-0)** Dust collectors shall be incorporated within the ventilation system to trap all excess powder. **(T-0)** Where applicable, exhaust ventilation shall be sufficient to maintain the atmosphere below the lowest explosive limits for the materials being applied. **(T-0)** The electrical equipment shall 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 shall 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 shall be cleaned in a manner that does not scatter powder or create dust clouds. **(T-0)** Vacuum sweeping equipment, where used, shall be of a type approved for use in hazardous locations. **(T-0)** Water-saturated cleaning cloths shall be used to remove powder dust and to preclude scattering dust deposits. **(T-0)**

27.17.5. Grounding. Objects being coated shall be maintained in contact with the conveyor or other support to insure proper grounding. **(T-0)** Hangers shall be regularly cleaned to ensure effective electrical contact and areas of contact shall be sharp points or knife edges where possible. **(T-0)** The powder coating equipment shall carry a prominent, permanently installed warning regarding the necessity for bonding and grounding all metal parts of the fluidized bed and the objects being coated. **(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, shall be permitted to use these materials. **(T-0)**

27.18.3. Fire Prevention. Do not interchange equipment used for organic peroxide coating with that used for any other application. **(T-0)** Peroxides are oxidizers and shall 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)** Smoking is prohibited and *NO SMOKING* signs shall 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 in accordance with AFMAN 32-7002, 29 CFR § 1910.107(g)(3), other approved hazardous waste disposal procedures and applicable environmental regulations. **(T-0)** Contact the installation Environmental Management office for local guidance. **Note:** Copper beryllium tools must not be purchased, kept or dressed. **(T-0)** If a copper beryllium tool is found that has lain undisturbed for more than three (3) years, notify BE for assistance in removal. **(T-0)** If there

is no copper beryllium non-sparking tool substitute, consult with BE to determine how to apply for an exception to this requirement.

27.18.4. Protective Equipment. Ensure respirators, gloves and protective clothing are used, as recommended or required in BE's occupational and environmental health risk 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 BE occupational and environmental health risk assessment, 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. Ensure personnel keep only the minimum quantity of peroxides needed for daily operations in the processing area. **(T-0)** Organic peroxide formulations shall be stored in accordance with NFPA 400 and the manufacturers' recommendations. **(T-0)**

27.18.7. Mixing of Organic Peroxides with Promoters. Organic peroxide formulations shall not be mixed directly with any cobalt compounds or other promoters or accelerations, as violent decomposition or explosion can result. **(T-0)** To minimize the possibility of such accidental mixing, these materials shall 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 hazards. Personnel shall 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 shall 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.

28.2.2. Climbing Hazards. The primary hazards associated with climbing are falls and contact with electrical systems. A record of climbing certification shall be maintained on AF 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 shall be determined by the climbing instructor. **(T-1)** Records shall be updated whenever recertification is accomplished. **(T-1)** Refer to [paragraph 28.7](#) for additional guidance. **(Warning:** Pole Top rescue shall 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:

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

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

28.2.2.3. Tower conditions such as cracks, rust, corrosion, loose/missing hardware, ice on climbing surfaces, bent/broken steps, improper grounding, dirt and excessive grease and oil.

28.2.2.4. 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.

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

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

28.2.2.7. Wearing climbers while working on wooden poles and tower structures.

28.2.2.8. Failure to maintain good physical condition.

28.2.3. Radiation Hazards.

28.2.3.1. Non-ionizing Radiation. Refer to AFI 48-109 *Electromagnetic Field Radiation (EMFR) Occupational and Environmental Health Program*, and 29 CFR § 1910.97, *Nonionizing Radiation*, for additional guidance on management of hazards associated with non-ionizing radiation. (**Caution:** 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:** All communications equipment employees should be made aware of this requirement. If there are questions, refer employee(s) for a medical assessment, in coordination with the installation BE.)

28.2.3.2. Ionizing Radiation. Refer to 29 CFR § 1910.1096, *Ionizing Radiation*, and AFMAN 48-148 for guidance on hazards associated with ionizing radiation.

28.2.4. Chemical Hazards. Chemicals used in conjunction with communications equipment maintenance may present health hazards due to skin contact and/or inhalation of toxic vapors. All employees who may be potentially exposed to chemical hazards during the course of work shall require HAZCOM training in accordance with AFI 90-821, 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 the host installation environmental management office. (**T-1**) **Note:** Supervisors shall ensure all personnel have access to Safety Data Sheets for chemicals used in work processes. (**T-0**) Refer to CFR § 1910.1200, *Hazard Communication*, for additional guidance.

28.2.5. Compressed Gases. Refer to **Chapter 19** for specific and additional guidance on compressed gases.

28.2.6. Falling from Heights. The potential of falling is the most obvious hazard encountered while climbing. Safety gear shall be used and worn properly. (**T-0**) Refer to **Chapter 13** and **paragraph 28.7.16** for additional guidance on personal fall arrest systems.

28.2.7. 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. Wipe it off with a damp cloth or sponge. Always place the soldering iron in the proper holder when not in use, and never leave the iron plugged in and unattended. (**T-1**)

28.2.7.1. Wear a face shield or safety goggles when soldering. Normal prescription glasses or plain safety glasses may be used in place of safety goggles for light electronic equipment soldering, such as electronic circuit boards.

28.2.7.2. Ensure the work area where soldering is performed is well ventilated in accordance with the requirements in the BE Occupational and Environmental Health risk assessment and the ACGIH's *Industrial Ventilation: A Manual or Recommended Practice for Operations and Maintenance*. (**T-0**) Ensure all power unit exhausts are vented to the building exterior. (**T-0**) Use approved respiratory devices when working in permit-required confined spaces that are not adequately ventilated. (**T-0**) Refer to AFI 48-137 and **Chapter 23** for additional guidance and information on confined spaces.

28.2.8. Confined Spaces. Employees required to enter confined spaces, such as manholes or underground vaults, shall be trained in self-rescue. **(T-0)** Safety observers or attendants shall be trained in rescue procedures for each type of confined space to be entered. **(T-0)** Refer to [Chapter 23](#), applicable TOs and 29 CFR § 1910.146, *Permit-Required Confined Spaces*, for additional requirements.

28.2.9. 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 or ground wire for the system shall 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 (2) or more pieces of conductive equipment with a suitable wire or strap to equalize the resistance and, in effect, make them as one piece of equipment as far as electrical potential is concerned. For specific guidance, refer to AFMAN 32-1065.

28.2.10. Respiratory Precautions. Respiratory protection is required if prolonged breathing of chemical vapors, mists or fumes is expected or if working in confined spaces when the atmosphere oxygen deficient or hazardous. A supplied breathing air system with quick access emergency egress air supply may be needed. BE's occupational and environmental health risk assessment identifies recommended controls. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and AFMAN 48-146 for additional guidance.

28.2.11. Miscellaneous.

28.2.11.1. Fluid/Chemical Leakage. Employees shall be especially watchful for any sign of oil or fluid leakage from transformers or similar devices. **(T-1)** There is a possibility the liquid may contain high concentrations of polychlorinated biphenyl, which is extremely toxic. Any sign of leakage from any component shall be reported to the nearest BE and Environmental Management office. **(T-1)** Employees shall not touch or disturb the leaking fluid without the approval of the appropriate medical activity. **(T-1)**

28.2.11.2. Heaters and Torches Used in Ground and Aerial Tents. Flame-type heaters shall not be used within ground tents or on platforms within aerial tents unless the tent covers are constructed of fire-resistant materials and adequate ventilation is maintained. **(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 actual use. The tent shall be adequately ventilated while torch is in use. **(T-0)**

28.2.11.3. Notifications. Provide the installation 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 the installation 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)** **Note:** Off-base facilities/sites shall coordinate and plan with the nearest local area medical facility for emergency medical services, if the host installation medical facility is too far to provide immediate emergency medical attention. **(T-1)**

28.2.11.4. 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 shall not begin until a qualified safety observer is present. (T-0) An individual shall not be assigned other duties while serving as safety observer. (T-1) Normally, the supervisor is also the safety observer.

28.2.11.4.1. When repairing or troubleshooting energized high voltage communications equipment, the safety observer does not have to be proficient in the task being observed.

28.2.11.4.2. Safety observers shall be trained in accordance with [paragraph 1.9](#) and be familiar with local installation procedures to obtain medical assistance. (T-1)

28.2.11.4.3. While the task is being performed, the safety observer shall 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 shall 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 shall be documented on the AF Form 55, *Employee Safety and Health Record*, or AF Form 623, *Individual Training Record Folder*, or an approved computer automated system in accordance with AFI 91-202. (T-1) A record of climbing certification shall be maintained on AF Form 1098 or approved computer automated system. (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 on streets and highways. Warning devices, barriers and guarding shall be used to protect personnel working at these locations. (T-0) Employees working on aerial cable installation and pole line construction along streets and highways will use the same barriers, and warning and guarding devices as required for manholes. (T-0) Ventilating equipment shall be positioned so the air intake is located away from vehicular exhaust. (T-0) Refer to TO 31W3-10-12, *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, shall be used on steel structures. (T-0) Safety harnesses, straps and lanyards shall be provided and supervisors shall ensure their use when work is performed at positions more than four (4) feet above the ground, on poles and on towers. (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 (2) 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)*, shall be followed. (T-0) Safety straps and harnesses shall also be worn when working at elevated positions on poles, towers or similar structures, which do not have adequately guarded work areas in accordance with 29 CFR §

1910.268. (T-0) Supervisors shall ensure all safety climbing equipment is inspected daily by a qualified individual to determine if it is in safe working condition. (T-0) Each person using safety harnesses, straps and lanyards shall inspect the equipment prior to each use. (T-0)

28.4.3. Climbing Safety Devices. Climbing safety devices shall be installed on all ladders that are an integral part of the antenna support. (T-0) Where climbing safety devices are not installed, installation or maintenance shall 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 systems equipment. (T-0)

28.4.4. Markings. All antenna support, power, telephone and transmission line poles shall be marked 12 feet from the butt of the pole to determine the depth of the pole. (T-0) The 12-foot mark shall be indicated with aluminum pole tags or marker nails. (T-0) If these are not available, 1-inch galvanized steel roofing nails shall 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 [Chapter 16](#), Chapter [12](#), [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. Hard Hats. Refer to [paragraph 14.4.5](#) 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 shall 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 shall not be used on energized communications systems equipment. (T-0)

28.5.2. All tools shall be kept clean and free of grease, oil, paint or other foreign material in accordance with 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)

28.5.5. Test equipment shall 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 shall be closed. **(T-0)** Only authorized personnel who have been briefed about the potential hazards involved shall be in this area when tests are performed. **(T-0)** At least one safety observer shall be present when high voltage is involved. **(T-0)**

28.5.5.1. Set Up. Test operators and technicians shall follow the exact methods of adjustment, operation and repair of test equipment given in TOs, manufacturer's instructions and manuals or applicable diagrams. **(T-0)** Employees shall be knowledgeable of the characteristics and safe operation of the various instruments before being authorized to use them. **(T-0)** This shall be accomplished by briefings and warning signs at affected locations. **(T-0)** Before voltage is applied, cable conductors shall be isolated to the maximum extent practicable. **(T-0)**

28.5.5.2. Approved and effective warning signs and/or signals shall be used to indicate when power is on. **(T-0)** A means of emergency power shutdown shall 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 shall be secure. **(T-0)**

28.5.6. Other Tools and PPE. All employees involved in test operations shall be provided with approved PPE. **(T-0)** Refer to Chapter 14, 29 CFR § 1910.268(e) and 29 CFR § 1910.268(i) for additional mandatory requirements for head and eye protection, portable lights, protective devices on tools and appliances, soldering devices and lead work.

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 shall 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 shall 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, shall only be authorized by the unit commander. **(T-1)** The unit commander shall 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 shall be instructed in the precautions necessary for their safety and the safety of others. **(T-0)** Employees shall be warned to stay clear while voltage is applied. **(T-0)**

28.6.2. Only qualified personnel shall perform work near energized overhead power lines. **(T-0)** Approach distances for qualified workers shall be in accordance with UFC 3-560-01, Table 3-1. **(T-0)** Before starting any communications work near overhead power lines, coordinate the work with CE's electrical shop. Safety precautions in accordance with 29 CFR §§ 1910.268 and 1910.333, *Selection and Use of Work Practices*, shall 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 shall be considered energized. **(T-0)** Personnel standing on the ground shall not contact any part unless using protective equipment rated for the voltage. **(T-0)**

28.6.4. Tree branches hanging on an energized conductor shall be removed only with appropriate electrically insulating equipment, and only by authorized personnel. **(T-0)**

28.6.5. Line workers' electrical safety boots shall be worn to provide additional protection against electrical hazards. **(T-0)** Rubber footwear or line workers' overshoes shall not be worn. **(T-0)**

28.6.6. Warning signs or Air Force Visual Aids shall be prominently posted in all areas housing high voltage equipment; the highest expected voltage shall 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 shall be worn while performing aerial work. **(T-0)**

28.7.2. Unit commanders shall 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)** Coordinate with installation BCE to ensure real property structures have current inspection and maintenance, and allow only structures with current inspections that identify the structure, as safe to climb, to be climbed. **(T-1)** Ensure employees who must climb structures are provided access to inspections/maintenance records. **(T-1)**

28.7.3. Installation BCE will ensure inspection and maintenance records are provided upon request by using agencies. **(T-1)** Maintain records on the inspection and maintenance of poles and towers considered real property in accordance with DAFI 32-9005, *Real Property Accountability and Reporting*, and the *Real Property Handbook*. **(T-1)** **Note:** The *Real Property Handbook* is maintained at each installation's CE facility.

28.7.4. Installation 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, each individual whose future duties will require climbing poles and towers where they may be subject to a fall of four (4) feet or more in height shall be trained and certified, as applicable. **(T-1)** For Air Force Specialty Codes other than 3D1X7, commanders shall 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 cardiopulmonary resuscitation (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. **(T-1)**

28.7.6.8. Determine and arrange for the specific safety equipment to use during performance evaluations. **(T-1)**

28.7.6.9. Evaluate a written and/or oral knowledge test. **(T-1)**

28.7.7. 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 precautionary requirements on tower and pole climbing.

28.7.8. Steps and Ladders. All antenna towers and structures will have steps and ladders installed when the design permits. **(T-0)** These steps and ladders shall be equipped with cages or safety devices where possible. **(T-0) Exception:** Structures designed to provide equivalent protection of a safety cage, e.g., triangular antenna towers that are climbed internally where structural members provide approximately the same protection normally afforded by a safety cage. Refer to Chapter 7, 29 CFR § 1910.25, *Stairways*, and 29 CFR § 1910.23, *Ladders*, for additional guidance on steps and ladders.

28.7.9. Radome Installation, Maintenance and/or Removal. Employees engaged in radome work shall be experienced riggers and work under the direction of a qualified supervisor. **(T-0)** Those who work on or in the immediate vicinity of the radome shall wear hard hats and safety-toed shoes. **(T-0)** Employees shall make frequent checks with the nearest weather forecasting agency to allow time to lash down equipment for impending inclement weather. **(T-1)** Also, employees shall never try to replace panels when the wind is blowing more than 30 miles per hour and shall never remove more than one panel at a time under normal conditions. **(T-0)** When mixing resin, employees shall follow the manufacturer's instructions. **(T-0)** Employees shall use the maintenance rope to lift the maintenance ladder to the top of the radome. **(T-0)** Prior to each use, the rope shall be inspected for frayed or worn spots and replaced, if required. **(T-0)**

28.8. Ground-Controlled Approach Radars. Before ascending to the roof of the ground-controlled approach trailer or other rotating antenna location, the supervisor shall inform all nearby personnel that work is being performed on the roof and shall ensure the following is accomplished: **(T-1)**

28.8.1. The surveillance antenna control switch is turned off, locked out and a warning sign or AFVA 91-303, *DANGER – DO NOT ENERGIZE – PERSON WORKING ON ANTENNA*, is placed on the high voltage power supply switch. The roof-mounted antenna safety switch shall be turned off. **(T-1)** 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. **Note:** 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 shall 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 shall not be required.

28.9.4. Metallic Encased Tools. The tools and equipment being powered by generators shall contain three-wire cords with grounded plugs. **(T-0)**

28.9.5. Fixed Wiring Systems. Portable and vehicle-mounted generators that supply fixed wiring systems shall be grounded in accordance with NFPA 70, Article 250, *Grounding*. **(T-0)**

28.10. Repairs and Adjustments.

28.10.1. Repairs and adjustments shall 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, shall 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 shall be removed from the area before power is applied. **(T-1)** When high voltages are present or transmitters of 1-kW power rating or higher are involved, unit commander will approve procedures and adjustments not specified by TO or manufacturer's instructions. **(T-1)** Additionally, use insulated gloves when directed by TOs or the manufacturer's instructions. Ensure insulated matting is used and a qualified safety observer is present. **(T-1)**

28.11. Power Distribution Panels.

28.11.1. Power Distribution Panels and Interlocks. Power distribution panels and interlocks shall 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 shall be locked open (off), if possible, and posted with a danger tag, warning sign, AFVA or other suitable identification until the equipment is again ready for use. **(T-0)** Tape shall not be used to “lock” open circuit breakers. **(T-0)** Refer to [Chapter 17](#) for additional guidance and information on signs and visual aids.

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) shall indicate in writing the equipment controlled by which fuse or circuit breaker. **(T-0)** Whenever possible, over-current devices shall be installed in electrical circuits of a size and type to interrupt the current flow when the current exceeds the current rating of the equipment or exceeds the capacity of the conductor, whichever is smaller. **(T-0)** Replace blown fuses by the type required by the manufacturer or manufacturer’s instructions. **(T-0)** When possible, use insulated fuse pullers when removing or replacing clip type or flat-mount cartridge fuses. Wire, foil, solder and similar materials shall 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 shall 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. Personnel shall be instructed in the hazards of non-ionizing radiation and shall not be exposed to non-ionizing radiation levels above the permissible exposure limits outlined in AFI 48-109. **(T-0)**

28.12.2. Exercise caution when working on or adjacent to transmitter antennas. A transmitter connected to an antenna being inspected or worked on shall be locked out and de-energized in accordance with hazardous energy control procedures in [Chapter 21](#). **(T-1)** Ensure adjacent antennas, which create hazardous levels of RF radiation at the work location, are secured. **(T-1)** Ensure employees 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, AFVA or other suitable identification advising others of the nature of work in progress shall be posted on the console of the transmitter and in all other critical locations. **(T-1)**

28.12.3. Employees shall 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 shall 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](#) shall be met before, during and after any entry operation.

28.13.1. Manholes, vaults and handholes shall be positively identified as to utility type (communication, electrical power distribution, sewer, etc.) prior to entry. **(T-0)** In the absence of positive identification, personnel shall coordinate with the installation occupational safety office to establish positive identification. **(T-1)**

28.13.2. Unidentified cables shall be positively identified as to the utility type. **(T-1)** Cables shall be evaluated using a nonintrusive device, such as a clamp-on voltmeter, to determine the absence or presence of electrical voltage and current prior to beginning any work on the cable. **(T-1)** Although discouraged, a small percentage of manholes, vaults, or handholes may be joint use. In these few instances, extreme caution shall be used and the communication cable shall be positively identified. **(T-1)** When requested, the installation BCE electrical shop shall provide an electrician to assist in determining guarding and 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 shall comply with the 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 make contact with power lines. **(T-0)**

28.14.3. When crossing over roadways, railroads, walkway, 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 (2) employees suspend their weight on it.

28.14.5. Cable cars shall 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 shall 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, *AF Comm Command (E-I) Standard Installation Practices – Outside Plant Cable Placement*, 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 31W3-10-12, *Outside Plant Cable Placement*, US Army Corps of Engineers Manual (EM) 385-1-1, *Safety and Health*

Requirements Manual, and 29 CFR § 1926.652, *Excavations — Requirement for Protective Systems*, for information and guidance.

28.15. Special Purpose Vehicles. See AFI 24-302 for additional guidance.

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*.

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 well clear of the winch when used. **(T-0)** Winches are extremely powerful tools and extreme caution shall be exercised when used. **(T-0)** The winch operator shall be thoroughly trained and familiar with both the operation of a winch gear train and power takeoff lever movement. **(T-0)**

Winch operators shall 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 shall not be rigged to pull against the flange of the winch drum. **(T-1) Note:** Some winches are designed for pulling while others are designed for raising or lowering. Winches shall be used for their designed purpose. **(T-1)**

28.15.3. Cable Reels. The safe handling, moving, and positioning of cable reels require well-trained operators in good physical condition. Pre-planning the move and final positioning will identify any problems with the surface condition and the best methods to use. Always use a spotter when backing cable reel trailers. Caution shall be used when handling cable reels and cable reel trailer. **(T-0)** A full reel of large cable may weigh as much as 10 tons. Therefore, it is necessary to carefully control the movement of the reel. Never permit the reel to tilt. On uneven or soft ground, provide a substantial runway of heavy planks. **(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 shall use approved Air Force Technical Orders (TOs) and manufacturer's instruction, where applicable. **(T-1)**

(Note: Commercial manufacturer's manuals are not authorized for DAF use on aircraft batteries and must be converted to technical data by the appropriate AF Engineering Support Office or Systems Program Office. **[T-1]**) The battery shop, room or area shall be designed to eliminate certain hazards associated with battery maintenance. **(T-1)**

29.1.1. Refer to 29 CFR § 1910.178, *Powered Industrial Trucks*; 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 shall be obtained from the applicable base agency. **(T-1)**

29.2. Safety.

29.2.1. An approved and certified Occupational and Environmental Health Risk Assessment shall be accomplished by the installation BE on battery maintenance and operations. **(T-1)** The assessment shall include PPE requirements and required battery maintenance and operations procedures. **(T-1)**

29.2.2. Electrical components and systems shall be de-energized and isolated from other energized circuits and/or power sources before working on, servicing, removing or replacing a battery, unless specifically directed by a TO or specific requirement. **(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 shall be permitted to change, maintain or charge batteries. **(T-1)** Qualified personnel or those accompanied by qualified personnel shall be allowed access to battery shops, rooms or areas. **(T-1)** Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance.

29.2.4. When working with corrosives, an emergency shower or eyewash unit shall 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 shall 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, *Stationary and Mission Batteries*, paragraphs 3-3 through 3-6 and associated subparagraphs. **(T-0)** The installation of stationary battery applications using Li-Ion technologies are prohibited in occupied facilities per UFC 3-520-01, paragraph 3-11.1.4. **(T-0)**

29.3.3. Doors. Battery shop exit doors shall 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 shall be painted with an acid-alkali-resistant epoxy-poly-urethane paint. **(T-1)** An acid-alkali-resistant epoxy-poly-urethane paint with primer shall be used. **(T-1)** These paints provide the most protection against corrosion.

29.3.5. All mechanical equipment and fixtures shall 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 shall be made of or coated with non-sparking materials and designed to permit free access for servicing batteries. **(T-1)** Metal racks shall be protected with an acid-alkali resistive coating and the actual supports on which a battery rests shall be made of non-conductive materials or be suitably insulated. **(T-1)** Tools used during battery charging or servicing shall be non-conductive or coated with non-conductive materials. **(T-1)**

29.3.7. Work Surfaces. Work surfaces shall be non-conductive, and resistant to both acid and alkali. **(T-1)** Whenever possible, battery servicing and maintenance shall be performed on elevated, non-conductive racks. **(T-1)** These racks shall 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)** The matting protects personnel from electric shock and slipping hazards. Matting shall conform to TO 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*. **(T-1)**

29.3.9. Battery Charging. Refer to 29 CFR § 1910.178(g) for additional guidance.

29.3.9.1. Chargers shall 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 shall be through a mating plug or connector assembly. **(T-1)** Before performing work on charger plug contacts, workers shall ensure chargers are turned off and disconnected from the input power source. **(T-1)**

29.3.9.2. Work shall 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 lockout/tagout guidance.

29.3.9.3. Charger leads shall be kept off the floor and out of aisles to avoid damage and potential tripping hazards. **(T-1)** Overhead leads shall 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 shall 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 shall 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. During 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 shall 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, shall be worn at all times. **(T-0)**

29.4.2.4. Installing or replacing electrical components in the presence of flammable or combustible liquids. **(T-1)** The employee shall 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 shall 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 Occupational and Environmental Health Risk Assessment will identify ventilation needs for battery shops, rooms and areas in accordance with ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. **(T-1)** **Note:** NFPA 70, Article 480.9(A), *Ventilation*, requires adequate ventilation to prevent classification of a battery location as a hazardous (classified) location. Without adequate ventilation, NFPA 70, Article 500, *Hazardous (Classified) Locations*, requires installation of explosion proof lighting fixtures and receptacles.

29.5.2. Ventilation in battery charging rooms shall be sufficient to keep rooms or areas maintained between 68°F and 85°F, unless permitted by a TO or other appropriate guidance. **(T-1)**

29.5.3. Batteries shall never be operated, charged or discharged at temperatures above 120° F, if normal service life is expected. **(T-1)** Floor fans with explosion-proof motors can help keep battery temperature from rising above 120°F.

29.6. Storage and Handling.

29.6.1. Chemical Spills and Environmental Issues.

29.6.1.1. Precautions shall be taken to prevent the electrolyte from spilling. **(T-1)** Batteries shall not be laid on their side unless permitted by TO. **(T-1)** Batteries shall not be transported without being properly secured with straps or other restraint devices. **(T-1)**

29.6.1.2. Spill control procedures shall be developed and coordinated with the installation Occupational Safety office, BE, CE and Environmental Management office. **(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 the installation Environmental Management office for waste disposal guidance.

29.6.2. Vented lead-acid and vented nickel-cadmium batteries shall be maintained and stored in separate rooms or areas. **(T-0)** The battery shop supervisor shall ensure all visitors entering the battery shop receive a safety briefing on the hazards located in the battery room or area before entry is authorized. **(T-1)** If maintenance is performed while visitors are in the battery shop, the visitors shall also wear required PPE, as required 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 as long as a five-foot minimum clearance is maintained between the different batteries. A sealed lead-acid battery can be charged in a dedicated nickel-cadmium battery shop as long as a minimum distance of five (5) feet is maintained between the different battery chemistries.

29.6.4. The electrolyte in lead-acid batteries contains water. These batteries are subject to damage in freezing temperatures and shall be stored in temperature-controlled areas. **(T-1)** Lower battery charges shall allow for freezing at higher temperatures. **(T-1)**

29.6.5. Batteries of different chemistries shall be stored as directed by the installation Occupational Safety office, BE, CE and Environmental Management office. **(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 (5) 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, shall be stored in heated or protected storage areas (temperature-controlled) to avoid broken cases and/or contamination of storage areas from electrolyte spill caused by freezing or overheating. **(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 shall 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 shall be consulted if the weight of a battery is not known and it cannot be weighed. **(T-1)**

29.7. Electrical.

29.7.1. Electrical test equipment shall be de-energized prior to being disconnected from energized circuits or power sources unless specifically directed by the appropriate TO. **(T-1)**

29.7.2. Receptacles and lighting switches shall be located outside the battery maintenance or storage area. **(T-1)** Lighting fixtures shall be protected from physical damage by guards or isolation. **(T-1)**

29.7.3. Flexible cords used for charging shall be suitable for the type of service used and approved for extra-hard usage. **(T-1)** Connectors shall 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.

29.8. Installation and Care of Vehicle and Support Equipment Batteries.

29.8.1. Batteries shall always 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 shall not be pounded on battery terminals, but shall be spread until they can be seated properly. **(T-1)**

29.8.2. When removing a battery from a vehicle, the battery ground cable shall be disconnected first to prevent the possibility of a spark. **(T-1)** Upon reinstallation, the battery ground cable shall 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 shall 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 shall 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 shall only be accomplished by trained and qualified personnel. **(T-1)** Follow TO guidance for proper jump-start procedures. If not available, follow manufacturer's instructions.

29.8.6. The battery in most industrial trucks also serves as a counterweight for the carried load. A replacement battery shall never be installed when its service weight is not within the range of battery weights marked on the truck nameplate. **(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 shall be cleaned or replaced if they show evidence of oxidation or pitting. **(T-1)** Excessive heating of current-carrying parts indicates a poor electrical contact which shall be investigated. **(T-1)**

29.9. Aircraft Battery and Electrical System Specific Requirements.

29.9.1. Aircraft Electrical System Maintenance. Only personnel qualified on aircraft battery and electrical systems shall perform maintenance on aircraft battery and electrical systems. **(T-1)** Specialists shall 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 shall be de-energized whenever possible. **(T-1)** If the approved procedure requires work on an energized circuit, the sequence of steps shall be followed and other maintenance personnel must be informed of this action. **(T-1)** If the system has been de-energized, procedures shall include a provision to effectively lockout or tagout the power source while work is in progress. An AFTO Form 492, *MX Warning Tag*, authorized by AFI 21-101, shall be used in accordance with local procedures. **(T-1)** Refer to [Chapter 21](#) for additional guidance on hazardous energy control.

29.9.3. Aircraft Battery Shop Requirements. Batteries shall never be charged while in the aircraft, unless permitted by the aircraft TO. **(T-1)** Battery chargers shall carry at least one permanently affixed warning sign, which reads: *Warning—Keep 25 Feet Clear of Aircraft Engines and Fuel Tank Areas*. **(T-1)** Refer to NFPA 70, Articles 511.10 and 513, for additional guidance on Class I locations and aircraft hangars.

Chapter 30

MOTOR VEHICLE – OPERATIONS AND MAINTENANCE

30.1. Scope. This chapter provides information for safe operations in vehicle maintenance operations, and is not intended to be all-inclusive. It addresses 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. **Note:** Refer to [Table 30.1](#) for a list of additional references for motor vehicle operations and maintenance guidance.

Table 30.1. Additional Guidance for Motor Vehicle – O&M.

Additional Guidance for Motor Vehicle – O&M
AFI 24-302, <i>Vehicle Management</i>
AFMAN 24-306, <i>Operation of Air Force Government Motor Vehicles</i>
AFMAN 48-146, <i>Occupational and Environmental Health Program Management</i>
TO 36-1-191, <i>Technical and Managerial Reference for Vehicle Maintenance</i>
TO 42B5-1-2, <i>Gas Cylinders (Storage Type) Use, Handling and Maintenance</i>

30.2. Specific Hazards.

30.2.1. Vehicle maintenance hazards include, but not limited to, hazardous noise, compressed gases, pressurized air, toxic materials, flammable or explosive mists, particulates and vapors. During servicing of single piece rim wheels, pressurized air in the tire may release suddenly either by bead break-in or by the bead slipping over the rim flange. Brake and clutch assemblies on military vehicles may contain asbestos, which poses an inhalation hazard. Inhalation of mists and vapors from nearly all fuels, paints, solvents, thinners, cleaning chemicals, strippers and epoxies can be hazardous depending upon the material's toxic characteristics and amount and method of exposure.

30.2.2. Many chemicals/solvents can cause skin irritations, burns and/or defatting of the skin. These chemicals/solvents can also be absorbed through the skin and cause internal damage. In addition, paints containing epoxy or polyurethanes can cause employee sensitization, which causes an allergic reaction to a given substance. Sensitivity usually occurs after exposure of a few days to a few months. After sensitivity is established, exposure to even a small amount of the sensitizing material will likely produce a severe reaction. Refer to AFI 90-821 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 shall be stored in metal lockers, vented at top and bottom. **(T-1)**

30.3.2. Approved self-closing metal waste containers shall be provided wherever rags or waste are impregnated with flammable or combustible materials and all such rags or waste deposited therein immediately after use. **(T-1)** In accordance with 29 CFR § 1910.107(g)(3), the contents

of waste containers shall be disposed of at least once daily or at the end of each shift. (T-0)
Contact the installation Environmental Management office 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 maintained in an operational fashion as designed and not modified. (T-0)

30.3.3.2. Backing of government-owned motor vehicles and the usage of spotters will be in accordance with AFMAN 24-306.

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 should 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 if prolonged breathing of chemical vapors, mists or fumes is expected or if working in confined spaces when the atmosphere is oxygen deficient or hazardous. A supplied breathing air system with quick access emergency egress air supply may be needed. BE's occupational and environmental health risk assessment identifies recommended controls.

30.4. Occupational Health.

30.4.1. Refer to [paragraph 2.2.2](#) for additional guidance on hazardous noise or noise level surveys.

30.4.2. Stationary internal combustion engine-driven equipment shall not be operated inside buildings unless an exhaust system, approved by BE, is installed and used. When equipment is operated adjacent to buildings, the exhaust shall be directed away from the building. (T-1) Ventilation shall be adequate to provide fresh air and prevent accumulation of JP-4, gasoline, carbon monoxide and other hydrocarbon vapors. (T-1) Refer to [paragraph 30.6](#) for additional guidance on ventilation.

30.4.3. Jet engine fuels containing toxic aromatics shall be handled with the same precaution(s) as gasoline. (T-1)

30.4.4. First Aid. First aid kits shall be approved by installation medical services in accordance with [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 installation Occupational Safety office, F&ES Flight, BE and CE shall coordinate on all layout plans. (T-1) Refer to [Chapter 7](#) for additional guidance.

30.5.2. Only authorized shop personnel shall be allowed on shop floor. (T-1)

30.5.3. Vehicle operators and mechanics shall sound vehicle horns before backing and intermittently during the entire backing operation unless vehicles are equipped with backup alarms. (T-1) Vehicle operators shall stop and sound horn prior to entering and leaving the

maintenance shop. (T-1) A spotter shall be posted when moving large equipment and vehicles backwards or in close quarters. (T-1) Refer to [paragraph 12.2.10](#) for additional backing/spotter guidance.

30.5.4. Shop entrances and exits shall be clearly marked and lighted to prevent mishaps. (T-0) Appropriate traffic signs shall be posted at entrances and exits. (T-1) To minimize mishaps, a maximum speed limit of five (5) miles per hour shall be enforced in and around shops. (T-1) The operator shall sound the vehicle horn prior to entering or exiting facilities to alert nearby personnel. (T-1)

30.5.5. Floor slopes, drains and oil/water separators in shops shall be constructed and maintained using guidance from the installation Environmental Management office. (T-1) Oil separators shall be cleaned at a frequency determined by the installation Environmental Management office. (T-1) The shop supervisor shall maintain the letter identifying the cleaning frequency and document compliance with the cleaning frequency. (T-1) Drains shall not be connected to sanitary sewers, except the effluent from oil separators shall be connected to sanitary sewers. (T-1)

30.5.6. When jacking a vehicle, consult the operator's or maintenance manuals for proper jacking procedures.

30.5.7. No person outside the range of prompt and easy communication with other employees shall perform work with a risk of serious injury unless a second person is available to assist in an emergency.

30.5.8. Employees shall never use ramps on soft earth. They shall ensure the ramps rest on a firm, level surface. (T-1)

30.5.9. Machinery and Machine Guarding. Supervisors shall 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 shall be maintained and operated by qualified personnel. Machine guarding and power transmission guarding not covered in this manual, shall be in accordance with equipment manufacturer's instructions or 29 CFR § 1910, Subpart O, *Machinery and Machine Guarding*, as applicable. Refer to [Chapter 11](#) for additional guidance.

30.5.10. Hand Tools: Portable Powered and Non-powered. Specific criteria unique to a certain tool shall be contained in the technical data requiring use of the tool. (T-1) To determine required tools and equipment, consult TO 32-1-2. Allowance Standards 403, *General Purpose Tools*, and Allowance Standards 457, *Vehicle Maintenance, Locomotive Maintenance, and Vehicle Operations*, and General Services Administration catalogs shall be used to determine additional requirements necessary for a particular maintenance mission. (T-1) **Note:** Refer to [Chapter 11](#) for specific requirements on hand tools.

30.5.11. Roll-up Doors. Refer to [paragraph 2.7](#) for roll up door requirements.

30.6. Fire Prevention.

30.6.1. The installation F&ES Flight shall be consulted for specific shop requirements. (T-1) **Note:** Refer to [Chapter 6](#) for additional guidance.

30.6.2. Open Flames. Flame-producing equipment shall 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. The vehicle maintenance work area shall have a suitable exhaust ventilation system either under the floor with readily available adapter hoses or an overhead system arranged so connecting hoses can be raised when not in use. **(T-1)** In shop areas with under floor systems, adapters shall be used on equipment having vertical exhaust stacks to conduce the exhaust to the floor connections. **(T-1)** Carbon monoxide (CO) concentration shall be monitored by BE and levels kept under occupational and environmental exposure limits listed in AFMAN 48-146. **(T-1)** The facility owner/operator shall ensure a proper calibration schedule for the airborne gas analyzer. **(T-1)**

30.7.1.2. Exhaust ducts shall be protected against mechanical damage. **(T-1)** In-floor ducts shall be flush with the floor, level when closed and capable of withstanding vehicle and equipment traffic or the maintenance operation being performed. **(T-1)** In-floor ducts shall be equipped with a fluid collection system that prevents drainage into the installation 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 shall be properly supported and located to avoid damage from moving vehicles and equipment. **(T-1)**

30.7.1.3. When not in use, ducting shall be stowed in a way that prevents damage to the equipment and does not cause a hazard to personnel. **(T-1)**

30.7.2. General Engine Exhaust Ventilation. Minimum general ventilation rates are specified in ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*. This ventilation, either natural or mechanical, is in addition to local exhaust ventilation and is required to remove vehicle exhaust gases and fuel vapors.

30.7.3. The following operations or processes may produce airborne contaminants that exceed occupational and environmental exposure limits. The vehicle maintenance supervisor shall have these and similar operations evaluated by BE and shall document the results, along with any corrective actions taken. **(T-1)**

30.7.3.1. Spray painting, spray cleaning, solvent cleaning or stripping operations.

30.7.3.2. Open surface tanks (dip tanks, etc.).

30.7.3.3. Welding, soldering, torch cutting and metalizing.

30.7.3.4. Abrasive blasting operations.

30.7.3.5. Metal cutting, grinding, buffing and polishing operations.

30.7.3.6. Machine shop operations (lathes, etc.).

30.7.3.7. Battery shops. Refer to **Chapter 29** for additional guidance.

30.7.3.8. Open tanks on refueler vehicle.

30.7.3.9. Brake lining discs.

30.7.3.10. Clutch linings.

30.7.4. In accordance with AFMAN 48-146, BE's risk assessment identifies controls.

30.7.5. If ventilation system deficiencies exists, the vehicle maintenance supervisor shall use current BE occupational and environmental health risk assessment to determine interim control measures needed. **(T-1)**

30.7.6. Periodic Testing. In accordance with AFMAN 48-146, BE shall perform periodic evaluations. **(T-1)** BE shall 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 BE and the 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 shall 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 shall be labeled with the contents. **(T-1)** Care shall be taken to avoid solvent spillage. **(T-1)**

30.8.1.2. Care shall be exercised in the correct selection of solvents. **(T-1)** The lower the flashpoint, the higher the risk of ignition at low temperatures. The flashpoints of various solvents differ widely due to their chemical properties. These properties determine the flammability, thus the need to understand the difference between solvents.

30.8.1.3. The following items shall not be used as cleaning solvents: acetone, benzene, carbon tetrachloride, gasoline, isopropyl alcohol, methanol, methyl ethyl ketone, naphtha (solvent), perchloroethylene, toluene, trichloroethylene or turpentine. Commercial cleaning solvents or other non-flammable emulsion type cleaning liquids shall be considered for use whenever possible. **(T-1)**

30.8.1.4. Flammable cleaning solvents, jet fuel or AVGAS shall 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 shall be equipped with an adequate mechanical ventilation system and blowers and exhaust systems shall conform to NFPA 91. Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and AFMAN 48-146 for additional guidance. **(T-1)**

30.8.1.6. There shall be no open flames, spark-producing devices or heated surfaces having a temperature sufficient to ignite vapors in any vapor area. **(T-1)**

30.8.1.7. There shall be no electrical equipment in the immediate vicinity of cleaning tanks subject to splashing or dripping of cleaning tank liquids, unless approved for use in that environment. **(T-1)**

30.8.1.8. There shall be no open flames or spark-producing devices in any floor space outside a vapor area or within 20 feet thereof (not separated by tight partitions), except as specifically permitted in NFPA 86. Areas in the vicinity of dip tanks shall be kept as clear of combustible stock as practical and shall be kept entirely free of combustible debris. **(T-1)**

30.8.1.9. Periodic inspection or tests of all dip tank facilities shall be made, including associated ventilation and fire protection equipment. **(T-1)** Any defects shall be promptly corrected. **(T-1)**

30.8.1.10. *DANGER - NO SMOKING* signs shall be conspicuously posted in the vicinity of dip tanks. **(T-1)**

30.8.1.11. Areas in the vicinity of dip tanks shall have manual fire extinguishers suitable for combustible liquids. **(T-1)** Protection systems shall 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. When handling parts cleaned in degreasing solvent, all personnel shall wear rubber gloves and keep the inside of gloves clean and dry. **(T-1)** Rubber gloves and an apron shall be worn when acids are poured or dumped. **(T-1)** ANSI/International Safety Equipment Association (ISEA) Z87.1-compliant eye protection with side shields shall also be worn. **(T-1)** Consult BE regarding the occupational and environmental health risk assessment. Refer to [Chapter 14](#) for additional guidance.

30.8.2.1.2. Contact lens wearers shall wear appropriate eye and face protection. **(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 sometimes compound the severity of an injury. Soft contact lenses may absorb and be contaminated by chemicals, their vapors and/or fumes. **Note:** Employees shall advise supervisors if they wear contact lenses. **(T-1)**

30.8.2.2. Vehicle Engine Cleaning. Starters, generators, alternators, distributors or magnetos shall be protected (covered with waterproof paper or plastic), so internal mechanisms are not exposed to water spray or cleaning agents. Remove the air cleaner and cover the carburetor throat or air intake with waterproof paper or plastic. **(T-1)** Follow TO 36-1-191 when cleaning installed engines.

30.8.2.2.1. Employees shall wear PPE listed in [paragraph 30.9.2.1](#) when cleaning engines. **(T-1)**

30.8.2.2.2. When cleaning tanks are located in an isolated room or facility, users shall obtain permission from the appropriate supervisor to use the tank. **(T-1)** A buddy system shall be used, when required by management or safety, to ensure assistance is available if a mishap or emergency occurs. **(T-1)**

30.8.2.2.3. Solvent Storage and Handling. Bulk solvents shall be stored in well-ventilated rooms, physically separated from other storage and operations. **(T-1)** Caution and warning labels shall not be removed. Leaking drums shall be removed

outdoors immediately so vapors or liquid will not collect and become a hazard. (T-1) Contact the installation Environmental Management office for proper disposal guidelines for leaking drums. Drip pans shall not be used to catch spilled liquids unless these pans drain into a closed container. Approved containers with the solvent name clearly marked on the container shall be used. (T-1) The BE shall help determine the adequacy of ventilation in areas where solvents will be used, prior to their use. (T-1) Through BE's occupational and environmental health risk assessment, appropriate ventilation, if any, is recommended.

30.8.2.3. Oil and Hydraulic Fluid Spills. The organization responsible for the spill shall contain and clean the spill using the applicable method, such as compound, oil and water absorbent. (T-1) Contact the installation Environmental Management office for additional guidance.

30.9. Paint Shop.

30.9.1. General Requirements. To ensure safe and efficient operation, all painting activities shall be performed in accordance with accepted safety standards and [Chapter 27](#).

30.9.2. Specific Requirements.

30.9.2.1. Personal Protective Equipment. BE's occupational and environmental health risk assessment outlines PPE, if required. Refer to [Chapter 14](#) for additional guidance.

30.9.2.2. Housekeeping. Good housekeeping is essential to safe paint shop operations. Paint rooms shall be kept clean and their equipment stored in an orderly manner.

30.9.2.3. Spray Booths. All high volume low pressure spraying shall be accomplished in a paint booth to minimize health, fire and explosion hazards. (T-1) The walls of these booths shall be made of fire-resistant material that can be easily and frequently cleaned. (T-1) Refer to [Chapter 27](#) and ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for construction and installation of ventilating systems for paint-spraying operations.

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. Coverings shall be replaced frequently to prevent the accumulation of deposits. (T-1) This paper shall be removed and disposed of in accordance with state and federal hazardous waste regulations. (T-1) Contact the installation Environmental Management office for disposal guidelines. Soap-like, water-soluble materials or coatings which can be stripped, or other similar materials that can be easily washed down, may be used to protect the walls and floors of spray booths from paint accumulation, provided they do not pose an environmental pollution problem. Protective paper wall coatings shall not be used for dry or dusty paint substances that can be removed from the booths by adequate ventilation. Refer to NFPA 33, *Spray Application Using Flammable and Combustible Materials*, for additional guidance.

Note: Paint facilities with overhead

sprinklers shall have sprinkler heads covered with a paper bag to prevent paint overspray from clogging the heads. (T-1)

30.9.2.3.2. Direction of Spray. Personnel shall always spray paint toward the exhaust portal to minimize accumulation of harmful mists and vapors in the booth and to minimize any potential health hazards from airborne contaminants. **(T-1)** Spray guns shall never be pointed toward other personnel.

30.9.2.3.3. Hand Work. Adequate exhaust ventilation shall be provided in booths when hand-spray painting. **(T-1)** BE's occupational and environmental health risk assessment identifies controls. Refer to **Chapter 14** for additional guidance. Care shall be taken to ensure hoses do not present a tripping hazard for personnel or are cut by passing vehicles. **(T-0) Caution:** Some paints and additives contain toxic isocyanates. Ensure all recommendations and warnings listed on the container label are followed. Adequate NIOSH-approved respiratory protection shall be worn during the entire paint process. **(T-0)** Refer to 29 CFR § 1910.134(d)(1)(ii).

30.9.2.4. Ventilation. Mechanical ventilation shall be provided in all paint spray booths to prevent accumulation of flammable and injurious vapors. **(T-0)** Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, and 29 CFR § 1910.107, *Spray Finishing Using Flammable and Combustible Materials*, for additional guidance.

30.9.2.5. Interlocks. Electrical equipment for electrostatic hand spraying shall be interlocked with spray booth ventilation controls so spraying cannot be done unless the ventilation fans are operating. **(T-0)** Refer to 29 CFR § 1910.107 for additional guidance.

30.10. Air Compressors.

30.10.1. General Requirements.

30.10.1.1. Only qualified personnel shall repair or adjust pressure-regulating equipment. **(T-0)**

30.10.1.2. All personnel operating air compressors shall 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 shall be constructed, installed and maintained in accordance with ASME's *Boiler and Pressure Vessel Code, Section VIII*. **(T-1)** The ASME's code seal is permanently stamped on tanks meeting this criteria.

30.10.2.2. Air receivers shall be installed so all drains are easily accessible. **(T-1)** Air receivers shall 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 drain pipe and valve shall be installed at the lowest point of the air receiver to remove accumulated oil and water. **(T-1)** The drain valve shall be opened and the receiver completely drained daily to prevent accumulation of excessive amounts of liquid in the receiver. **(T-1)** Air receivers shall be stenciled to reflect this requirement (exclude air receivers with automatic drains). **(T-1)**

30.10.2.4. Every air receiver shall 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 shall 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 shall be placed between the air receiver and its safety valve or valves.

30.10.2.6. All safety valves shall be tested at regular intervals by installation BCE 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 air line outlets shall have the delivered air pressure tagged or marked showing maximum working pressure. **(T-1)**

30.10.2.8. Air hoses shall not be placed where they may create tripping hazards. All hoses shall be inspected to ensure they are properly connected to pipe outlets before use. **(T-1)** Hoses shall not be kinked to stop air flow. The control valve shall be used to turn off the air. **(T-1)** Water hose type clamps or wire connections shall not be used to replace or repair broken fittings.

30.10.2.9. When used for approved cleaning, compressed air shall be regulated to less than 30 psi and only when effective chip guarding and eye protection is used. **(T-0)** Compressed air shall not be routinely used to blow dry parts since this process can increase the inhalation hazards to employees.

30.10.2.10. Vehicles shall not be parked or left running near air intakes of compressors used to supply breathing air to painters.

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 shall be used at all times when cleaning with compressed air. **(T-0)**

30.10.3.1. Personnel with cuts/lacerations on their hands or fingers shall not hold parts that have been washed in cleaning solvent if using compressed air to blow dry the parts. Personnel shall wear neoprene or rubber gloves to avoid problems from contact with solvents. **(T-1)**

30.10.3.2. A vacuum system or water hose shall be used to remove dust, etc., from large surfaces. **(T-1)**

30.10.3.3. Compressed air shall not be used to clean clothing or body parts.

30.10.3.4. Compressed air shall not be used to “spin-dry” or “air-dry” bearings, unless permitted by the applicable TO.

30.10.3.5. Never point compressed air toward other personnel.

30.10.3.6. Assume all brakes contain asbestos, unless proven otherwise. Personnel shall utilize the OSHA Wet Method, in accordance with 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 shall be disposed of in accordance with local guidance. **(T-1)** Consult the installation Environmental Management office for further disposal guidelines. Never use compressed air to clean clutch and brake assemblies.

30.11. Compressed Gas Cylinders. (Note : Refer to [Chapter 19](#) for additional guidance. 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 in accordance with DOT regulations and bear the DOT identification. This stamping is generally found near the neck of the cylinder. Subsequent re-inspections shall be stamped in the same area. (T-0) The cylinder contents shall be legibly marked on each cylinder in large letters. (T-0) Refer to MIL-STD-101C, 29 CFR §§ 1910.101, *Compressed Gases*, 1910.102, *Acetylene*, 1910.103, *Hydrogen*, 1910.104, *Oxygen*, 1910.105, *Nitrous Oxide*, and applicable TOs for additional guidance. Non-government owned cylinders shall be tagged or otherwise marked to indicate cylinder contents. (T-0)

30.12. Lifting Devices.

30.12.1. Inspection. Many lifting device problems can be detected prior to use if properly inspected. Periodic inspections shall be performed by qualified inspection or maintenance personnel. (T-1) Test and certification of cranes and hoists shall be performed by experienced, qualified inspectors. Certification, inspection and test reports shall be available on the premises where the crane or hoist is located, in the supervisor's office or in a central maintenance shop. (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 shall be as follows:

30.12.2.1. Permanently Installed Equipment (Real Property Installed Equipment). The installation BCE shall 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 shall be responsible for mobile equipment inspection requirements. (T-1)

30.12.2.3. Fixed Shop and Portable Equipment (Equipment Authorized Inventory Data). The responsible activity shall 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 the installation BCE or 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. Employees shall stand to one side of the vehicle as it is driven on or off the lift. (T-1) The load shall rest squarely on the lift. The operator shall close the vehicle doors, hood and trunk and make sure there is no one inside the vehicle prior to raising it, except to facilitate repairs. (T-1) This applies to vehicle lifts equipped with automatic locking devices that shall not allow the vehicle to descend with loss of power. The operator shall know the load limits of the lift and adapter and ensure it is not overloaded. (T-1) The operator shall not lock the hoist controls in the open or shut position, but operate them manually. All vehicle lifts shall be equipped with a safety device to prevent accidental lowering. (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 shall 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 shall 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 shall be automatic (springing into position when the vehicle is on the lift). **(T-1)**

30.12.3.1.3. All vehicle lifts shall be marked with the manufacturer name, lift capacity and date of installation. **(T-1)** These markings shall 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 shall be equipped with “dead man” controls, which automatically return to *NEUTRAL* or *OFF* when released by an operator. **(T-1)** Controls shall be conveniently located near a lift, if feasible. **(T-1)**

30.12.3.1.5. A lift shall not be used and an appropriate hazard warning tag shall be attached if 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. Never operate it if it has damaged parts which render it unsafe. Make repairs with original equipment parts, if possible.

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. Never overload the lift. The manufacturer’s rated capacity is shown on the lift nameplate.

30.12.3.2.4. Do not operate the lift if any safety devices are inoperative.

30.12.3.2.5. Allow only trained and authorized personnel to position the vehicle and operate the lift.

30.12.3.2.6. Never raise the vehicle with anyone inside, except to facilitate repairs. **(Note:** This applies to vehicle lifts with automatic locking devices that do not allow the vehicle to descend with loss of power.) Do not allow anyone under the vehicle when raising or lowering the lift. When operating the lift, stand outside of it and keep hands clear of moving parts.

30.12.3.2.7. Always keep the lift area free of obstructions, grease, oil, trash and other debris.

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 carefully. Position lift supports to contact at the vehicle manufacturer's recommended lifting points. Raise lift until supports contact the vehicle. Check supports for secure contact with vehicle. Raise the lift to desired working height. **Caution:** Raise the lift high enough for the locking device to engage whenever someone is working under the vehicle.

30.12.3.2.10. Do not attempt to move the vehicle when the lift is 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 shall not use hydraulic floor jacks, post jacks or mechanical jacks to support vehicles while repair is accomplished. The vehicle shall be blocked and placed on approved axle or frame stands before a repair operation is started. **(T-1)**

30.12.3.3.1. The rated load of the jack shall be legibly and permanently marked in a prominent location by casting, stamping or other suitable means. **(T-1)**

30.12.3.3.2. Shop personnel shall not use a leaking or faulty jack. Defective jacks shall be taken out of service immediately, tagged and not used until repaired. **(T-1)**

30.12.3.3.3. Shop personnel shall exercise care in positioning jacks under vehicles, making sure the cap is properly located to preclude the jack slipping after the load is applied. **(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 shall be properly lubricated at regular intervals and only lubricants recommended by the manufacturer shall be used. **(T-1)**

30.12.3.3.5. Improper jacking can cause serious injury or property damage. The following jacking procedures shall be used:

30.12.3.3.5.1. Equipment shall be properly chocked prior to jacking. **(T-1)**

30.12.3.3.5.2. Jack stands shall be used any time equipment is jacked for maintenance. **(T-1)**

30.12.3.3.5.3. Equipment shall be removed from jacks as soon as possible. **(T-1)**

30.12.3.3.5.4. Equipment shall be jacked to the minimum height required for the particular task. **(T-1)**

30.12.3.3.5.5. Personnel shall 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 shall 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 shall ensure placement of jack does not cause damage to the equipment. **(T-1)**

30.12.3.3.5.9. Jacks and jack stands shall be inspected and maintained in accordance with equipment TOs. **(T-1)** If no technical data exists, manufacturer's manuals may be used as long as it meets criteria in 29 CFR § 1910, Subpart P, *Hand and Portable Powered Tools and Other Hand-Held Equipment*.

30.12.3.3.5.10. Defective jack stands shall 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 of equipment and personnel, all personnel involved in wheel dismantling or buildup operations shall be thoroughly familiar with applicable TOs, rim manuals, OSHA 3421, *Servicing Multi-Piece and Single-Piece Rim Wheels*, and this publication for the particular wheel involved. **(T-1)** Precautions outlined in these publications shall be strictly adhered to when working on wheels and rims. **(T-1)** As an added safety measure, procedures shall be reviewed prior to starting tire maintenance operations. **(T-1)**

30.13.1.2. The supervisor shall ensure all employees who service multi-piece or single piece rim wheels are trained in the proper servicing techniques and practices applicable to the type of wheels being serviced. **(T-1)** A mechanic's level of proficiency shall be established by demonstrating his or her familiarity with and ability to use the information contained in the charts, rim manuals, TOs and this publication.

30.13.1.3. The supervisor shall ensure each employee demonstrates and maintains the ability to service rim wheels safely, including the following tasks:

30.13.1.3.1. Inspection of rim wheel components. **(T-1)**

30.13.1.3.2. Mounting of tires, including inflation within a restraining device or other safeguard required by this chapter. **(T-1)**

30.13.1.3.3. Use of the restraining device, barrier and other equipment required by this chapter. **(T-1)**

30.13.1.3.4. Handling of rim wheels. **(T-1)**

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 shall evaluate each employee's ability to perform these tasks and to service rim wheels safely and shall provide additional training as necessary to ensure each employee maintains proficiency. **(T-1)**

30.13.2. Tire Servicing Equipment.

30.13.2.1. The supervisor shall ensure a restraining device for servicing multi-piece rim wheels is available and used. **(T-1)**

30.13.2.2. When servicing single piece rim wheels, the employee shall use a restraining device or barrier, except where the rim wheel is bolted to the vehicle during inflation. **(T-1)**

30.13.2.3. Supervisors shall ensure restraining devices and barriers meet the following requirements:

30.13.2.3.1. Each restraining device or barrier shall withstand the maximum force transferred to it during an explosive rim wheel separation occurring at 150 percent of maximum tire specification pressure for the type wheel being serviced. **(T-1)**

30.13.2.3.2. Restraining devices and barriers shall prevent rim wheel components being thrown outside or beyond the device or barrier for any rim wheel positioned within the device. **(T-1)**

30.13.2.3.3. A restraining device or barrier shall not contain a solid flat surface against which the rim wheel can lie or lean during inflation, such as the bed or table of a tire changing machine. **(T-1)**

30.13.2.3.4. Restraining devices and barriers shall be visually inspected prior to each day's use and after any explosion or explosive separation of the rim wheel components. **(T-1)** Any restraining device or barrier exhibiting damage such as the following defects shall be immediately removed from service:

30.13.2.3.4.1. Cracks at welds. **(T-1)**

30.13.2.3.4.2. Cracked or broken components. **(T-1)**

30.13.2.3.4.3. Bent or sprung components caused by mishandling, abuse, tire explosion or rim wheel separation. **(T-1)**

30.13.2.3.4.4. Pitting of components due to excessive corrosion. **(T-1)**

30.13.2.3.4.5. Rust or other structural damage. **(T-1)**

30.13.2.3.4.6. Inoperative air pressure warning light or gauge. **(T-1)**

30.13.2.3.4.7. Leaking, cracked or deteriorating hoses. **(T-1)**

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 restraining device, a weld is found to be severely rusted or whenever a weld's integrity is in doubt.

Note: Accomplish a one-time NDI of all welds on locally manufactured restraining devices or commercially procured devices when weld integrity has not been documented.

30.13.2.3.6. Restraining devices or barriers removed from service and requiring structural repair, such as component replacement or re-welding, shall not be returned to service until certified, by the manufacturer or a Registered Professional Engineer. **(T-1)** This certification shall ensure the restraining device or barrier will withstand the maximum force transferred during a rim wheel separation at 150 percent of the maximum tire specification pressure for the rim wheel being serviced or as required by the applicable TO, whichever is greater. **(T-1)**

30.13.2.4. The supervisor shall 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-1)**

30.13.2.4.2. A sufficient length of hose to allow the employee to stand outside the trajectory. **(T-1)**

30.13.2.4.3. An in-line valve with a pressure gauge or an adjustable regulator. **(T-1)**

30.13.2.5. An approved tire inflator cage appropriately sized for tires being serviced shall be used for inflating multi-piece wheels. **(T-1)** A regulator gauge, shutoff valve, service hose and lock-on type chuck shall be used with the cage to control the air when inflating. **(T-1)** In addition, a bleed valve shall be used to relieve pressure in the hose when the tire is filled. **(T-1)** 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,*” shall 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, shall be available in the service area. **(T-1)**

30.13.2.8. The supervisor shall ensure only tools recommended in the rim manual for the type of wheel being serviced are used to service rim wheels. **(T-1)** **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 shall not be interchanged except as provided in the charts or applicable rim manual. **(T-1)**

30.13.3.2. Multi-piece wheel components and single piece wheels shall be inspected prior to assembly. **(T-1)** Any wheel part bent out of shape, pitted from corrosion, broken or cracked shall not be used and shall be rendered unserviceable and discarded. **(T-1)** Damaged or leaky valves shall be replaced. **(T-1)**

30.13.3.3. Rim flanges, rim gutters, rings, bead seating surfaces and bead areas of tires shall be free of any dirt, surface rust, scale or loose or flaked rubber build-up prior to mounting and inflation. **(T-1)**

30.13.3.4. The size and type of the tire and wheel shall be checked for compatibility prior to assembly of the rim wheel. **(T-1)**

30.13.4. Safe Operating Procedure – Multi-piece Rim Wheels. The supervisor shall establish a safe operating procedure for servicing multi-piece rim wheels and shall ensure employees are instructed in and follow that procedure. **(T-1)** The procedure shall include, as a minimum, the following elements:

30.13.4.1. Tires shall 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 shall 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 shall be applied to bead and rim mating surfaces during assembly of the rim wheel and inflation of the tire, unless the wheel or tire manufacturer advises against its use. **(T-1)**

30.13.4.3. Tires mounted on multi-piece rims shall only be inflated when constrained by a restraining device or placed in a tire cage. **(T-1)** Tires on multi-piece rims mounted on vehicles that are more than 20 percent under-inflated shall not be re-inflated until inspected by a qualified person and the tire certified safe to re-inflate. **(T-1)** Safeguards, such as chains or remote control inflation systems, shall be used to encase the wheel and tire during the re-inflation process. **(T-1)** Supervisors shall ensure no personnel are in the trajectory area during tire re-inflation. **(T-1)**. Heat shall not be applied to a multi-piece rim with a tire mounted on it. **(T-1) Exception:** After the tire is completely deflated, the lug nuts may be heated briefly to facilitate their removal.

30.13.5. Safe Operating Procedure – Single Piece Rim Wheels. The supervisor shall establish a safe operating procedure for servicing single piece rim wheels and shall ensure employees are instructed in and follow that procedure. **(T-1)** The procedure shall include as a minimum the following elements:

30.13.5.1. Tires shall be completely deflated by removing the valve core before demounting. **(T-1)** Mechanical devices, such as dollies, shall be used to mount or remove large, heavy tires. **(T-1)**

30.13.5.2. Mounting and demounting of tire shall be performed only from the narrow ledge side of wheel. **(T-1)** Care shall be taken to avoid damage to tire beads while mounting tires on wheels. **(T-1)** Tires shall be mounted only on compatible wheels of matching bead diameter. **(T-1)**

30.13.5.3. A nonflammable rubber lubricant shall be applied to bead and wheel mating surfaces before assembly of the rim wheel and inflation of tire. **(T-1)**

30.13.5.4. If a bead expander is used to seat the beads, it shall be removed before the valve core is installed and before the tire is inflated to more than 10 psi. **(T-1)**

30.13.5.5. Tires may be inflated above 10 psi only when contained within a restraining device, positioned behind a barrier or bolted on the vehicle with lug nuts fully tightened.

Tires shall never be serviced above the pressure stamped on the tire sidewall, unless the manufacturer recommends a higher pressure.

30.13.5.6. When inflating a tire, employees shall not place a rim wheel where it will rest against or within one foot of any flat solid surface, as measured from the sidewall.

Exception: Hold-down components of a restraining device may be placed within one foot of the sidewall.

30.13.5.7. Tires shall not be inflated to more than their recommended operating pressure. The proper tire inflation pressure, tire size and load range can be found on the vehicle information/data plates or stenciled on the door jamb/glove box or as specified in the Dash-1 TO or owner's manual. If this information is not available, TO 36-1-191 shall be used to obtain the recommended tire pressure. **(T-1)** Refer to [paragraph 30.13.5.5](#) for additional guidance.

30.13.5.8. Employees shall stay out of the trajectory when inflating a tire. **(T-1)**

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 shall be deflated and rim wheel disassembled. **(T-1)** The wheel and tire shall be rechecked for compatibility, re-lubricated, repositioned and then re-inflated in accordance with [paragraphs 30.13.5.2](#) thru [30.13.5.7](#). **(T-1)**

30.13.5.10. No heat shall be applied to a single piece wheel when a tire is mounted on it. **Exception:** After the tire is completely deflated, the lug nuts may be briefly heated to facilitate their removal.

30.13.5.11. Cracked, broken, bent or otherwise damaged wheels shall not be reworked, welded, brazed or otherwise heated, except as provided in [paragraph 30.13.5.10](#).

30.13.5.12. High pressure air shall not be used to inflate tires.

30.13.5.13. Rims shall be inspected and maintained in accordance with the 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 shall:

30.13.6.1.1. Respect the potential power and explosive force of air under pressure. **(T-1)** Serious mishaps have resulted from lack of awareness of the explosive potential of compressed air. Respect it as you would an explosive!

30.13.6.1.2. Make sure all tools are in good condition – not damaged, dented or deformed. **(T-1)**

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 a 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, regardless of how hard or firm the ground appears. **(T-1)**

- 30.13.6.1.6. Place safety jack stands – or crib up with blocks – at an appropriate spot under the vehicle, in case the jack slips. **(T-1)**
- 30.13.6.1.7. Check rim diameter to ensure it exactly matches rim diameter molded on tire. **(T-1)**
- 30.13.6.1.8. Clean and inspect used rim parts thoroughly. **(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 carcass damage. Tires that are damaged beyond simple repair shall 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, such as thin vegetable oil or soap solution. **(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-1)**
- 30.13.6.1.13. Center tire properly on rim before inflating. **(T-1)**
- 30.13.6.1.14. Securely lock wheel down or place assembly in safety cage or portable safety device before attempting to inflate tire to seat beads. **(T-1)**
- 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. Replace damaged or leaky cores. **(T-1)**
- 30.13.6.2. Personnel shall 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 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. Jagged edges of mangled fenders, decks and quarter panels can be razor sharp. Protective gloves shall be worn when handling them. **(T-1)**

30.14.1.2. A full protective plastic face shield plus safety glasses or goggles shall be worn while cutting or grinding glass. **(T-1)** If handling large sheets of glass, gloves shall 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 regularly. **(T-1)** Equipment with worn, leaky or burned hoses or damaged cables and connections shall not be used.

30.14.2.1.2. Never weld or cut gas tanks, oil barrels or drums without first purging and inerting them. **(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-1)** Arrange work so air movement pulls fumes away from the breathing zone. **(T-1)**

30.14.2.1.5. Wear clean, oil free, flame resistant clothing while welding. **(T-1)** Wear protective gloves and apron (hearing protection may be required for some welding operations). **(T-1)**

30.14.2.1.6. Wear special welder's goggles as specified in **Chapter 20** (a welding helmet may also be required). **(T-1)**

30.14.2.1.7. Provide a suitable fire extinguisher and pails of sand 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 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 the 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 shall include as part of their equipment: baking soda for neutralizing acid spills, adequate fire extinguishers, container of water and eye and/or face protection for use by individual performing vehicle jump start procedures. **(T-1)** **Note:** In cold climate regions, effort shall be made to prevent container of water from freezing. **(T-1)**

30.14.4. Air Conditioning Maintenance. Gas and liquid coolants used in automotive air conditioners shall be handled with care, especially those stored under pressure. **(T-1)** Eye and face protection and gloves shall be worn while 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. Use eye protection and caution 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. Vehicles with leaking fuel tanks shall be removed 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 (5) minutes. Then dry the inside and outside thoroughly, using warm air. After cleaning, check for fuel odor and, if needed, repeat the cleaning process. Test the tank for vapors prior to any welding.

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 shall be no smoking within 50 feet of a refueler maintenance building. **(T-1)** Danger signs shall be posted in the immediate area and worded as follows: *NO OPEN FLAME OR IGNITION SOURCE BEYOND THIS POINT* or the nearest commercially available equivalent. **(T-1)** Refer to **Chapter 18** for additional guidance.

30.14.7.2. Static Grounding.

30.14.7.2.1. Aircraft refuelers shall have a static ground system in serviceable condition. **(T-1)** Refueling equipment in a refueler maintenance facility or undergoing maintenance shall be connected to a serviceable ground at all times, except when the vehicle is in motion. **(T-1)** Refueling maintenance support equipment shall be grounded. **(T-1)**

30.14.7.2.2. Storage bins shall be grounded if located inside the maintenance bay. **(T-1)**

30.14.7.2.3. Ramp ground rods shall 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 shall be removed or replaced. **(T-1)** Static ground test data shall be maintained by the installation BCE. **(T-1)**

30.14.7.2.4. Fuel nozzle static grounding shall be in accordance with TO 00-25-172. Only approved 75 amperes ground clips shall be used in accordance with TO 00-25-172. **(T-1)**

30.14.7.2.5. Alligator clips shall not be used to ground or bond aircraft and support equipment. Only specified ground wire shall be used in the shop or on refueling equipment. **(T-1)** Ground cables shall be inspected weekly for broken strands. **(T-1)** Repaired or newly constructed grounding cable assemblies shall be checked for continuity. **(T-1)** User shall 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, in accordance with the weather support document, shall advise the Fuels Management Flight of adverse or mission-limiting weather, such as thunderstorms, lightning, strong winds, heavy rain, snow or freezing precipitation. **(T-1)** All maintenance on fuel systems of fuel servicing vehicles shall cease work conducted outside. The supporting Air Force weather organization shall advise the Fuels Service Center when the adverse weather advisory is terminated. **(T-1)** Refer to **Chapter 3** for additional information on weather.

30.14.7.4. As an extra precaution, personnel shall ground themselves prior to entering a refueler maintenance shop. **(T-1)** Several methods can be used to discharge static electricity from the body. If the facility or building is metal, it shall be grounded and bonded. **(T-1)** Personnel can ground themselves by touching their hand to the bare metal. By touching their bare hand to the door knob they are grounded (if the door is metal and sufficiently bonded to the metal structure).

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, the operation shall be shut down 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 shall be cleaned out from the tank pumping system and filter separator and the tank purged prior to any maintenance. **(T-1)** Cleaning procedures shall comply with TO 36Y31-1-1, *Removal of Rust and Sediment from Fuel and Oil Servicing Truck and Trailer Tanks and Application of Coating, Interior, Fuel and Water Resistant*. **(T-1)** Precautions outlined in the applicable TO of the equipment being serviced shall be followed. **(T-1)**

30.14.7.7. When fuel filter elements are changed, old filters shall be disposed of in accordance with installation Environmental Management office regulations. **(T-1)**

30.14.7.8. A minimum of two (2) persons, one qualified in the task to be performed and the other a safety observer to provide assistance, shall be available in the refueling maintenance site whenever repairs are done on a vehicle fuel system. **(T-1)** For minor maintenance after duty hours, the Vehicle Flight Commander may waive, in writing, the two-person policy if all safety precautions are taken and a qualified 5-skill level mechanic does the work. **Note:** A vehicle operator for the type of equipment being repaired may be the second person. Refer to AFI 24-302 for additional guidance.

30.14.7.9. Personnel performing maintenance on fuel trucks shall not wear shoes with exposed nails or metal plates.

30.14.7.10. Clothing containing more than 65 percent nylon, rayon, wool or polyester shall not be worn as outer garments when working with/around low flash point fuels. Flak vests shall not be worn during aircraft fuel servicing operations or during fuel operations where low flashpoint vapors may be present. In all cases (e.g., servicing with any fuel), an employee wearing a flak vest will always ground or bond him or herself when approaching an aircraft and prior to beginning work. **(T-1)** 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 him or herself frequently during all work

phases. **(T-1) Note:** Commanders may authorize wear of body armor/flak vests and Gortex-type clothing in combat areas. Outer garments shall not be removed or put on in the work area. Matches or lighters shall not be handled or removed from pockets.

30.14.7.11. All tools used in the refueling maintenance shop shall be approved for such use. **(T-1)**

30.14.7.12. Axle stands, rated at least 10 tons, shall be used for axle support on refuelers. **(T-1)**

30.14.7.13. Hydraulic jacks, rated at least 10 tons, shall be used when lifting refueling vehicles. **(T-1)**

30.14.8. Refueler Maintenance Buildings.

30.14.8.1. An empty refueling vehicle containing fuel vapors is a potential bomb and shall be treated as such. **(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 only if no other fuel servicing vehicles are present. **Note:** For remote/austere locations or where vehicle maintenance services are distant to the location where refueling vehicles are assigned, 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 and operates on only high flashpoint fuels (e.g., the refueler transports and operates only on JP-8). **Note:** While the exceptions provide commanders additional flexibility, organizations shall still perform and document an appropriate risk assessment prior to introducing other vehicles into a refueler maintenance facility or performing maintenance on refuelers in other than a refueler maintenance facility. **(T-1)** Risk assessments shall be coordinated with the installation F&ES Flight and Occupational Safety office. **(T-1)**

30.14.8.1.3. Because of the large number of fueling vehicles and carts normally assigned, an AF installation shall have a separately sited maintenance and repair facility, unless approved by AFCEC/COSM. **(T-1)** It shall be physically separated from other inhabited structures and any other source of ignition by at least 50 feet. **(T-1)** Due to space restrictions and the low number of fueling vehicles and carts normally assigned to an Air National Guard unit, a separately sited maintenance and repair facility, separated from other inhabited structures and any other source of ignition by at least 50 feet, is recommended. Refer to AFI 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 should be located so the installation F&ES Flight will have immediate and direct access on paved roads. **(T-1)** One or two minutes saved in response time may mean the difference between saving or losing the facility.

30.14.8.4. Both external and internal earth grounds shall be provided for the refuelers and a lightning protection system provided for the structure. **(T-1)**

30.14.8.5. Separate locker areas, washing areas and eating areas shall be provided for employees. **(T-1)** Adequate PPE for exposure to liquid fuels and vapors shall be provided. **(T-1)** 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. Contamination from floor drains is a potential fire, safety and health hazard. Floor drains shall be kept clean at all times. **(T-1)** Solvent or fuel shall not be used to clean floor drains. **(T-1)** Protective clothing such as goggles, rubber boots and gloves shall be worn during drain cleaning. **(T-1)**

30.14.9. Vehicle Maintenance Repair Pits.

30.14.9.1. Vehicle repair pits shall be guarded. **(T-1)** The type of guard used is dependent on the location, reason for the opening and frequency of use. Where railings are used, they shall be permanently attached leaving only one exposed side. **(T-1)** The exposed side shall have a removable railing kept in place when not in use. **(T-1)** It shall be painted yellow to designate caution. **(T-1)**

30.14.9.2. A vertical barrier shall be placed at the floor level, along open edges of the pit, to prevent materials, tools, etc., from dropping and striking employees. **(T-1)**

30.14.9.3. All pits equipped with steps shall have handrails and approved lighting in accordance with NFPA 70. **(T-1)** Steps shall be painted, coated or made with an approved nonskid material to prevent slippage. **(T-1)**

30.14.9.4. Adequate explosion-proof lighting shall be installed in pits or portable explosion-proof extension lights furnished. **(T-1)**

30.14.9.5. Pits shall be built with drains equipped with oil or grease traps and shall not be connected to sanitary sewers. **(T-1)** In addition, local exhaust should be provided to remove vapors. Refer to BE's occupational and environmental health risk assessment for additional guidance. Exhaust fans used in pit ventilation systems shall be suitable for use with fuel vapors, e.g., have explosion-proof motors and non-sparking blades in accordance with NFPA 70. **(T-1)**

30.14.9.6. Pit contamination is a potential fire, safety and health hazard. Pits shall be cleaned regularly with soap and water or an approved caustic solution, but not flammable or combustible solvents. **(T-1)** PPE, including goggles, rubber boots and gloves, shall be worn during pit cleaning. **(T-1)**

30.14.9.7. To prevent accumulation of hazardous gases, the vehicle engine shall not be operated while a vehicle is positioned over a repair pit, unless required by manufacturer's instructions or TO.

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 shall evaluate any operations involving composite materials. **(T-1).** **Paragraph 1.6,** *Job Hazard Analysis*, AFI 90-802, Air Force Pamphlet (AFPAM) 90-803, *Risk Management (RM) Guidelines and Tools*, and AFI 90-821 shall be observed and adhered to 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 shall follow guidance in **Chapter 23**.

31.2. Specific Responsibilities. Functional managers and supervisors shall:

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 workers performing composite repair and fabrication tasks, or handling or using hazardous materials, receive hazard communication training in accordance with AFI 90-821. **(T-0)**

31.2.3. Ensure safety data sheets (SDSs) are available for all hazardous materials used in composite work tasks. **(T-0)**

31.2.4. Ensure workers 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. Ensure appropriate PPE is available and worn when handling composite materials and chemicals. **(T-0)** Refer to **Chapter 14** for additional guidance.

31.2.7. Coordinate with the installation Environmental Management office 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. **(Warning:** Do not exceed manufacturer's maximum batch size or a violent exothermic reaction may result.) Workers shall refer to the TO and/or SDS prior to starting any work when hazardous materials or chemicals are involved or needed for the process. **(T-1)**

31.3.2. Training. All personnel who work with composite materials shall be trained on the hazardous properties of chemicals and materials used. **(T-0)** As a minimum, job safety training shall include need for and use of approved PPE; maintenance and care of PPE; safe chemical handling procedures; and emergency treatment practices in case of exposure, ingestion or inhalation of liquids, vapors or dusts from composite operations. **(T-1)** This training shall be documented in accordance with AFI 91-202. **(T-1)**

31.3.3. Hazard Communication. Workers shall receive hazard communication training. (T-0) Refer to AFI 90-821 for additional guidance.

31.3.4. Eyewash and Emergency Showers. Emergency shower facilities for composite repair shops shall be installed in accordance with [Chapter 9](#). (T-1)

31.3.5. Exposure Monitoring. Supervisors shall consult with BE to ensure workers who may be potentially exposed to airborne composite materials are monitored, and appropriate respiratory protection requirements are established in accordance with AFI 48-137. (T-1) Additional protective equipment for workers handling composite materials shall be provided in accordance with [Chapter 14](#).

31.3.6. Fire Protection. All facilities and operating areas shall have fire protection appropriate in accordance with [Chapter 6](#). (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 of BE's occupational and environmental health risk assessment and installed in accordance with the manufacturer's instructions. (T-1)

31.3.8. Handling Flammable and Combustible Liquids and Materials. Refer to [Chapter 22](#) regarding appropriate procedures for handling flammable and combustible materials.

31.3.9. Storage Of Composite Materials. Composite materials, including resins and catalysts, shall be stored in accordance with technical order requirements or, if not available, the manufacturer's instructions. (T-1) If neither are available, storage shall be in accordance with locally developed guidance prepared in coordination with the installation F&ES Flight, Occupational Safety office, BE and Environmental Management office. (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, storage shall comply with [Chapter 22](#) of this instruction, NFPA 30 or the manufacturer's suggested guidelines. (T-1)

31.3.9.2. Outside Storage. To minimize the potential for environmental contamination, the installation Environmental Management office shall coordinate on the siting of all outside storage areas. (T-1) Refer to [Chapter 22](#) and NFPA 30 for additional guidance and information.

31.3.10. Electrical Requirements for Flammable Vapor Areas. Facility wiring shall be installed and maintained in accordance with NFPA 70E and UFC 3-600-01 guidance, and any specialized criteria necessary to maintain the safety of the operation. (T-0) Design and installation shall be in accordance with UFC 3-600-01. (T-1)

31.3.11. Powered and Non-powered Equipment and Tools Used Near Flammable and Combustible Materials. Tools and equipment used in composite operations shall be procured, installed and maintained such that they pose no ignition source to chemicals, chemical byproducts and finished products of the operation. (T-1)

31.4. Specific Applications.

31.4.1. Laboratories. All laboratories shall have fire protection appropriate for their fire hazard classification. (T-0) For additional details, refer to NFPA 45, *Standard on Fire Protection for*

Laboratories Using Chemicals, and AFI 90-821 for occupational exposure to hazardous chemicals in laboratories. Refer to [paragraph 22.6.1](#) for storage and handling of flammable and combustible materials.

31.4.2. Military Exchanges, Commissaries and Associate Retail Stores. Facilities offering unreacted composite materials (e.g., auto body fillers, fiberglass repair kits) shall ensure the materials are kept in their original containers and that all manufacturer's precautions and use information is provided to purchaser at time of sale. **(T-1)** Damaged or leaking packages shall be removed from sale and disposed of properly. **(T-0)** Contact the installation Environmental Management office for disposal guidelines. In rooms or areas accessible to the public, storage shall be limited to quantities needed for display and normal merchandising purposes. **(T-1)** For storage of flammable and combustible materials, refer to [Chapter 22](#) and NFPA 30.

31.5. Hazardous Waste Disposal. Supervisors shall coordinate with the installation Environmental Management office to establish a hazardous waste material list for their unit and establish procedures for hazardous waste disposal. **(T-1)** Refer to AFMAN 32-7002 for additional guidance.

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 installation F&ES Flight, BE and Environmental Management office shall 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 shall be carefully reviewed for fire protection, occupational safety, health (bioenvironmental concerns), and environmental impact prior to use by the Air Force 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 shall 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 Precision Measurement Equipment Laboratory (PMEL) operations. Refer to AFMAN 21-113, *Air Force Metrology and Calibration (AFMETCAL) 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 shall 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 shall be kept clean and free of unnecessary obstructions. (T-0) Equipment and materials shall 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 shall ensure:

32.1.2.1. Personnel are trained on the location, selection and use of fire extinguishers, alarm systems, main power switches and evacuation procedures. (T-0)

32.1.2.2. CPR training is provided for workers required to perform work on energized high voltage electric circuits. (T-0) Refer to [paragraph 1.9](#) for additional guidance on CPR training requirements.

32.1.2.3. Personnel performing maintenance on ionizing radiation equipment receive the proper ionizing and non-ionizing radiation safety training from the installation Radiation Safety Officer. (T-1)

32.1.2.4. Fire extinguishers are properly mounted, readily accessible, in a serviceable condition and clearly visible. (T-0)

32.1.2.5. All exits are clearly identified, posted with signs, doors unlocked, easily accessible and clear paths of egress are provided. (T-0) Consult the installation F&ES Flight for guidance on emergency lighting and exit requirements.

32.1.2.6. All new chemicals, machines and processes are evaluated by the installation Occupational Safety office, F&ES Flight, Environmental Management office and BE, as appropriate, prior to introduction into the work area. (T-0) Once approved, supervisors shall ensure all personnel are trained prior to using the new chemicals, machines or processes. (T-0) Training shall be documented, as required, for personnel, and the supervisor shall keep a list of trained personnel on each chemical, machine or process. (T-1)

32.1.2.7. Housekeeping requirements are complied with in accordance with [Chapter 2](#) of this instruction.

32.2. Hazards. Personnel engaged in PMEL operations are exposed to several potential hazards. They include, but are not limited to, exposure to electrical and electromagnetic energy, hazardous chemicals/materials and flammable and combustible liquids and gases. PMEL personnel are also

subject to physical injuries associated with on-site job environments. Particular attention must be given to protection against exposure to toxic chemicals and ionizing radiation, because the effects of any exposures are not always immediately apparent. Potential health hazards can be managed by following guidance in this publication, adhering to proper work procedures, engineering controls and facility design, and by using proper PPE and clothing.

32.2.1. Electrical Hazards. All sources of electrical energy are potentially hazardous if proper safety precautions are not routinely followed. Personal injury from electric shock, arcing and resulting physical reactions may cause severe or fatal injuries. Safe electrical work practices, safe equipment and approved grounding procedures are essential to prevent electrical mishaps. Personnel working on, with or near energized electrical circuits or equipment shall adhere to guidance in [Chapter 8](#) and [Chapter 21](#). (T-1)

32.2.2. Radiation Hazards. Radiation is electromagnetic energy in the form of waves or particles that radiate into space from an emitting source. Hazardous radiation in PMEL operations may be classified as either ionizing radiation or non-ionizing radiation.

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. **Caution:** 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 should be made aware of this requirement. If there are questions, refer the employee for a medical assessment in coordination with the installation BE office.

32.2.2.3. Laser Radiation. Laser energy presents a significant hazard to the eyes and skin under direct or reflected viewing conditions. The use of optical viewing aids, 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 and information on managing laser radiation hazards.

32.2.2.4. 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 and information on managing radio frequency radiation hazards.

32.2.3. Chemical Hazards. PMEL operations use and may expose personnel to hazardous chemicals. OSHA defines a hazardous chemical as any chemical which is a physical or health hazard. This definition clearly applies to most of the chemicals typically used in PMEL

operations. Refer to AFMAN 48-146 for additional guidance and information on the management of hazards associated with chemical exposure.

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. **Warning:** Injected oil may be life threatening and requires immediate medical treatment. Refer to [Chapter 19](#) for additional guidance on hazards of compressed gases.

32.2.5. Fire Hazards. Flammable and combustible liquids shall be properly handled, stored and used. **(T-0)** Refer to [Chapter 22](#) and [Chapter 6](#) for additional guidance. Also, consult the installation F&ES Flight for guidance on the selection and placement of fire extinguishers within the workplace.

32.2.6. Laser Eye Protection. Appropriate laser eye protection shall be worn when working with laser equipment. The installation Laser Safety Officer and BE's Occupational and Environmental Health Risk Assessment shall be consulted for the type of laser eye protection required. **(T-1)** Lasers shall 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), low-level or high-level (acute), or both. Health effects from these exposures may vary from minor irritation and temporary illness to permanent organ damage, cancer and death. The proper use of approved respirators shall protect the wearer from toxic levels of airborne chemicals. **(T-0)** AFI 48-137 provides guidance on the proper use and application of respiratory protection. Installation BE's Occupational and Environmental Health Risk Assessment will identify respiratory protection, if necessary. **(T-3)** Refer to [Chapter 14](#) and [29 CFR § 1910.134](#), *Respiratory Protection*, for additional guidance.

32.3. Ventilation Systems. As a minimum, PMEL cleaning areas and work areas must have appropriate ventilation. **(T-0)** Ventilation shall continue for a sufficient time after job completion to minimize residual vapors and provide adequate makeup air. **(T-0)** Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, AFMAN 48-146, and FC 4-218-01F, *Air Force Criteria for Precision Measurement Equipment Laboratory Design and Construction*, for additional information on workspace ventilation, including information on permissible exposure levels, flow rate requirements and design criteria. Installation BE will determine what, if any, periodic testing of ventilation systems is required. **(T-1)**

32.4. Electrical Safety for PMEL Operations. Refer to [Chapter 8](#) and [Chapter 21](#) for additional guidance and information during PMEL operations.

32.4.1. Laboratory Floors. The floor covering of calibration/repair areas shall be as specified in FC 4-218-01F. **(T-0)** Floor coverings that are damaged or do not meet specified requirements, shall be repaired or replaced. **(T-0)** Insulated mats (Black – 24 inches wide / Blue – 36 inches wide / Green – 36 inches wide), or suitable substitutes, are required when personnel are exposed to and working on energized high voltage circuits.

32.4.2. Equipment Grounding. Refer to the manufacturer's instructions or 29 CFR §§ 1910.303, *General Requirements*, 1910.304, *Wiring Design and Protection*, 1910.305, *Wiring Methods, Components, and Equipment for General Use* and 1910.308, *Special Systems*, for guidance and information.

32.4.3. Facility Ground. The facility ground shall be marked at its connection to the ground buss bar. **(T-1)** The facility custodian shall visually inspect the electrical and grounding systems on a monthly basis for security and damage. **(T-1)** After repairs, they shall 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 shall 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 shall 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 shall be placed on the equipment. **(T-1)** Interlocks shall not be permanently disabled or bypassed. **(T-1)** Refer to [Chapter 17](#), [Chapter 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 authorized maintenance personnel shall 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 and working on energized high voltage circuits, e.g., greater than 600 volts, nominal, safety observers trained in CPR shall be present, unless the area supervisor determines the risk of the operation does not warrant a safety observer. **(T-0)** Personnel shall follow guidance in UFC 3-560-01 when an arc flash exists. **(T-0)**

32.4.6. Fuses and Circuit Breakers. Refer to NFPA 70, Article 408.4(A), *Circuit Directory or Circuit Identification*, for circuit breakers/fuse box identification additional guidance and information.

32.4.6.1. Circuit breakers or fuses shall be installed in all electrical circuits to interrupt the current flow when it exceeds the current carrying capacity of the conductor and/or circuit. **(T-0)** Do not bypass circuit breakers and fuses. Refer to 29 CFR § 1910.306 for additional guidance.

32.4.6.2. Equipment fuses shall 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. 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 shall 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 shall be disconnected before technicians perform adjustments or repairs not involving alignment of mechanical/electrical components. **(T-0)** Adjustments with power on shall only be accomplished when required by applicable TOs or manufacturer's instructions. **(T-1)** Technicians performing the adjustment/alignment shall 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 [paragraph 8.12](#) for required items included in an emergency equipment kit or board.

32.5. Radioactive Material Safety.

32.5.1. Radioactive material shall be handled in a manner that results in as low as reasonably achievable exposures to personnel. **(T-1)** The installation Radiation Safety Officer (RSO) and BE shall prescribe special procedures and precautionary measures as necessary. **(T-1)** In overseas areas, disposal procedures shall be coordinated with the installation RSO and BE, who, in turn will coordinate with the host nation. Refer to AFMAN 40-201 for additional guidance.

32.5.2. Personnel shall not handle or expose a radioactive source except as required in the performance of duty. **(T-1)** Personnel involved in the actual use of radioisotopes shall receive formal training in their use and any precautionary measures, followed by continuing OJT. **(T-1)** No one shall be authorized to use, handle or access any area with an exposed or open ionizing radiation source without the worker and task being evaluated by the installation Radiation Safety Officer for possible entry into the US Air Force Dosimetry Program and placed on the dosimetry program, if deemed necessary. **(T-1)** Refer to DAFMAN 48-125 for additional guidance and information.

32.5.3. In restricted areas where radioactive material is used or stored, appropriate placards shall be conspicuously posted at each entrance and around the exterior perimeter of each area so at least one placard is clearly visible from any direction of approach. **(T-0)** Obstacles, such as rope, barricades, etc., shall be used to discourage unauthorized entry into controlled areas. **(T-1)** Individual containers of radioactive material within the area shall be appropriately identified. **(T-1)**

32.5.4. Pregnant military personnel must report to Public Health (PH), and civilian workers are encouraged to report to PH, who will, in coordination with 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 shall wash their hands and face before eating or drinking and upon leaving a contaminated area. **(T-1)**

32.5.6. Regardless of radiation intensity, radioactive items used in PMEL operations shall 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, shall be established to prevent unauthorized entry into high radiation areas, as defined in AFMAN 48-148. (T-1) Entry of personnel into a high radiation area will energize a conspicuously visible or audible alarm signal designed to alert personnel present or cause the exposure to terminate.

32.5.8. If containers of radioactive materials are broken or damaged, the area shall be cleared of all personnel not required in evaluation of the condition, recovery of the radioisotope or decontamination of the area or material. (T-1) Once the area is cleared, it shall be secured. (T-1) If radioactive material becomes airborne, doors and windows shall be closed and ventilation equipment turned off. (T-1) The PMEL supervisor and installation Radiation Safety Officer shall be notified immediately. (T-1) A survey of the area shall be conducted to determine the extent of the radiological hazard. (T-1) Personnel who have been, or may have been, exposed shall be monitored to determine the extent of medical action required. (T-1) The Radiation Safety Officer shall direct the decontamination or recovery operation, as necessary. (T-1) Broken or damaged items shall be safely packaged and disposed of. (T-1) Refer to AFI 40-201 for additional disposal and handling instructions.

32.6. Equipment/Component Cleaning.

32.6.1. Vacuuming using a nonmetallic wand and suction nozzle is the preferred method for cleaning electronic equipment. If compressed air is used, the air pressure shall be limited to the lowest possible level. (T-1) Generally, five (5) psi is adequate for equipment cleaning. However, pressures shall not exceed 30 psi. (T-1) A diffuser nozzle shall be provided. (T-1) Refer to TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance, and Test of Electrical Equipment*, for additional guidance.

32.6.2. Only approved and authorized solvents shall be used. (T-1) Adequate ventilation shall be provided. (T-1) BE's occupational and environmental health risk assessment shall be consulted if the characteristics of a solvent are in question. (T-1) Refer to ACGIH's *Industrial Ventilation: A Manual of Recommended Practice for Operations and Maintenance*, for additional guidance and information on ventilation requirements. Appropriate PPE, as required in maintenance data and SDS, shall be worn. (T-0) Additionally, refer to [Chapter 14](#) for additional PPE requirements when working around solvents.

32.6.3. Ultrasonic Cleaning. When using ultrasound-cleaning equipment, workers shall always follow the manufacturer's instructions for parts and equipment cleaning. (T-1) Refer to TO 00-25-234 for additional guidance on equipment cleaning and proper use of ultrasonic-cleaning equipment.

32.7. Tools and Equipment.

32.7.1. Insulated tools shall 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 shall 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 shall 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 shall be instructed on radio frequency radiation hazards prior to working on this equipment and shall not be exposed to radio frequency radiation levels above permissible exposure limits. **(T-0)** Caution shall be observed with any open waveguide connected to an energized source of microwave radiation, as high power densities can be found at the waveguide opening. **(T-1)** A radio frequency radiation warning sign shall 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 shall 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. Workers shall wear appropriate PPE when using this equipment and associated chemicals. **(T-1)**

32.7.8. Calibration/Repair of Radiation Measuring Equipment. Personnel shall follow AFI 48-109, AFI 48-139 and AFMAN 40-201 when calibrating or repairing radiation test, measuring and diagnostic equipment. **(T-1)**

JEANNIE M. LEAVITT
Major General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFI 13-213, *Airfield Driving*, 4 February 2020

AFI 16-1007, *Management of Air Force Operational Training Systems*, 1 October 2019

AFI 21-101, *Aircraft and Equipment Maintenance Management*, 16 January 2020

AFI 23-201, *Fuels Management*, 9 August 2021

AFI 24-301, *Ground Transportation*, 22 October 2019

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 32-2001, *Fire and Emergency Services Program*, 28 September 2018

AFI 32-10141, *Planning and Programming Fire Safety Deficiency Correction Projects*, 15 May 2019

AFI 33-322, *Records Management and Information Governance Program*, 23 March 2020

AFI 48-104, *Tobacco Free Living*, 11 July 2019

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 48-145, *Occupational and Environmental Health Program*, 11 July 2018

AFI 48-151, *Thermal Injury Prevention Program*, 7 April 2016

AFI 90-802, *Risk Management*, 1 April 2019

AFI 90-821, *Hazard Communication (HAZCOM) Program*, 13 May 2019

AFI 91-202, *The US Air Force Mishap Prevention Program*, 12 March 2020

AFJMAN 23-210, *Joint Service Manual (JSM) for Storage and Materials Handling*, 12 April 1994

AFMAN 10-2503, *Operations in a Chemical, Biological, Radiological, and Nuclear Environment*, 14 May 2019

AFMAN 11-218, *Aircraft Operations and Movement on the Ground*, 5 April 2019

AFMAN 15-129, *Air and Space Weather Operations*, 9 July 2020

AFMAN 21-113, *Air Force Metrology and Calibration Program Management*, 29 April 2020

AFMAN 24-306, *Operation of Air Force Government Motor Vehicles*, 30 July 2020

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 32-1067, *Water and Fuel Systems*, 4 August 2020

AFMAN 32-1068, *Heating Systems and Unfired Pressure Vessels*, 16 June 2020

AFMAN 32-7002, *Environmental Compliance and Pollution Prevention*, 4 February 2020

AFMAN 40-201, *Radioactive Materials (RAM) Management*, 29 March 2019

AFMAN 48-146, *Occupational and Environmental Health Program Management*, 15 October 2018

AFMAN 48-148, *Ionizing Radiation Protection*, 20 July 2020

AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*, 13 March 2020

AFPAM 90-803, *Risk Management (RM) Guidelines and Tools*, 11 February 2013

AFPD 91-2, *Safety Programs*, 3 September 2019

AFVA 91-303, *DANGER—DO NOT ENERGIZE—PERSON WORKING ON ANTENNA*

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

AFVA 91-305, *DANGER—INTERLOCKS DISABLED*

AFVA 91-306, *DANGER—HIGH VOLTAGE SIGN*

DAFI 32-9005, *Real Property Accountability*, 4 February 2020

DAFI 33-360, *Publications and Forms Management*, 1 December 2015

DAFMAN 32-1084, *Standard Facility Requirements*, 15 January 2020

DAFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, 27 October 2020

DAFMAN 65-605, Volume 1, *Budget Guidance and Technical Procedures*, 31 March 2021

DESR 6055.09_AFMAN 91-201, *Explosives Safety Standards*, 28 May 2020

DLAI 4145.25, *Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders*, 16 June 2000

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

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

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-161H, *DoD Standard Practice: Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels*, 4 September 2015

MIL-STD-882E, *DoD Standard Practice: System Safety*, 11 May 2012

MIL-STD-1411C, *DoD Standard Practice: Inspection and Maintenance of Compressed Gas Cylinders*, 5 March 2020

MIL-STD-1472H, *DoD Design Criteria Standard: Human Engineering*, 11 January 2012

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*, 6 September 2019

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*, 15 December 2020

TO 4T-1-3, *Inspection, Maintenance Instruction – Storage and Disposition of Aircraft Tires and Inner Tubes*, 30 January 2018

TO 11A-1-33, *Handling and Maintenance of Explosives Loaded Aircraft*, 25 February 2019

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 2020

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 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 Maintenance*, 8 November 2017

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*, 15 July 2013

TO 37A-1-101, *General Instructions – USAF Fuel, Water, and Lubricant Dispensing Equipment*, 1 August 2012

TO 42B-1-1, *Quality Control Fuels and Lubricants*, 15 November 2016

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

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

UFC 4-740-14, *Design: Child Development Centers*, 1 August 2002

US Army Corps of Engineers Manual (EM) 385-1-1, *Safety and Health Requirements Manual*, 30 November 2014

American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation; A Manual of Recommended Practice*, 21 April 2015

ANSI (www.ansi.org)

ANSI A92.2, *Vehicle-Mounted Elevating and Rotating Aerial Devices*, 7 July 2015

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*, 1 January 2019

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/ASSP Z359.0, *Definitions and Nomenclature Used for Fall Protection and Fall Arrest*, 23 February 2012

ANSI/ASSP Z359.2, *Minimum Requirements for a Comprehensive Managed Fall Protection Program*, 9 January 2017

ANSI/ASSP Z359.4, *Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components*, 8 March 2013

ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel and Accessories*, 1 February 2016

ANSI/ISEA Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices*, 1 January 2015

ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection*, 15 May 2014

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

ASME (www.asme.org)

ASME *Boiler and Pressure Vessel Code*, 1 July 2019

ASME A13.1, *Scheme for the Identification of Piping Systems*, 7 October 2020

ASME A17.1, *Safety Code for Elevators and Escalators*, 30 November 2016

ASME A17.2, *Guide for Inspection of Elevators, Escalators and Moving-Walkways*, 26 January 2018

ASME B30.2, *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)*, 30 May 2017

ASME B30.5, *Mobile and Locomotive Cranes*, 6 August 2018

ASME B30.7, *Winches*, 16 September 2016

ASME B30.9, *Slings*, 15 May 2018

ASME B30.10, *Hooks*, 30 June 2014

ASME B30.16, *Overhead Underhung and Stationary Hoists*, 31 August 2017

ASME B30.17, *Cranes and Monorails (With Underhung Trolley or Bridge)*, 9 March 2016

ASME B30.21, *Lever Hoists*, 30 May 2014

ASME B30.23, *Personnel Lifting Systems*, 16 December 2016

ASTM (www.astm.org)

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 (www.cganet.com)

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

NFPA (www.nfpa.org)

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 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*

10 USC § 1073c, *Administration of Defense Health Agency and Military Medical Treatment Facilities*

Department of Justice Privacy Act of 1974, as amended by 5 USC § 552a

10 CFR § Part 20, *Standards for Protection Against Radiation*

21 CFR § Part 1020.30, *Diagnostic X-ray Systems and Their Major Components*

21 CFR § Part 1020.31, *Radiographic Equipment*

21 CFR § Part 1020.32, *Fluoroscopic Equipment*

21 CFR § Part 1020.33, *Computed Tomography (CT) Equipment*

33 CFR § Part 156, Subpart A, *Oil and Hazardous Material Transfer Operations*, Section 156.120, *Requirements for Transfer*

49 CFR § 180.209, *Requirements for Regualification of Specification Cylinders*

OSHA (<http://www.osha.gov/>)

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*

OSHA Publication 2254, *Training Requirements in OSHA Standards*, 2015

UL 94, *Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*, 8 July 2015

Prescribed Forms

AF Form 592, *USAF Hot Work Permit*

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*

AF Form 1024, *Confined Space Entry Permit*

Adopted Forms

AF Form 55, *Employee Safety and Health Record*

AF Form 103, *Base Civil Engineering Work Clearance Request*

AF Form 469, *Duty Limiting Condition Report*

AF Form 483, *Certificate of Competency*
AF Form 623, *Individual Training Record Folder*
AF Form 847, *Recommendation for Change of Publication*
AF Form 1098, *Special Task Certification and Recurring Training*
AF Form 1118, *Notice of Hazard*
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*
DD Form 1574, *Serviceable Tag – Material*
DD Form 1577-2, *Unserviceable (Reparable) – Tag Materiel*

Abbreviations and Acronyms

ACGIH—American Conference of Governmental Industrial Hygienists
AFCEC—Air Force Civil Engineer Center
AFI—Air Force Instruction
AFJMAN—Air Force Joint Manual
AFMAN—Air Force Manual
AFMC—Air Force Materiel Command
AFOSH—Air Force Occupational Safety and Health
AFPAM—Air Force Pamphlet
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
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
AVGAS—Aviation Gasoline

BAK—Barrier Arresting System
BCE—Base Civil Engineer
BE—Bioenvironmental Engineering
C—Celsius
CAP-USAF—Civil Air Patrol
CBT—Computer-based Training
CE—Civil Engineer or Civil Engineering
CFR—Code of Federal Regulations
CGA—Compressed Gas Association
CH₄—Methane
cm—Centimeter
CO₂—Carbon Dioxide
CPR—Cardiopulmonary Resuscitation
CSPT—Confined Space Program Team
C₂H₆—Ethane
dBA—Decibels-A-Weighted
DFPE—Designated Fire Protection Engineer
DoD—Department of Defense
DoDI—Department of Defense Instruction
DOT—Department of Transportation
DRU—Direct Reporting Unit
E-I—Engineering/Installation
EM—Engineers Manual
DAFMAN—Department of the Air Force Manual
F—Fahrenheit
FES—Fire Emergency Services
FLDCOM—Field Command
FOA—Field Operating Agency
FOD—Foreign Object Damage
GFCI—Ground Fault Circuit Interrupter
HAZCOM—Hazard Communication
HAZMAT—Hazardous Material

HMMWV—High Mobility Multipurpose Wheeled Vehicle

HQ—Headquarters

IDLH—Immediately Dangerous to Life and Health

ISEA—International Safety Equipment Association

JHA—Job Hazard Analysis

JP—Jet Petroleum

JSM—Joint Service Manual

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

MHE—Material Handling Equipment

MIL-PRF—Military Performance Specification

MIL-STD—Military Standard

MPH—Miles Per Hour

MX—Maintenance

NAF—Numbered Air Force

NATO—North Atlantic Treaty Organization

NDI—Non-Destructive Inspection

NFPA—National Fire Protection Association

NRTL—Nationally Recognized Testing Laboratory

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
PCB—Polychlorinated Biphenyl
PFAS—Personal Fall Arrest System
PH—Public Health
PMEL—Precision Measurement Equipment Laboratory
PPE—Personal Protective Equipment
PSI—Pounds per Square Inch
PSM—Process Safety Management
RM—Risk Management
ROPS—Rollover Protection Structure
SABC—Self-Aid Buddy Care
SDS—Safety Data Sheet
SE—Support Equipment
SEG—Occupational Safety
TO—Technical Order
UFC—Unified Facilities Criteria
US—United States
USAF—United States Air Force
USC—United States Code

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, a push button, toggle switch, foot pedal, hand lever or a hand set 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 aiseways 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 Worker—A worker approved or assigned by the employer to perform a specific type of duty or duties, or to be at a specific location or locations at the jobsite. Example: A worker 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 and/or Hand Protection—Any glove, finger guard, arm protector, apron, bib or garment designed to protect the body, arms, hands or fingers from contamination or injury due to absorption or physical contact.

Body Harness—A harness secured about the wearer so fall arrest forces are distributed over the thighs, buttocks, chest and shoulders, or any combination thereof. Includes provisions for attaching a lanyard centered in the back near shoulder level or above the head.

Bonding—The interconnecting of metal raceways, equipment cabinets, shields, etc., to the facility equipment system to eliminate electrical potential of individual pieces of equipment relative to each other.

Boom (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, footwalks 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 (2) types of buddy systems. One involves both persons subjected to the same hazard at the same time, and each assures the other's well-being and assists if a mishap occurs. The other system is where one person is exposed to the hazard while the other is not and acts as an observer.

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, rivetless, 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 worker from contact with chemicals. It may include items such as: hoods, face shields, chemical goggles, jackets, coats, aprons, bib overalls, coveralls, splash suits, boots, shoe covers and full-body encapsulating suits.

Chuck—A clamp that holds a tool or material being worked in or on a machine.

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.

Combination Unit (Emergency Shower and Eyewash)—A unit combining a shower with an eye and face wash, or eyewash with a drench hose, or both.

Combustible Liquid—A liquid having a flashpoint at or above 100° F (37.8° C). Combustible liquids shall be divided into two classes as follows:

(1) Class II liquids have a flashpoint at or above 100° F (37.8° C) and below 140° F (60° C), except any mixture having components with flashpoints of 200° F (93.3° C) or higher, the volume of which makes up 99 percent or more of the total volume of the mixture.

(2) Class III liquids have flash points at or above 140° F (60° C) and are subdivided into two subclasses:

(a) Class IIIA liquids have flashpoints at or above 140° F (60° C) and below 200° F (93.3° C), except any mixture having components with flashpoints of 200° F (93.3° C) or higher, the total volume of which makes up 99 percent or more of the total volume of the mixture.

(b) Class IIIB liquids have flashpoints at or above 200° F (93.3° C).

Competent Person—Competent person is an individual who, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, is designated by the unit commander, unit representative or supervisor and has authority to take appropriate actions.

Compressed Gas—Any gas or mixture of gasses in a container having a pressure exceeding 40 psia at 70° F (21.1° C), or a pressure exceeding 104 psia at 130° F (54.4° C), or any liquid having an absolute vapor pressure exceeding 40 psia at 100° F (37.8° C).

Conductor—A substance or device that readily conducts heat, electricity, sound, etc. Definitions of specific conductors follow:

(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 a worker can bodily enter and perform assigned work; has limited or restricted means for entry or exit (for example: tanks, vessels, silos, storage bins, hoppers, vaults, manholes and pits); and is not designed for continuous human occupancy.

Confined Space Program Team—A group of professionals, consisting of representatives from installation Occupational Safety office, F&ES Flight and BE, working together for the purposes of organizing and controlling the installation confined space program. Commanders, functional

managers or their representatives are members of the team when their particular organizations are involved.

Control—The system governing the starting, stopping, direction of motion, acceleration, speed, retardation and function of the moving member in a predetermined manner.

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 (2) 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 (2) or more runway tracks on which hoists and carriers may travel for the purpose of lifting, transporting and lowering loads. It is suspended under its runway tracks system, the trolley of which operates on the bottom flange of the track.
- (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 -160o C (-256o 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 a worker 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 workers, 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 (2) closed in-line valves and locking or tagging open to the outside atmosphere a drain or bleed in the line between the two (2) closed valves.

Drive—An assembly of the necessary structural, mechanical and electrical parts which provides the motive power for a conveyor, monorail, crane, etc.

Dropline—A vertical line attached to a fixed anchorage to which a lanyard is attached.

Emergency Shower—A unit that cascades water over a worker's entire body to remove hazardous chemicals splashed or sprayed on the worker.

Employee—For the purpose of this publication, the term Employee applies to all Personal Services Contractors, Department of Defense Civilian Personnel, Department of Defense Military Personnel and Department of the Air Force 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 (2) or more sections traveling in guides or brackets arranged to permit length adjustment. Its size is designated by the sum of the lengths of the sections measured along the side rails.

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 shall 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 100° F (37.80° C) closed cup test and having a vapor pressure not exceeding 40 pounds psi at 100° F (37.80° C). Flammable liquids are categorized as Class 1 liquids and are further subdivided as follows:

- (1) Class 1A have a flashpoint below 73° F (22.8° C) and boiling points below 100° F (37.8° C).
- (2) Class 1B have flashpoints below 73° F (22.8° C) and boiling points at or above 100° F (37.8° C).
- (3) Class 1C have flashpoints at or above 73° F (22.8° C) and below 100° F (37.8° C).

Flange—A collar, disk or plate used to hold an abrasive wheel in position on a rotating shaft.

Flashpoint—The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

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.

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.

Hazardous Atmosphere—An atmosphere presenting a potential for death, disablement, injury or acute illness from one or more of the following causes: a flammable gas, vapor or mist in excess of 10 percent of its lower explosive limit (LEL) or lower flammable limit (LFL); an airborne combustible dust at a concentration that meets or exceeds its LEL or LFL; atmospheric oxygen concentration below 19.5 percent or above 23.5 percent; an atmospheric concentration of any chemical substance greater than the occupational and environmental exposure limit (OEEL), which is capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to its health effects.

Hazardous 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 shall 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 workers when there is the potential for injury to the head from impact and penetration from flying, falling or stationary objects or limited electrical shock, heat or burn. Protection includes a suitable chinstrap and harness to secure the helmet to the head.

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 worker 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 an, 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—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 a worker’s ability to escape unaided from a permit-required space.

Inclined Ladder or “Ship’s” Ladder—A stairway installed at an angle greater than 50 degrees. All stairway criteria, except the angle of rise, applies to inclined ladders.

Inerting—Rendering the atmosphere of a confined space non-flammable, non-explosive or otherwise chemically non-reactive by displacing or diluting the original atmosphere with steam or a gas that is non-reactive with respect to the contents of the space. Nitrogen is a common inerting gas. **Note:** This procedure creates an IDLH oxygen-deficient atmosphere.

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 a worker or operation through the use of blanking, double block and bleed or lockout and/or tagout.

Job Hazard Analysis (JHA)—A technique or procedure used by supervisors and workers that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, 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 AFI 91-202 and 29 CFR § 1910.132.

Kickback—The tendency of blades and cutters to force material being cut or milled up and back toward the operator.

Ladder—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 workers, materials and scaffolding.

May—Indicates an acceptable or satisfactory method of accomplishment.

Midrail—A rail approximately midway between the guardrail and platform and secured to the uprights erected along the exposed sides and ends of platforms.

Military-Unique (Workplaces, Operations, Equipment and Systems)—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 Sign—A visual display made of some durable material (metal, wood, rigid plastic) intended to caution, warn or provide information.

Mishap Prevention Tag—A visual display, intended to caution or warn, made of materials that will withstand the environmental conditions expected in the workplace and are securely attached in an appropriate manner to ensure visibility, as close to the machine or equipment as possible.

Mobile Scaffold (Tower)—A light, medium or heavy duty scaffold that is mounted on casters or wheels.

Mobile Unit—A combination of an aerial device, its vehicle and related equipment.

Mobile Work Platform—A scaffold that provides a work level, one or more frames high, on casters or wheels, with bracing across or diagonally from the platform to the posts.

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, National Fire Protection Association and the American Society of Mechanical Engineers. 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 the 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 OSHA-approved NRTLs, visit <https://www.osha.gov/dts/otpc/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—A written warning of a condition, procedure or practice that constitutes an occupational hazard. As used in the context of this publication, Notice of Hazard refers to AF Form 1118.

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://www.mil.nwd.kirtland.af.mil.mncl>

Occupational and Environmental Exposure Limit—The most appropriate limit adopted from established recognized standards including, but not limited to, those in AFI and AFOSH Standards, the latest edition of the TLV® Booklet published annually by the American Conference of Governmental Industrial Hygienists, 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 workers from permit space hazards and for regulating entries into permit spaces.

Personal Fall Arrest System—An assembly of components and subsystems used to arrest a person in a fall from a working height.

Phase Change—The passing of a substance from one phase (state) to another (liquid to gas, solid to liquid, etc.).

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 a 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 ramsets, 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.

Rated Load Test—Also called load test. A 100-percent to 125-percent test of the rated capacity (working load limit), as determined by type of equipment and designated by the manufacturer. See individual chapters for applicable equipment-specific test procedures.

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 a worker's full harness or wristlets, with the other end secured to a lifting or other retrieval device. The retrieval line shall be used to remove an unconscious entrant from a confined space.

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 in accordance with 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—A worker trained in CPR and qualified to operate the equipment in use. Responsible for placing equipment in safe/neutral mode and administer immediate assistance to a technician in the event of an emergency. The safety observer may be the supervisor.

Scaffold—Any temporary raised platform and all the necessary vertical, diagonal and horizontal parts used for supporting workers and materials or both. Also known as a Scaffold Tower.

Sectional Ladder—A non-self-supporting portable ladder, nonadjustable in length, consisting of two (2) or more sections constructed so it functions as a single ladder. Its size is designated by the overall length of the assembled sections.

Self-Retracting Lifeline and/or Lanyard—A deceleration device which contains a drum-wound line which may be slowly extracted from, or retracted onto, the drum under slight tension during normal worker movement and that, after onset of a fall, automatically locks the drum and arrests the fall.

Service, Normal—That service that involves operation of cranes and hoists with randomly distributed loads within the rated load limit, or with uniform loads less than 65 percent of rated load, for no more than 15 percent of the time of a single work shift for manually operated cranes and hoists, and 25 percent of the time of a single work shift for electric- or air-powered cranes and hoists.

Service, Heavy—That service that involves operation of cranes and hoists within the rated load limit that exceeds normal service.

Service, Severe—That service that involves normal or heavy service of cranes and hoists with abnormal environmental conditions, such as excessively high or low ambient temperatures, exposure to adverse weather, corrosive fumes, dust-laden or moisture-laden atmospheres and hazardous locations.

Shall—Indicates a mandatory requirement.

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 (2) 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 (81 cm) 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 of 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.

Switch, Track—A device with a section of track that can be moved to permit passage of a carrier from an incoming track to one of various outgoing tracks.

System Safety Engineering Analysis—Evaluates and approves new operations previously prohibited due to the perceived risks. A team of engineers (AFMC) conducts actual demonstrations and analysis of the operation to validate overall risk assessment and recommend actions. Past examples include hot pit refueling, integrated combat turn around (ICT) and concurrent servicing.

Tag Line—A rope or cable used to prevent a load from swinging or rotating.

Tagout Device—A mishap prevention tag that is capable of being securely attached and that, to protect personnel, forbids operation of an energy isolating device and identifies the applying individual or authority who has control of the procedure.

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.

USAF Hot Work Permit (AF Form 592)—The written authorization to perform “hot work” operations such as riveting, welding, cutting, burning or heating that could provide a source of ignition.

Wire Rope—A rope composed of steel wires, strands and a core. The individual wires are cold drawn to predetermined size and breaking loads according to use. They are then helically laid or formed around the core, which may be sisal or synthetic fiber, a metallic strand or an independent wire rope. The size, number and arrangement of wires; and the number of strands, the lay and the type of core in a rope are determined by the service for which the rope is to be used.

Work Level—A raised platform, used for supporting workers and their materials, made up of the necessary vertical, horizontal and diagonal braces, guardrails and ladder for access to the work platform.

Attachment 2

SAFETY INSTRUCTIONS TO BE POSTED IN ALL INSTALLATION 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 confined spaces of pits, fuel vapors may overcome a worker and cause death due to asphyxiation.

A2.1.4. AVGAS with tetraethyl lead are highly toxic to the central nervous system. Tetraethyl lead can be: Inhaled or ingested; 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 unless designed for ungrounded operation.

A2.3.4. Avoid spills. Vapors from fuel can form an explosive environment.

A2.3.5. Always wash hands thoroughly with soap and water after working with fuels.

A2.3.6. Immediately clean up fuel spills.

A2.3.7. Ensure that eyewashes, emergency showers and personal protective and fire extinguishing equipment are available and operational prior to operations involving hydrocarbon fuels.

A2.3.8. Consult the SDS for specific information.