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Safety

CIVIL ENGINEERING



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The criteria in this standard are the Air Force's minimum safety, fire prevention, and occupational health requirements for all Air Force-specific civil engineering (CE) operations and maintenance activities (chapters 3-13) except entomology, fire fighting, liquid fuels maintenance, and snow and ice removal and control. (Refer to Air Force Instructions [AFI] 32-2001, *The Fire Protection Operations and Fire Prevention Program*, and 32-1045, *Snow and Ice Control*.) **NOTE:** **Chapter 1** and **Chapter 2** apply to all CE activities. Major commands (MAJCOM), direct reporting units (DRU), and field operating agencies (FOA) may supplement this standard when additional or more stringent safety, fire prevention, and health criteria are required. Refer to AFI 91-301, *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program*, for instructions on processing supplements or variances. Report conflicts in guidance between this standard, federal standards, or other Air Force directives through MAJCOM, DRU, or FOA ground safety offices to Headquarters Air Force Safety Center, Ground Safety Division, Safety Engineering and Standards Branch (HQ AFSC/SEGS) 9700 Avenue G, SE, Suite 222, Kirtland AFB NM 87117-5670.

This standard applies to all United States (US) Air Force organizations, including all US Air Force Reserve personnel and when Air National Guard personnel are on federal service. It is directed toward actual operations versus facility or equipment design requirements. Task and design requirements are not all-inclusive. Use current Air Force directives, AFOSH standards, military specifications (Mil Spec), and consensus standards. This standard addresses CE shop and maintenance practices and comparable facility repair and maintenance activities conducted by other Air Force organizations.

No Technical Order (TO), AFOSH Standard, or Operating Instruction can possibly address every hazard or potential hazard that may arise from a specific task or combination of tasks. Where situations exist that do not appear to be adequately covered by existing directives, use an Operational Risk Management (ORM) process to assess risk associated with those situations and determine adequate safeguards or procedures to manage the risk.

NOTE: The ORM process may not be used to violate directives or other regulatory guidance. Normal waiver or variance procedures must be followed in all cases (refer to the first paragraph on page 1).

Most of the information in this standard is Air Force developed, derived from American National Standards Institute (ANSI) standards, the National Safety Council (NSC) data sheets, and other nationally recognized reference sources, plus Air Force CE directives. The standard implements pertinent portions of Occupational Safety and Health Administration (OSHA) Standards 29 Code of Federal Regulations (CFR) 1910 and 1926. OSHA cross-references are included at the end of applicable paragraphs.

SUMMARY OF REVISIONS

Administrative changes have been made to update this standard to electronic format. Paragraphs have been renumbered and references updated. References to TO 36-1-58, *General Requirements for Repair, Maintenance, and Testing of Lifting Devices*, have been removed (paragraphs 2.10., 2.10.2.4., 2.10.4., 3.1.2.2.1., and 3.1.2.9.). Requirement for weight-testing of jacks and portable hoists every 12 months has been removed (paragraph 2.11.). AF Form 979, **Danger Tag**, replaced AF Form 267, **Electrical Danger—Men at Work**, and AF Form 980, **Caution Tag**, replaced AF Form 268, **Caution—Abnormal Conditions** (paragraphs 10.4.3.1. and 10.4.3.2.). A glossary of references and supporting information is at Attachment 1. A bar (|) preceding a paragraph indicates changes from the previous edition. **NOTE:** AFOSH 127-series standards are being converted to 91-series standards and 161-series to 48-series standards. However, not all standards have been converted as of the effective date of this standard. To help you locate these documents, references to AFOSH standards are stated in the updated series and standard number, with the outgoing series and standard number stated as “formerly designated as” in the references section of Attachment 1.

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Chapter 1

INTRODUCTION

1.1. Application. Civil engineering normally has one of the largest work forces on an Air Force installation. This work force is involved in numerous planning, maintenance, and fire prevention activities that have the potential to significantly contribute to the reduction of Air Force mishaps experienced by the installation. Civil engineering support is one of the most important keys to the overall safety, fire prevention, and occupational health protection of the entire installation. Safe management of its work force, inclusion of safe features (most economical during the identification, planning or design phases), and the correction of facility and grounds hazards, are instrumental to the success of the US Air Force Mishap Prevention Program.

1.2. Hazards and Human Factors. Civil engineering craftworkers are exposed to a large variety of hazardous situations, machinery, equipment, and chemicals. This section addresses general hazards. If there are specific hazards or factors for a specific work center that have not previously been addressed, they will be discussed in the pertinent chapter.

1.2.1. Use of soaps and solvents can cause surfaces to become slippery and create the potential for slips and falls. Certain cleaning solvents may ignite if applied to hot surfaces or when heated, causing fires and (or) injuries to workers. Pressure cleaners and steam cleaners operate at pressures in excess of 100 pounds per square inch (psi) and temperatures near 200 degrees Fahrenheit (F). Improper use can result in severe personal injury. Soaps and solvents can also cause health problems such as dermatitis, eye irritation, and other medical problems especially if the solvents become inhaled.

1.2.2. Interruption of services, injury to workers, and (or) equipment damages all result when electrical, gas, and steam lines are broken during digging operations.

1.2.3. The use of flammable and combustible liquids can result in explosions, burns from fire and chemicals, asphyxiation, inhalation of vapors, absorption through the skin, skin irritation, and eye damage from direct contact or exposure. The volatility of flammable or combustible liquids is increased by heating and, when heated to temperatures higher than their flashpoints, they present additional hazards.

1.2.4. Portable power tools receive power from electricity, air pressure, explosive charges, or a rotating flexible cable. While the portable tool increases mobility and convenience, it is frequently more hazardous to use than its stationary counterpart. The reason for this is that portable tools are, of necessity, small, making safety guarding more difficult. Typical injuries resulting from the use of portable power tools include electrical shock, burns, cuts, eye injuries from flying particles, and muscle strains. The most common injuries which occur when using portable circular saws are the result of contact with the blade, electric shock or burns, tripping over cords or saws, losing balance while using the saw, dropping the saw on self or another person, and kickbacks from pinching blades in the cut. Severe eye injuries result from flying sawdust or small particles.

1.2.5. Electrical installations and equipment present the potential for shock or electrocution from contact with energized systems. Electrical equipment can also cause property damage because of its potential as an ignition source for fire or explosion. Fire can be caused by short circuits, over-heated equipment, or failure of current limiters, thermal sensors, and other devices. Explosions may occur

when flammable liquids, gases, or dusts are exposed to ignition sources generated by electrical equipment.

1.2.5.1. Cord abuse is probably the most often single cause for electric shock to workers in the field.

1.2.5.2. Excessive scraping, kinking, stretching, and exposure to grease and oils will damage power cables and cause premature failure and possible shock or burns.

1.2.5.3. Because electric power hand tools are portable, the operator may allow the power cable to run below the material being worked or sawed and cut the cord.

1.2.6. Hernias, back strains, crushed hands and feet, broken bones, and severe lacerations can result from poor manual handling practices. The injury problem associated with manual handling has increased in recent years because of the greater size and quantities of equipment and materials being used throughout the Air Force. Many injuries to civil engineering personnel are due to improper lifting procedures and (or) failure to use mechanical lifting devices for handling heavy loads.

1.2.7. There are many hazards associated with limitations (e.g., fatigue) and adverse conditions:

1.2.7.1. Mental lapses and inability to concentrate on job tasks that could result in trips, falls, inability to carry heavy articles, and exposure to vehicles and other moving objects.

1.2.7.2. Extreme or adverse weather conditions (heat, cold, and extreme humidity) affect each individual worker's physical output differently.

1.2.8. Use of the wrong tool for the work or job and the lack of inspection of tools causes mishaps, such as cuts, eye damage, and broken bones.

1.2.9. Unsafe work practices when performing hot-work operations, such as burning, soldering, or brazing may result in serious burns.

1.2.10. Working with or around hazardous substances places workers in hazardous situations, such as working with or around battery acids, paints, chemicals, sewage, or other cleaning operations. Also, the mercury and phosphor contained in fluorescent lamps are dangerous in open cuts or in eyes. Skin problems or dermatitis are the result of handling epoxy cements, caustics, oils, and solvents without protection.

1.2.11. Inadequate ventilation or unacceptable respirator programs for certain operations in confined spaces can cause asphyxiation resulting in death. This hazard exists in any oxygen-deficient atmosphere. Personnel working with electricity, plumbing, water and wastewater treatment, heating maintenance, power production, and other allied trades are exposed to this situation in tanks, vaults, manholes, and other above- or below-ground level environments.

1.2.12. Work requiring removal of earth and (or) rock is essentially simple, yet dangerous. Too often the result of cave-ins is death by suffocation or injury or death by crushing. Additionally, hazards may also be encountered when excavating around utilities as a result of contact with buried pipes or lines.

1.2.13. Hazards are present when working in areas where flying or falling objects may be present.

1.2.14. Exposure to hazardous noise either in the shops or in other work areas such as equipment rooms, generator rooms, and the flight line without proper hearing protection can result in temporary or permanent loss of hearing.

1.2.15. Attics, crawl spaces, tanks, vaults, and similar areas are frequently lacking in illumination that may contribute to other hazards resulting in falls, burns, cuts, or electrical shock.

1.2.16. Injuries resulting from working on or near moving machinery range from minor cuts and bruises to a severed limb. This hazard exists where shop machinery is being operated and may exist at all job sites where vehicles, equipment, or machinery are in use.

1.2.17. Mechanical lifting devices include a large variety of cranes, hoists, slings, jacks, and forklifts. Their use is subject to certain hazards that cannot be controlled by mechanical means, but only through the use of intelligence, care, and common sense. Hazards include overloading, dropping, or slipping of the load, obstructing the free passage of the load, moving a vehicle with an unsecured load, not using outriggers, and other misuse of the lifting devices.

1.2.18. Motor vehicle operations result in many needless mishaps. Many are caused by improper backing of the vehicle. Others occur when the vehicle is moving slightly, (e.g., injuries sustained when a person gets on or off the vehicle or a vehicle is left in neutral with no brake on). Most are operator errors caused by failure to adjust for weather conditions, speeding, and inattention to the driving task. The use of propane, diesel, or gasoline-powered equipment (e.g., forklifts and materials handling carts) produces carbon monoxide. The employee's exposure to carbon monoxide may be excessive if such operations are conducted in low ceiling or confined areas.

Chapter 2

GENERAL SAFETY, FIRE PREVENTION, AND OCCUPATIONAL HEALTH REQUIREMENTS

2.1. Supervisory Responsibilities. Supervisors must recognize those factors in the workplace with mishap potential. Supervisors shall not require their personnel to work in environments or conditions that are hazardous to their safety or health without first providing adequate engineering and administrative controls or personal protective equipment (PPE). The supervisor shall provide frequent inspections of job sites, work methods and materials, and equipment used. Any unsafe equipment or material shall be tagged and rendered inoperative or physically removed from its place of operation. The supervisor shall permit only qualified personnel to operate equipment and machinery according to safe work practices.

2.1.1. Supervisors will:

2.1.1.1. Ensure safe working conditions.

2.1.1.2. Ensure all interior and exterior electrical and power production personnel are trained in cardiopulmonary resuscitation (CPR) procedures.

2.1.1.3. Provide necessary protective equipment.

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

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

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

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

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

2.1.1.9. Ensure workers exposed or potentially exposed to hazardous chemicals or materials are trained on the hazards of those chemicals and materials per AFOSH Standard 48-21, *Hazard Communication*. Information may be retrieved from the Material Safety Data Sheet (MSDS) for the chemical or material.

2.1.1.10. Conduct job safety analysis (JSA) of job tasks whenever required to ensure a safe work environment. **NOTE:** A JSA shall be accomplished when new equipment is installed, equipment is relocated, or new procedures are implemented in critical or hazardous operations. AFI 91-202, *The US Air Force Mishap Prevention Program*, will be consulted.

2.1.2. The following guides will aid each supervisor in briefing employees:

2.1.2.1. Check the work area for hazards.

2.1.2.2. Check the work request or sketch with employees.

2.1.2.3. Explain why the job is being done.

2.1.2.4. Point out existing and potential hazards and the action required to control them.

2.1.2.5. Explain the work methods to be used.

2.1.2.6. Assign the work clearly and definitely.

2.1.2.7. Ask for questions and suggestions. Let employees know they may come to you or the safety representative with safety, fire prevention, or occupational health problems.

2.1.2.8. Ensure all employees fully understand their work assignments and safety responsibilities.

2.2. Nonsupervisory (Employee) Training. Supervisors shall provide specialized job safety, fire prevention, and occupational health training to all employees (see AFI 91-301 for guidance). Employees shall be thoroughly trained in the use of protective equipment, guards, and safeguards for chemicals (AFOSH Standard 91-68, *Chemical Safety*) and safe operation of equipment, machines, and tools they use or operate. Only employees who have been trained and those undergoing supervised on-the-job training (OJT) will be allowed to use shop equipment, machines, and tools. Certification and licensing are required for some tools and equipment, (e.g., powder-actuated tools and electrical generators). The supervisor will ensure these special qualifications are complete before allowing or requiring the employee to use the tools. Recurring safety meetings (monthly is suggested) are an excellent way for the supervisor to stress the importance of employee safety, both on- and off-the-job. The meetings may allow for employee feedback and discussion and include one or more of the following as applicable to the job.

2.2.1. Lifting and handling techniques.

2.2.2. Hazards associated with various jobs in progress.

2.2.3. Unsafe practices.

2.2.4. Recent mishaps.

2.2.5. Protective equipment. (Refer to [Attachment 2](#) for a list of PPE that may be required when specific tasks are performed.)

2.2.6. Portable electric tools.

2.2.7. Hand tools.

2.2.8. Chemicals and health hazards.

2.2.9. Use of MSDS.

2.2.10. Safe housekeeping practices.

2.2.11. Working on or near machinery.

2.2.12. Use of ladders.

2.2.13. Work on elevated platforms or positions.

2.2.14. Falls from elevated positions.

2.2.15. Lifting and hoisting equipment.

2.2.16. Fire hazards and fire prevention.

2.2.17. First aid and CPR training.

2.2.18. Falls—same levels.

2.2.19. Pertinent safe practices. **NOTE:** Any valid employee identification of safety, fire prevention, or occupational health hazards that cannot be corrected by the supervisor will be handled by the exist-

ing documentation system (e.g., hazard report, self-inspection report, or internal employee complaint channels).

2.3. Occupational Health. Health hazards that affect civil engineering workers also affect occupants of buildings in which the work is being done and (or) people passing by work in progress. Adequate controls shall be used whenever an operation possesses a potential health hazard to any or all of these personnel.

2.3.1. AFOSH Standard 48-19, *Hazardous Noise Program*, addresses program responsibilities, designation of hazardous noise-producing equipment and hazardous noise areas, required PPE, and required medical examinations for personnel exposed to hazardous noise. The installation Bioenvironmental Engineer (BEE) will be contacted for consultation in this area.

2.3.2. Respirators will be provided and used when exposure to workers exceeds permissible levels and engineering controls are not feasible or have not been installed. The installation BEE determines when respirators are needed and selects the type based on the material of concern.

2.3.3. Internal combustion engines will not be operated inside buildings unless an exhaust system approved by the installation BEE is installed and used. When equipment is operated adjacent to buildings, the exhaust will be directed away from the buildings. Substitution of electric forklifts, modification of existing equipment, or appropriate ventilation may be necessary to lower the carbon monoxide concentrations to allowable levels. Where high concentrations of carbon monoxide accumulate (e.g., in warehousing areas where there are a large number of forklifts in use), the installation BEE should be contacted to survey and identify requirements to make the work area safe. See Air Force Manual (AFMAN) 24-306, Manual for the Wheeled Vehicle Driver, for requirements and information on safe vehicle operation.

2.3.4. Dermatitis is one of the leading occupational diseases in today's workplace and also is one of the easiest to prevent. Protection in the form of gloves or barrier creams can easily provide adequate protection. Caution is advised in the selection process as not all gloves or creams are adequate for all cleaning solvents or applications. The installation BEE will be contacted for assistance.

2.3.5. AFOSH Standard 91-31, Personal Protective Equipment, and other specific job safety standards outline requirements for protective equipment, barriers, and procedures to prevent injuries from flying or falling objects (e.g., face shield, hard hats, or construction barriers). Proper eye protection equipment will be provided when needed, and its use will be strictly enforced. This requirement includes workers not actually involved but who are within the area and may be affected by flying or falling objects.

2.3.6. Asbestos fibers, which are capable of causing the lung disease asbestosis as well as cancer of the lung and mesothelioma, are among the most dangerous substances present on the job site. If asbestos is used (normally not, except in some military-unique operations) or already in place, safe handling procedures will be followed. Employees will not be exposed to unsafe levels of airborne asbestos. Occupants or passersby will be provided protection or kept out of the facility during asbestos clean-up and removal (refer to AFOSH Standard 48-8, Controlling Exposure to Hazardous Materials, for further guidance). The installation BEE will be consulted on all planned asbestos projects and will be immediately notified upon discovery of asbestos during a project or suspension of work due to asbestos.

2.3.7. Working in confined spaces can pose serious health hazards to workers involved in entry. Supervisors and workers alike must be aware of these potential hazards and the precautions needed to

avert a potential serious consequence. AFOSH Standard 91-25, Confined Spaces, addresses specific responsibilities, requirements, and procedures concerning entry into confined spaces.

2.3.8. National Fire Protection Association (NFPA) 491M, *Manual of Hazardous Chemical Reactions*, will be consulted for guidance on chemical reactions that have the potential to create toxic gases or explosion and fire.

2.3.9. Supervisors will watch for signs of fatigue and prevent workers from overextending themselves. Physical limitations will be considered when assigning job tasks. Other mental limitations that should be considered when assigning job tasks are mental preoccupation resulting from personal problems that could have an impact upon worker and co-worker safety.

2.3.10. Shop supervisors should be aware of each employee's limitations under different weather conditions and on-site job conditions and select personnel for job assignments accordingly.

2.3.11. Supervisors and workers will perform pre-job planning. Supervisors will ensure operators are competent, careful, physically and mentally fit, and thoroughly trained by the shop supervisor in the safe operation of lifting devices.

2.4. Shop Layout:

2.4.1. Layout. Proper layout, spacing, and arrangement of equipment, machinery, passageways, and aisles are essential to orderly operations. Good layout can best be achieved in the design stage, with recommendations from the installation ground safety, fire prevention, bioenvironmental engineering (BE), and engineering officials. Regardless whether a facility is in the design stage, being remodeled, or if new or existing equipment and machinery are repositioned, basic layout considerations are important factors in planning a facility for safe operations. When barricaded work areas are not worked each day, the shop supervisor will ensure the area is checked each day to ensure barricades and signs are in place and operating as required. AFOSH Standards 91-22, *Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders*, and 91-12, *Machinery*, and OSHA Standard 29 CFR 1910.212, *General Requirements for All Machines*, will be consulted for guidance on proper layout, spacing, and arrangement.

2.4.1.1. Equipment and machinery will be arranged to permit an even flow of materials. Sufficient space should be provided to handle the material with the least possible interference from or to workers or other work being performed. Machines should be placed so the operator does not stand in a passageway or aisle. Additionally, machine positioning should allow for easy maintenance, cleaning, and removal of scrap. After the initial positioning of equipment and machines is decided, clear zones (work spaces) shall be established. These clear zones should be of sufficient dimensions to accommodate typical work. If material exceeds established clear zones, rope and stanchions may be used to temporarily extend the workspace. Marking of machine clear zones may be yellow or yellow and black hash-marked lines, 2 to 3 inches wide when marking is necessary (optional). Machines designed for fixed locations will be securely anchored. Machines with shock-mounting pads will be securely anchored and installed according to manufacturer's instructions.

2.4.1.2. Passageways and (or) aisles shall be provided and marked to permit the free movement of employees bringing and removing material from the shop. These passageways are independent of clear zones and storage spaces. They will be clearly recognizable. Floor markings should provide

a contrast to the floor color, such as yellow lines 2- to 3-inches wide on a gray floor (29 CFR 1910.22, *Walking-Working Surfaces General Requirements*).

2.4.1.3. Where powered materials handling equipment is used, facility layout shall provide enough clearance in aisles, on loading docks, and through doorways to permit safe turns. Aisles shall be at least 2 feet wider than the widest vehicle used or most common material being transported.

2.4.1.4. At least 18 inches will be provided for passageways through or between obstructions.

2.4.2. Electrical Installations and Equipment:

2.4.2.1. Supervisors will ensure work areas are inspected for possible electrical hazards. Sufficient workspace shall be provided and maintained around electric equipment to permit safe operation and maintenance of such equipment. Only qualified operators designated in writing by the supervisor will be allowed to operate the equipment. This listing of personnel certified to operate the equipment will be maintained in the work area.

2.4.2.2. Frames of all electrical equipment, regardless of voltage, will be grounded.

2.4.2.3. Exposed noncurrent-carrying metal parts of electrical equipment that may become energized under abnormal conditions will be grounded according to NFPA 70, *National Electrical Code (NEC)*.

2.4.2.4. Exposed noncurrent-carrying metal parts of the following plug-connected equipment that may become energized will be grounded or double insulated and distinctly marked:

2.4.2.4.1. Portable, hand-held, motor-operated tools.

2.4.2.4.2. Appliances.

2.4.2.4.3. Any equipment operated in excess of 150 volts to ground.

2.4.2.5. Wires will be covered wherever they are joined (e.g., outlets, switches, and junction boxes).

2.4.2.6. Parts of electrical equipment which in ordinary operation produce arcs, sparks, etc., will not be operated or used in explosive atmospheres or in close proximity to combustible materials.

2.4.2.7. Flexible extension cords may not be:

2.4.2.7.1. Used as a substitute for fixed wiring.

2.4.2.7.2. Run through holes in walls, ceilings, or floors.

2.4.2.7.3. Attached to building surfaces.

2.4.2.7.4. Spliced, stapled, tacked, or placed where they create a hazard or are subjected to damage.

2.4.2.8. Flexible extension cords will be:

2.4.2.8.1. Continuous lengths without splices or taps.

2.4.2.8.2. Fastened so there is no pull on joints or screws of the plug or sockets.

2.4.2.8.3. Replaced when frayed or insulation has deteriorated.

2.4.2.8.4. Of proper size and temperature rating to withstand the electrical load and approved by a recognized testing agency.

2.4.2.8.5. Three-prong, dead-front plug type.

2.4.2.9. Equipment connected by flexible extension cords will be grounded either by a three-wire cord or by a separate ground wire (except double-insulated equipment).

2.4.2.10. Ground Fault Circuit Interrupters (GFCI) will be used on all 120-volt, single-phase, 15- and 20-ampere receptacle outlets at job sites when the receptacles are not a part of the permanent wiring of the building or structure. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5 kilowatts (kW), where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with GFCIs.

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

2.4.3. Illumination. Adequate illumination will be provided to ensure safe working conditions. Illumination for night work will also be supplied for warning as well as work visibility. Essential regulatory information is listed below. (OSHA Standards 29 CFR 1926.26, *Illumination*, and 1926.56, *Illumination*.)

2.4.3.1. Portable lamps will have Underwriter's Laboratory (UL)-approved plugs, handles, sockets, guards, and cords for normal working conditions. For submersion, such lamps, will be equipped with a waterproof housing. In flammable gaseous atmospheres approved explosion-proof lights will be used.

2.4.3.2. For work in boilers, condensers, tanks, turbines, or other grounded locations that are wet or may cause excessive perspiration, a low-voltage lighting system should be used, either from a battery system or low-voltage lighting unit. In situations where these lighting systems are not available, a vapor-proof 110-volt lighting system shall be used.

2.4.3.3. Flashlights for use near energized electrical equipment and circuitry will have insulated cases.

2.4.3.4. At least 50 foot-candles of illumination will be provided at all work stations. However, fine work may require 100 foot-candles or more. This can be obtained with a combination of general lighting plus supplemental lighting. If fluorescent lighting is installed, it will be installed to eliminate any stroboscopic effect with moving machinery. Slotted fluorescent fixtures will be fitted with tube-retainer devices to prevent tubes from falling out.

2.4.4. Ventilation:

2.4.4.1. Only essential safety, fire prevention, and occupational health items are included. For more details, including information on flow-rate requirements, refer to AFOSH Standard 161-2, *Industrial Ventilation*. Ventilation and exhaust systems will be according to NFPA Standard 91, *Standard for Blower and Exhaust Systems for Dust, Stock, and Vapor Removal*, and will also conform to the provisions of this standard.

2.4.4.2. Machines that generate dust, vapors, mists, etc., will be connected to an effective industrial-exhaust ventilation system. In shops where small numbers of installed machines are not continuously in operation, portable collection systems may be used. Hoods and exhaust systems will

be constructed and installed to meet requirements in AFOSH Standard 161-2. Also, AFOSH Standard 91-12 will be consulted.

2.4.4.3. In areas where welding, soldering, brazing, and burning hot-work operations are performed, fumes from operations contain the metals being welded together (e.g., cadmium, zinc, lead, iron, or copper). The filler material, flux, and the coating on the welding rods used during such operations may also generate other gases (e.g., carbon monoxide, arsine, or ozone) at concentrations that may be hazardous to the health of workers. When extensive hot-work operations, particularly in confined areas, are done there could be an excessive fume over-exposure to these materials. Ventilation or respiratory protection may be required for these operations based on measured or calculated concentrations. When welding, soldering, brazing, and burning hot-work operations must be performed in a space screened in on all sides, the screens will be arranged so they do not seriously restrict ventilation.

2.4.4.4. Boiler and furnace rooms shall have ventilation to permit clean, safe combustion and to minimize soot formation. An unobstructed air opening shall be provided, sized on the basis of 1 square inch (645 square millimeter [sq mm]) free area per 2,000 British Thermal Units (BTU) maximum fuel input of the combined burners located in a boiler room. Air supply openings will be kept clear at all times and regularly inspected. American National Standards Institute (ANSI) Boiler Codes may be consulted for more detailed information on boiler ventilation and combustion air requirements.

2.4.5. Walking-Working Surfaces and Fall Protection. Civil engineering workers are frequently victims of falls at work sites outside the shop, and supervisors will ensure adequate fall protection is provided and worn. Work on flat roofs, where a fall would be to the same level, does not require fall protection (e.g., work on an air conditioner in the center of a flat roof). Work on sloping roofs or roof edges may require fall protection where the use of other work devices is impractical. Fall protection will be required where the potential of a fall from a height of 10 feet or more exists.

2.4.5.1. Fixed ladders and requirements for guarding and training workers are addressed in AFOSH Standard 91-22 and OSHA 29 CFR 1910.27, *Fixed Ladders*. Any fixed ladder of 20 feet or more continuous length requires the use of fall protection.

2.4.5.2. When working over or near water:

2.4.5.2.1. Where the danger of drowning exists, workers shall be provided with US Coast Guard-approved life jackets or buoyant work vests. This includes, but is not limited to, water-treatment ponds, storage tanks, and Air Force-operated Morale, Welfare, and Recreation (MWR) recreational lakes or large ponds.

2.4.5.2.2. Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects that would alter their strength or buoyancy. Defective units shall not be used.

2.4.5.2.3. Ring buoys with at least 90 feet of line shall be provided and be readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

2.4.5.2.4. At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.

2.4.5.3. Personal fall arrest systems are often necessary to safely accomplish tasks in elevated areas. The following specifics apply:

2.4.5.3.1. Lifelines, safety harnesses, and lanyards shall be used only for employee safeguarding. Any lifeline, safety harnesses, or lanyard actually subjected to in-service loading, as distinguished from static load testing, shall be immediately removed from service for disposal and shall not be used again for employee safeguarding.

2.4.5.3.2. Lifelines shall be secured above the point of operation to an anchorage or structural member.

2.4.5.3.3. Lanyards shall be a minimum of one-half-inch nylon, or equivalent, with a maximum length to provide for a fall of no greater than 6 feet.

2.4.5.3.4. Hardware shall be drop forged or pressed steel, cadmium plated. The surface shall be smooth and free of sharp edges.

2.4.5.3.5. Safety harnesses and lanyards will be inspected as required by AFOSH Standard 91-31.

2.4.5.4. Safety nets are sometimes necessary to accomplish tasks in elevated areas.

2.4.5.4.1. Safety nets shall be provided when work places are more than 25 feet above the ground, water surfaces, or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, lifelines, or safety harnesses is impractical.

2.4.5.4.2. Where safety net protection is required by this chapter, operations shall not be undertaken until the net is in place and has been tested. Testing consists of dropping a 400-pound bag of sand not more than 30 inches (± 2 inches) in diameter from a height of 25 feet above the net into the center of the net.

2.4.5.4.3. Nets shall extend 8 feet beyond the edge of the work surface where employees are exposed and shall be installed as close under the work surface as practical, but in no case more than 25 feet below such work surface. Nets shall be hung with sufficient clearance to prevent user's contact with the surfaces or structures below. Such clearances shall be determined by impact load testing.

2.4.5.4.4. Only one level of nets is required for bridge work. **NOTE:** The mesh size of nets shall not exceed 6 by 6 inches. All new nets shall meet accepted performance standards of 17,500 foot-pounds minimum impact resistance as determined and certified by the manufacturer, and shall bear a label of proof test. Edge ropes shall provide a minimum breaking strength of 5,000 pounds.

2.4.5.4.5. Forged steel safety hooks or shackles shall be used to fasten the net to its supports.

2.4.5.4.6. Connections between net panels shall develop the full strength of the net.

2.4.6. Exits and Exit Markings. Essential regulatory OSHA information is included below. (OSHA 29 CFR 1910.37, *Means of Egress, General.*)

2.4.6.1. Every exit will have "EXIT" in plain legible letters not less than 6-inches high with the strokes of the letters not less than three-quarters of an inch wide.

2.4.6.2. Doors, passageways, or stairways that are neither exits nor ways to an exit (but may be mistaken for an exit) will be clearly marked "NOT AN EXIT" or by a sign indicating their actual use; for example: "STORAGE ROOM" or "BASEMENT."

2.4.6.3. When the direction to the nearest exit may not be apparent to an occupant, an exit sign with an arrow indicating direction will be used.

2.4.6.4. Exit access will be arranged so it is unnecessary to travel toward any area of high hazard potential in order to reach the nearest exit (unless the path of travel is effectively shielded by suitable partitions or other physical barriers).

2.4.6.5. Exit signs will be clearly visible from all directions of egress and will not be obstructed at any time. If occupancy is permitted at night, or if normal lighting levels are reduced at times during working hours, exit signs will be suitably illuminated by a reliable light source (self-illuminating, auxiliary lighting, etc.). Use of radioluminescent signs and markers is discouraged and shall be approved by the installation BEE prior to installation, to ensure compliance with AFI 40-201, *Managing Radioactive Materials in the USAF*.

2.4.6.6. A door from a room to an exit or to a way-of-exit access will be the side-hinged swinging type. It will swing out in the direction of travel if 50 or more persons occupy the room or the exit is from an area of high hazard potential.

2.4.6.7. Areas around exit doors and passageways shall be free of obstructions. The exit route shall lead to a public way. No lock fastening will be used to prevent escape from inside the building.

2.4.6.8. Where occupants may be endangered by the blocking of any single exit due to fire or smoke, there will be at least two means of exit remote from each other.

2.4.6.9. Exits, exterior steps, and ramps will be adequately lighted to prevent mishaps. Separate lighting will not be required if street or other permanent lighting gives at least one foot-candle of illumination on the exit, steps, and ramp.

2.4.7. Housekeeping. Good housekeeping will be maintained in all shops, yards, buildings, and mobile equipment. Supervisors are responsible for good housekeeping in or around the work they are supervising. As a minimum, the following requirements will be adhered to:

2.4.7.1. Material will not be placed where anyone might stumble over it, where it might fall on someone, or on or against any support unless the support can withstand the additional weight.

2.4.7.2. Aisles and passageways will be kept clear of tripping hazards.

2.4.7.3. Nails will be removed from loose lumber or the points turned down.

2.4.7.4. Snow and ice will be removed from all walkways and work areas where they may create a hazard or interfere with work to be done. If ice cannot be removed readily, sand or other approved materials will be applied. Snow and icicles above walkways and work areas will be removed.

2.4.7.5. Trash and other waste materials will be kept in approved receptacles. Trash will not be allowed to accumulate and will be removed and disposed of as soon as practicable, at least once per shift (or more often if needed).

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

2.4.7.7. Disconnect switches, distribution panels, and alarm supply boxes will not be blocked by any obstruction that may prevent ready access.

2.4.7.8. Wire reels will be stacked with strips of wood between reels.

2.4.7.9. Flammable materials will be stored in approved containers in approved areas. These are the minimum requirements. For further information refer to AFOSH Standard 91-43, *Flammable and Combustible Liquids*.

2.4.7.10. Combustible materials will be placed in covered self-closing metal containers.

2.4.7.11. Noncombustible materials, for preventive or organized maintenance, will be neatly kept in designated cabinets (plainly marked with their contents) where possible.

2.4.7.12. Clothing lockers will be maintained in a clean, orderly condition. Apparel not needed to perform official duties will be stored in lockers. Objects will not be stored on or under clothing lockers, and no flammable liquids will be stored in lockers. Separate lockers will be provided for each employee, as required by the nature of their job (e.g., plumbing, water or wastewater treatment, or paint).

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

2.4.7.14. To protect skin and clothing from cleaning compounds, workers will wear (as required) safety glasses, face shields, aprons, wet suits, and gloves.

2.4.8. Machinery, Shop Equipment, Machine Guarding, and Power Transmission. All aspects of shop machinery are covered in detail in AFOSH Standard 91-12. The information will not be duplicated here.

2.5. Hand Tools. Information (including proper use) on the hand tools most frequently used by civil engineering craftworkers has been included in this standard. Normally, hand tools will be properly used so the working force is away from a person's body in case the tool slips. See Technical Order (TO) 32-1-101, *Use and Care of Hand Tools and Measuring Tools*, for additional guidance.

2.5.1. Mishaps at the job site involving hand tools are usually the result of misuse. Hand tools are precision tools capable of performing many jobs when used properly. Prevention of mishaps involving hand tools on the job site becomes a matter of good instruction, adequate training, and proper use.

2.5.1.1. Hand tool safety requires the tools be of good quality and adequate for the job. All tools will be kept in good repair and maintained by qualified personnel.

2.5.1.2. Racks, shelves, or tool boxes will be provided for storing tools that are not in use.

2.5.1.3. When workers use hand tools while they are working on ladders, scaffolds, platforms, or work stands, they will use carrying bags for tools that are not in use. Workers will not drop tools.

2.5.2. Supervisors will frequently inspect all hand tools used in the operation under their supervision. Defective tools will be immediately removed from service. Some common tool defects are:

2.5.2.1. Handles. When handles of hammers, axes, picks, or sledges become cracked, split, broken, or splintered, they will be immediately replaced. Tool handles will be well fitted and securely fastened by wedges or other acceptable means. Wedges, always used in pairs, will be

driven into the handle when repairing a sledge hammer or maul, to prevent the head from accidentally flying off if the handle shrinks.

2.5.2.2. Tangs. Files, wood chisels, and other tools with tangs will be fitted and used with suitable handles covering the end of the tang. Ends of the handles will not be used for pounding or tapping.

2.5.2.3. Mushroom Heads. Cold chisels, punches, hammers, drift pins, and other similar tools have a tendency to mushroom from repeated soundings. They will be dressed down when they begin to crack and curl.

2.5.2.3.1. When dressing tools, a slight bevel of about three-sixteenths of an inch will be ground around the head. This will help prevent the heads from mushrooming.

2.5.2.3.2. When tool heads mushroom, the material is highly crystallized and, with each blow of the hammer, fragments are likely to break off.

2.5.3. Information on the proper usage of specific tools follows:

2.5.3.1. Screwdrivers. Standard, straight blade screwdrivers will be maintained with their working edges square and free from chipped areas. If it is not possible to regrind a working edge, the screwdriver will be turned in and a new tool obtained. Screwdrivers with cracked or loose handles should be turned in for new units. Screwdrivers are not to be used as a prying tool, punch, wedge, chisel, pinch bar, nail puller, or be struck with a hammer. Workers will ensure they select the size screwdriver that matches the screw slot. Conventional type drivers will not be used on Phillips head-type screw slots. Phillips screwdrivers will be used in the correct size relative to the fastener. Worn Phillips or any special fastener screwdriver will be turned in for a replacement issue.

2.5.3.1.1. Objects will not be held by hand, under the arm, or on the lap when being worked on with a screwdriver.

2.5.3.1.2. Work will be secured to a flat surface or held in a vise.

2.5.3.1.3. Workers will ensure they are well braced before applying force to a screwdriver. Firm footing is particularly necessary when using a screwdriver on a ladder or stand where loss of balance could result in a fall.

2.5.3.2. Chisels. Chisels will be kept sharp with the edge ground true. Chisels and punches with mushroom heads will not be used. A chisel or punch holding device will be used when working space permits. The angle of cut will be away from the body. Goggles will be worn when using a chisel, punch, and tapered or straight drifts.

2.5.3.3. Wrenches. Wrenches with sprung or distorted jaws or that are bent or broken will not be used. Wrenches will not be struck with a hammer unless the wrench is designed for this purpose. Care will be taken to avoid overstraining small wrenches, and no wrench will be subjected to severe side strain at any time. Worn box wrenches or sockets will be exchanged for new tools.

2.5.3.3.1. A few simple rules for the correct use of open-end wrenches are:

2.5.3.3.1.1. Ensure the wrench fits the nut or bolt head.

2.5.3.3.1.2. When attempting to loosen a tight nut or tighten a loose nut, ensure the wrench seats squarely on the sides of the nut.

2.5.3.3.1.3. Always PULL on a wrench—do not push on it. There may be situations in which pushing is the only way you can work the wrench. In these situations use the base of the palm and hold your hand open. On adjustable wrenches always place the wrench on the nut so the pulling force is applied to the stationary jaw side of the handle.

2.5.3.3.1.4. Where possible, use box wrenches for torque and less chance of slipping off the nut or bolt.

2.5.3.3.2. Pipe wrenches will have sharp jaws to prevent slippage. Using too small a wrench will cause the jaws to crack or break.

2.5.3.4. Hammers. Hammers with broken or cracked handles or with mushroom or chipped striking surface shall not be used. In some instances, the striking surface can be dressed on a grinding wheel and the hammer returned to service. If the hammer head cannot be restored, it will be turned in for replacement.

2.5.3.4.1. Workers, when hammering, will hold the tool so the head is parallel to the face of the material being struck. The sides of hammer heads are not case hardened and will never be used for pounding.

2.5.3.4.2. If a nail cannot be withdrawn from an object after full rotation of the hammer, then a piece of wood will be placed under the hammer head and the remainder of the nail will be withdrawn. This increases the leverage and reduces strain on the handle.

2.5.3.4.3. Hammers with highly-tempered steel heads will not be used on hard steel objects. Hammers with heads made of soft materials will be used.

2.5.3.5. Shovels, Rakes, Ice Chippers, and Sod Lifters. None of these tools will be used as prying tools. If the handle has been cracked or broken, the tool will be discarded and replaced. These tools will be properly stored when not in use. When shovels, rakes, hoes, and similar tools are not in use at the job site, they will be positioned where the working surface cannot be stepped on.

2.5.3.6. Saws:

2.5.3.6.1. Hack saws should be adjusted in the frame to prevent buckling and breaking, but should never be tight enough to break off the pin that supports the blade. The blades will be installed with the teeth pointing forward. Pressure should be applied on the forward stroke only. If the blade is twisted or too much pressure is applied, the blade may break causing injury to the hands and arms of the user.

2.5.3.6.2. Only sharp and properly set hand saws will be used. If a saw binds while cutting, the worker will not attempt to force it through the stock.

2.5.3.6.3. The proper saw will be chosen to do the job; cross-cut saws for cutting across the grain, ripsaws for cutting with the grain.

2.5.3.6.4. When a saw sticks in damp or gummy wood, a small amount of oil or paraffin applied to the blade will make it cut smoothly. Wedges may be used to hold the cut open if oil or paraffin does not prevent the saw from sticking.

2.5.3.7. Knives. Pocket knives and hook-bill knives will be carried in a holder or sheath. The blade of a hook-bill knife will be covered when not in use. Retractable cutters will have the blade

retracted into its case when carried or not in use. Workers will always cut away from the body. Hacking motions will never be applied when cutting.

2.5.3.8. Chains. Chains, when used on a job, will be the right size. Using too small a chain will cause the links to stretch and lose strength. The chain will be inspected before and after each use. The chain should not be held in the hand when pressure is applied, nor should an employee stand closer than one-half the length of the chain when the chain is under tension.

2.5.3.9. Crowbars and Wrecking Bars. Crowbars and wrecking bars of sufficient size and weight will be chosen to do the job safely and easily. Makeshift bars, such as pipes or other metal objects, will never be used in place of crowbars and wrecking bars.

2.5.3.9.1. Use. Persons using crow and wrecking bars will ensure they prevent their tool from slipping and causing injuries to their fellow workers. A block of wood placed under the bar usually keeps it from slipping, and at the same time, gives more leverage.

2.5.3.9.2. Misuse. Case-hardened steel tools will never be used to strike crow bars or wrecking bars. Only plastic, wood, or soft metal objects will be used to hammer on pry-type bars.

2.6. Portable Power Tools. Portable power tools increase mobility and convenience but are frequently more hazardous to use than their stationary counterparts. Personnel who are required to use portable power tools in their work will be thoroughly trained in safe operating practices. Safe operating procedures will be set up for each type of tool (consistent with this standard and the manufacturer's instructions).

2.6.1. Cords, Hoses, and Cables. Care will be taken to prevent cords, hoses, and cables, which supply power to portable tools, from becoming tripping hazards on the job site. Only rubber-sheathed cords approved by UL that meet the requirement of the NEC will be used on portable electric tools and extension lamps. All power cables for this application will be the type that includes a ground wire in addition to the power wires. Special type cords (rubber covered or plastic) will be used in areas where oils or solvents may be encountered.

2.6.2. Switches and Controls:

2.6.2.1. To ensure greater operator safety, the power tools listed below will be equipped with a constant-pressure switch or control that will shut off the power when the pressure is released. Portable power tool switches will be protected against accidental operation.

2.6.2.1.1. Hand-held powered circular saws having a blade diameter greater than 2 inches.

2.6.2.1.2. Electric or pneumatic chain saws.

2.6.2.1.3. All hand-held gasoline-powered chain saws.

2.6.2.1.4. Percussion tools without positive accessory holding means.

2.6.2.2. The portable hand-held power tools listed below will be equipped with a constant-pressure switch or control and may have a lock-on control, provided turn-off can be accomplished by a single motion of the same finger (or fingers) that turns it on:

2.6.2.2.1. Drills.

2.6.2.2.2. Tapers.

2.6.2.2.3. Fastener devices.

2.6.2.2.4. Horizontal, vertical, and angle grinders with wheels greater than 2 inches in diameter.

2.6.2.2.5. Belt sanders.

2.6.2.2.6. Reciprocating saws.

2.6.2.2.7. Saber, scroll, and jigsaws with blade shanks greater than a nominal one-quarter of an inch.

2.6.2.2.8. Other similarly operating powered tools.

2.6.2.3. All other hand-held powered tools such as routers, planers, and shears may be equipped with a positive "on-off" control. GFCI devices will be used.

2.6.3. Electric Powered Tools. Because of their source of power, electric powered tools often present the same hazards as other electrical facilities and equipment. Personnel who use electric power tools will be responsible for being familiar with accepted safe operating standards and, also, with the general hazards of electricity associated with tool use.

2.6.3.1. Fire Hazards. Electric powered hand tools will not be used near flammable materials or in explosive atmospheres unless they are approved explosion-proof type that meet the requirements of the NEC for the type of area and atmosphere in which the tool is to be used.

2.6.3.2. Grounding. All portable electric tools with exposed metal parts will be grounded according to the requirements of the NEC. When grounds are not included as part of the power cable, as in approved three-wire cords, an additional wire will be used to effectively ground the tool. An incomplete grounding circuit can subject the user to electrical shock. Double-insulated portable electric hand tools (grounding wire not required) are authorized. The ground prong of a three-wire plug will never be removed. If a cord is found with the ground prong removed, it will be removed from service, rendered unusable, and turned in for repair.

2.6.3.3. Damp Locations. When electric powered tools are used in damp or wet locations, such as in tanks or boilers, effective grounding is absolutely necessary. Use of GFCI devices is recommended.

2.6.3.4. Cord Abuse. Workers will avoid abusing power cords. Heavy-duty plugs, clamped securely to the cords, will be used on all power tools. Workers will not attempt to unplug power cords by jerking them from their connections by the cord. Personnel using electric power hand tools will be aware of the location of the power supply cord at all times.

2.6.4. Portable Circular Saws. All portable, power-driven circular saws having a blade diameter greater than 2 inches shall be equipped with guards above and below the base plate shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to cover the blade. A circular saw with a sticking spring-operated guard shall be removed from service and repaired before workers are allowed to use it.

2.6.4.1. When using the circular saw, workers will not stand directly behind the saw while cutting operations are in progress. Kickbacks sometimes occur, and if the lower guard sticks, the moving saw blade could come in contact with the operator's body causing severe injury. The saw's tele-

scoping saw guard will be checked frequently while in use to ensure it works freely, encloses the teeth as completely as possible, and covers the unused portion of the blade when it is cutting. Both upper and lower guards will be kept clean and free of sawdust or dirt accumulations. Workers will remove the power cord from the power supply when checking the guards; cleaning or installing and removing the blade; and performing maintenance.

2.6.4.2. Periodic inspections are essential to discover operating defects. A systematic inspection schedule and maintenance record for each tool will help prevent mishaps and ensure maximum use of the tool at a minimum operating cost. During the inspection, defective tools will be taken out of service immediately and tagged for repair. Employees will be instructed to inspect tools used on the job site and will be trained to recognize defects and improper functioning. The extent of this inspection and the responsibility for correcting defects should be clearly outlined so there is neither unnecessary duplication of effort nor misunderstanding regarding the responsibility for maintenance. Additional guidance on carpenter and (or) woodworking equipment can be found in AFOSH Standard 91-12. (OSHA 29 CFR 1910.243, *Guarding of Portable Powered Tools*.)

2.6.5. Chain Saws. The following safety precautions shall be observed by all users of chain saws:

2.6.5.1. Do not operate a chain saw when fatigued.

2.6.5.2. Use safety footwear, snug-fitting clothing, protective gloves, and eye, hearing, and head protection devices. Use leggings as described in AFOSH Standard 91-31 (when possible).

2.6.5.3. Use caution when handling fuel. Allow the engine to cool before refueling. Move the chain saw at least 10 feet from the fueling point before starting the engine.

2.6.5.4. Do not allow other persons to be near the chain saw when starting or cutting with the chain saw. Keep bystanders and animals out of the work area.

2.6.5.5. Do not start cutting until you have a clear work area, secure footing, and a planned retreat path from the falling tree or limb, etc.

2.6.5.6. When the engine is running, hold the chain saw firmly with both hands, the right hand on the rear handle and the left hand on the front handle. Use a firm grip with thumbs and fingers encircling the chain saw handles.

2.6.5.7. Keep all parts of the body away from the saw chain when the engine is running.

2.6.5.8. Before starting the engine, ensure the saw chain is not contacting anything.

2.6.5.9. Carry the chain saw with the engine stopped, the guide bar and saw chain to the rear, and the muffler away from the body.

2.6.5.10. Do not operate a chain saw that is damaged, improperly adjusted, or not completely and securely assembled. Ensure the saw chain stops moving when the throttle control trigger is released. Whenever the guide bar is worn to a point where the chain will tilt sideways, replace the bar. Keep the chain sharp. A dull chain requires the use of extra pressure by the operator, lessening control over the saw.

2.6.5.11. Shut off the chain saw engine before setting it down.

2.6.5.12. Use extreme caution when cutting small size brush and saplings because slender material may catch the saw chain and be whipped toward you or pull you off balance.

2.6.5.13. When cutting a limb that is under tension, be alert for springback so you will not be struck when the tension in the wood fibers is released.

2.6.5.14. Keep the handles dry, clean, and free of oil or fuel mixture.

2.6.5.15. Operate the chain saw only in well-ventilated areas.

2.6.5.16. Do not operate a chain saw in a tree.

2.6.5.17. Ensure all chain saw service, other than the items listed in the owner's manual maintenance instructions, is performed by competent chain saw service personnel. (For example, if improper tools are used to remove the flywheel or to hold the flywheel in order to remove the clutch, structural damage to the flywheel could occur and subsequently cause the flywheel to burst.)

2.6.5.18. Guard against kickback. Kickback is the upward motion of the guide bar that occurs when the saw chain at the nose of the guide bar contacts an object. Kickback can lead to dangerous loss of control of the chain saw. To reduce kickback:

2.6.5.18.1. Hold the chain saw firmly with both hands.

2.6.5.18.2. Do not overreach.

2.6.5.18.3. Do not let the nose of the guide bar contact a log, branch, ground, or any other obstruction.

2.6.5.18.4. Cut at high engine speeds.

2.6.5.18.5. Do not cut above shoulder height.

2.6.5.18.6. Follow manufacturer's maintenance instructions when sharpening or performing maintenance on the chain saw.

2.6.5.18.7. Use devices, such as low-kickback chain, guide bar nose guards, chain brakes, and special guide bars, that reduce the hazards associated with kickback.

2.6.5.19. When transporting the chain saw, use the appropriate guide bar scabbard.

2.6.6. Powder-Actuated Tools. Cartridge-type explosives are the source of power for this group of hand tools. Their use is accompanied by hazards normally encountered when using ammunition and other explosives. These tools are used primarily to sink fasteners into nonbrittle surfaces, such as driving studs into steel or concrete, and tightening rivets. Workers will be thoroughly instructed in the safe use of any powder-actuated tool before being permitted to operate it. When a tool of this type is suggested for a job, a thorough study of the operation will be made. Kinds of materials encountered, size and strength of explosives needed, and possible dangers to nearby workers will all be considered before tools are issued to operators. Instructions to be followed on unloading when cartridge misfires will be developed and coordinated with the ground safety manager or superintendent and the explosive ordinance disposal (EOD) officer. These tools will not be used on walls or studs adjacent to occupied facilities. (Paragraph 4.6. and manufacturer's operating manuals will also be consulted.)

2.6.6.1. Ammunition and charges for these tools and the tools themselves will be secured. Ammunition will be stored according to instructions in AFMAN 91-201, *Explosives Safety Standards*.

2.6.6.2. Each tool will be equipped with a steel muzzle guard at least 3-1/2 inches in diameter, mounted perpendicular to the barrel, and designed to confine flying fragments or particles that might otherwise create a hazard. When a standard shield or guard cannot be used, or when it does not cover all apparent avenues through which flying particles might escape, a manufacturer's special shield or guard, fixture, or jig that provides equal protection may be used instead of the standard steel guard. To use the tool inside boxes or recessed areas, the guard will be secured to the muzzle so it can be easily adjusted.

2.6.6.3. Cartridge-powered tools will be constructed to prevent operation if they are not fitted with a muzzle guard or protective jig of the manufacturer's design.

2.6.6.4. All tools of this type will be constructed so they cannot be fired unless the operator is holding the tool against a work surface with a force at least 5 pounds greater than the total weight of the tool.

2.6.6.5. Powder-actuated tools equipped with standard muzzle guards will be built so the operation will be prevented if the guard is tilted more than 8 degrees from contact with the working surface.

2.6.6.6. No fastener of any kind will be driven into masonry closer than 3 inches to a corner or edge. Unless jigs or special guards are used to stop flying particles, fasteners will not be fired into steel closer than one-half of an inch to an edge, corner, or joint.

2.6.6.7. Projectile firing tools will be constructed to prevent discharge if dropped. For additional guidance, **Chapter 4** will be consulted.

2.6.7. Clothing. Each portable power tool operator will wear suitable work clothes. Operators will, if necessary, wear caps or other garments to keep their hair from coming in contact with rotating or moving parts of the tool. No worker will wear loose sleeves, neckties, rings, or other clothing or jewelry that could become tangled in a hand power tool.

2.6.8. Goggles and Respirators. Operators will wear protective goggles and (or) face shields for hand power tool operations that may cause flying particles. Overhead work makes this requirement extremely important. Respirators approved by the Bureau of Mines or National Institute for Occupational Safety and Health (NIOSH) for the agent of concern will be used. The installation BEE will be consulted for specific advice on the respiratory protection required for specific shop activities on the job site according to AFOSH Standard 48-1, *Respiratory Protection Program*.

2.7. Fire Prevention. All civil engineering personnel shall receive fire prevention training as part of their general nonsupervisory (AFOSH) training. Training will be documented on AF Form 55, **Employee Safety and Health Record**. Regulatory OSHA fire extinguisher requirements are included in paragraph **2.7.2.** AFOSH Standard 91-56, *Fire Protection and Prevention*, will be consulted for further guidance.

2.7.1. Supervisors in charge of operations where fuels, solvents, or other flammable liquids are used will be constantly alert for hazards and unsafe acts. Fuels such as gasoline will NEVER be used to clean floors or clothing, solvents will not be used as cigarette lighter fluid, and open solvent or gasoline containers will not be kept near electrical equipment. The use of low flashpoint petroleum solvents will be avoided whenever possible. Open flames, open element heaters, equipment not properly grounded, and nonexplosion-proof electrical equipment used in the presence of flammable or combustible liquids will be avoided.

2.7.2. Fire extinguishers of at least 20 BC or greater rating will be installed in shop areas. The number of extinguishers depends upon the size and layout of the facility. The installation fire department staff will be consulted and AFOSH Standard 91-56 referred to for more detailed information on the type, selection, installation, inspection, maintenance, and hydrostatic testing of portable fire extinguishers. Fire extinguishers will meet the following regulatory OSHA requirements:

2.7.2.1. Be kept fully charged and in their designated area.

2.7.2.2. Be located along normal paths of travel.

2.7.2.3. Not be obstructed or obscured from view.

2.7.2.4. Be visually inspected by management or a designated employee at least monthly to ensure they:

2.7.2.4.1. Are in their designated places.

2.7.2.4.2. Have not been tampered with or actuated.

2.7.2.4.3. Do not have corrosion or other impairments.

2.7.2.4.4. Are accessible and not obstructed.

2.7.2.5. Be examined at least yearly and (or) recharged or repaired to ensure operability and safety. Attach a tag or keep a central record to show the maintenance or recharge date and signature or initials of the person performing the service.

2.7.2.6. Be hydrostatically tested. Consult AFOSH Standard 91-56.

2.7.2.7. Be placed so the maximum travel distance, unless there are extremely hazardous conditions, does not exceed 75 feet for Class A or 50 feet for Class B locations.

2.7.3. Smoking at job sites will only be permitted in approved designated smoking areas and NEVER while performing work.

2.7.4. Supervisors will ensure employees remove construction debris and rubbish from the job site upon completion of the job, or daily if extended beyond one day. Hazardous materials shall not be left at job sites unless properly stored. Work being performed on job sites shall not endanger building occupants (e.g., exits blocked, fire alarm devices disconnected, etc.).

2.8. Compressed Air:

2.8.1. All workers will beware of compressed air; it can be dangerous. Alternate methods of cleaning surfaces should be sought. Compressed air may be used if no alternative method of cleaning surfaces is acceptable. *Compressed air shall never be used to blow debris from a person.* The downstream pressure of compressed air will remain at a pressure level below 30 psi whenever the nozzle is dead ended and then only when effective chip guarding and PPE are used.

2.8.2. Following are requirements for air compressors:

2.8.2.1. All personnel assigned to shops with air compressors will be familiar with compressor operating and maintenance instructions.

2.8.2.2. The drain valve on the air tank shall be opened daily to prevent excessive accumulation of liquid.

2.8.2.3. Air tanks will be protected by adequate safety relief valves. These valves will be tested at regular intervals to ensure they are in good operating condition.

2.8.2.4. The pressure controller and gauge will be maintained in good operating condition. There will be NO valves between the air tank and the safety valve.

2.8.2.5. Air compressors will be maintained strictly according to the manufacturer's instructions or an applicable TO.

2.8.2.6. The maximum working pressure of compressed air lines will be identified in psi. Pipe-line outlets will be tagged or marked showing maximum working pressure immediately adjacent to the outlet.

2.9. Ladders and Scaffolds. (Refer to AFOSH Standards 91-22 and 91-2, *Vehicle-Mounted Elevating and Rotating Work Platforms, Manually-Propelled and Self-Propelled Mobile Work Platforms, and Scaffolds (Towers)*).

2.9.1. When working in an elevated position, employees will take all possible precautions against dropping tools or materials that might endanger others in the work area.

2.9.2. Every reasonable effort will be made to warn or otherwise prevent others from passing underneath work areas. Approved signs or guards will be suitably placed as required for this purpose.

2.9.3. Lifelines with approved harness and safety straps will be used where a falling hazard exists (unguarded areas over 10-feet high or any height over hazardous material).

2.9.4. Defective or improvised ladders will not be used. Portable metal ladders and wooden ladders with metal siderail reinforced or metal rungs will not be used by workers when they are working on electrical circuits. The side rails of metal ladders will be stenciled (when not previously stenciled by the manufacturer or if the stencil has become unreadable) in 2-inch high red letters (or smaller, if necessary, to fit on the side rails): "DANGER-DO NOT USE AROUND ELECTRICAL EQUIPMENT." Fiberglass ladders with metal rungs are acceptable. Ladders used will be of sufficient length to permit workers to reach their work when standing no higher than the third rung from the top of a straight ladder, or the second step from the top (the top is not a step and is not counted as a step) of a stepladder which is over 5 feet in length. No more than one person will be on a ladder at one time. Ladders will be equipped with rubber safety feet to prevent slipping.

2.9.5. Ladders will be inspected before climbing to ensure all parts are in good condition. To permit inspection, wood ladders will be procured and maintained with transparent finish only.

2.9.6. A ladder will never be placed on a slippery, icy, slanting, or vibrating footing unless it is securely lashed in position or held by another person.

2.9.7. On jobs requiring the use of a ladder, the ladder will be placed directly in front or under the work. When work cannot be done without overreaching, the ladder will be moved to the proper location or another approved means will be used (e.g., scaffold or work platform).

2.9.8. Workers will not carry anything that will interfere with the free use of both hands when climbing a ladder. Material and equipment should be raised to the working position using a rope and canvas bucket or other approved means.

2.9.9. Straight and extension type ladders will be placed in a position to have at least 1 foot of slope for each 4 foot of ladder length, for example, a 12-foot extension ladder must be 3 feet from the supporting structure.

2.9.10. Ladders will not be placed over machines with exposed moving parts.

2.9.11. Stepladders will be fully opened out and locked in position.

2.9.12. Where ladders are set up in front of doorways, the door will be locked or a person will be stationed at the foot of the ladder to direct pedestrian traffic. If a ladder is used on walkways, in aisles, or adjacent to roads, cones or barricades will be used to warn and direct pedestrians away from the ladder.

2.9.13. Where ladders used are of the extension type, the following precautions will be taken to prevent possible injury.

2.9.13.1. In raising the ladder, place it against the structure and extend the ladder while the bottom end is in place by either pushing or by means of a rope furnished to pull the top section in place. Before ascending the top portion of the ladder, check carefully to determine whether or not the devices locking the two sections together are thoroughly engaged. Ensure the top of the ladder extends at least 3 feet above the support structure.

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

2.9.14. All ladders, whether straight, step, or extension type, shall be laid down before the worker leaves the job site. Where possible, workers will secure or remove the ladder to prevent unauthorized use.

2.9.15. All platforms or scaffolds will be inspected by the supervisor before use.

2.9.16. All temporary construction platforms will have substantial railings and toeboards on all open sides.

2.9.17. Scaffolds will be well braced and fully capable of supporting the total load to be imposed on them. All decking will be securely fastened. No part of the scaffold will be removed while the decking is in place.

2.9.18. Scaffolds with wheels constructed on the base (bottom) section will not be used unless all wheels are intact and at least one wheel on each side is locked to prevent movement.

2.9.19. Following are scaffolding rules:

2.9.19.1. Know scaffolding safety rules prior to set up, during operations, and for dismantling of scaffolding. Ensure manufacturer's instructions and safety warnings are legible and remain on scaffolding.

2.9.19.2. Inspect the equipment before use for damage or deterioration.

2.9.19.3. Keep equipment in good repair.

2.9.19.4. Inspect erected scaffolds regularly to ensure they are maintained in a safe condition.

2.9.19.5. Provide adequate sills and posts and use base plates.

- 2.9.19.6. Anchor wall scaffolds securely between structure and scaffold.
- 2.9.19.7. Use caution when working near powerlines. Never be any closer than 10 feet to electrical power lines.
- 2.9.19.8. Use adjusting screws instead of blocking to adjust for uneven grades. Use outriggers where so equipped.
- 2.9.19.9. Equip all planked areas with proper guardrails and toeboards.
- 2.9.19.10. Do not ever take chances while working on scaffolding.
- 2.9.19.11. Do not ride rolling scaffolding.
- 2.9.19.12. Do not leave materials and equipment on the platform when moving scaffolding.
- 2.9.19.13. Do not try to move rolling scaffolding without help.
- 2.9.19.14. Do not extend adjusting screws over 12 inches.
- 2.9.19.15. Do not let working platform height exceed four times the smallest base dimension unless guyed or otherwise stabilized.
- 2.9.19.16. Do not overload scaffolds.
- 2.9.19.17. Do not use ladders or makeshift devices on top of scaffolds to increase height.
- 2.9.19.18. Ensure the footing and anchorage for scaffolds are sound, rigid, and capable of carrying the maximum intended load without settling or displacement. Do not use unstable objects, such as barrels, boxes, loose bricks, or concrete blocks, to support scaffolds or planks.

2.10. Hoists and Cranes. Many lifting-device mechanical failure problems can be detected prior to failure if proper inspection procedures are followed. AFOSH Standard 91-46, *Materials Handling and Storage Equipment*, contains detailed inspection requirements and procedures. (OSHA 29 CFR 1910.179, *Overhead and Gantry Cranes*; .180, *Crawler Locomotive and Truck Cranes*; .181, *Derricks*; .184, *Slings*, and 29 CFR 1926.550, *Cranes and Derricks*; .552, *Material Hoists*; .554, *Overhead Hoists*; and .556, *Aerial Lifts*.) ANSI Standards B30.11, *Monorails and Underhung Cranes*, and B30.16, *Overhead Hoists (Underhung)*, will also be consulted.

2.10.1. Periodic inspections will be performed by qualified inspectors or maintenance personnel. Tests and certification of cranes and hoists will be by experienced, qualified inspectors. Certification, inspection, and test reports will be available on the premises where the crane or hoist is located or in the supervisor's office.

2.10.2. Responsibilities for periodic inspection, maintenance, and test of lifting devices and separate lifting aids will be as follows:

- 2.10.2.1. For permanently installed equipment such as Real Property Installed Equipment (RPIE)—installation civil engineer.
- 2.10.2.2. For mobile equipment—transportation officer.
- 2.10.2.3. For aircraft maintenance equipment—aircraft maintenance officer.

2.10.2.4. For fixed shop and portable equipment, Equipment Authorized Inventory Data (EAID)—responsible activity, as described in Air Force Manual (AFM) 67-1, Volume 4, *Air Force Equipment Management System*.

2.10.3. Following are requirements for hoists:

2.10.3.1. The rated load shall be legibly marked on each side of the hoist. Operators should be made aware of the weight of the loads to be carried.

2.10.3.2. The hoist shall be equipped with a self-setting brake applied to the motor shaft or some part of the gear train.

2.10.3.3. For powered hoists, holding brakes shall be applied automatically when the power is off.

2.10.3.4. Hooks, chains, and all functional operating mechanisms shall be visually inspected daily for any indication of damage or wear, and inspection records shall be maintained by civil engineering.

2.10.3.5. Loads shall not be carried over the heads of people, nor will personnel be allowed to walk under suspended loads.

2.10.3.6. The operator shall test the brakes each time a near-capacity load is handled. This test is done by raising the load a few inches and applying the brakes.

2.10.3.7. The hoist rope or chain shall be free from kinks or twists and shall not be wrapped around the load.

2.10.4. Following are requirements for cranes: Refer to AFOSH Standard 91-46 for additional guidance. (OSHA 29 CFR 1910.179 and 1926.550.)

2.10.4.1. Only personnel designated as qualified by the supervisor shall be permitted to operate cranes.

2.10.4.2. The rated load of the crane shall be plainly marked on each side of the crane and be clearly legible to the operator.

2.10.4.3. Operators shall be made aware of the weight of the load.

2.10.4.4. Hooks, ropes, chains, brakes, and all functional operating mechanisms shall be inspected daily for indications of damage and excessive wear.

2.10.4.5. Written and signed inspection reports shall be made monthly on critical items such as brakes, hooks, and ropes. These reports shall be readily available.

2.10.4.6. Hand signals to operators shall be those prescribed by the applicable ANSI standard for the type of crane in use. (Refer to ANSI Standards on lifting devices if additional information is required.) These shall be posted in view of the operator.

2.10.4.7. The hoist chain or rope shall be free from kinks or twists and shall not be wrapped around the load.

2.10.4.8. Hoisting, lowering, swinging, or traveling is not permitted while anyone is on the load or hook.

2.10.4.9. Loads shall not be carried over the heads of people.

2.10.4.10. The operator shall test the brakes each time a near capacity load is handled, by raising it a few inches and applying the brakes.

2.10.4.11. The operator shall remain in position at the controls while the load is suspended.

2.10.4.12. All cranes using a lifting magnet shall have a switch in the magnet circuit with provisions for locking the switch in the open position.

2.10.4.13. When the hook is in the extreme low position, at least two complete wraps of rope must remain on the drum. Rope ends shall be safely and securely attached to the drum by means of a clamp or socket arrangement approved by the crane or rope manufacturer.

2.10.4.14. When connecting the hook to a load, the hook shall be centered over the load to prevent swinging.

2.10.4.15. The trip-setting of hoist limit switches shall be determined by tests with an empty hook.

2.10.5. End fastenings of chains will be capable of holding loads equal to the breaking point of the chain. Safe load limits will be reduced according to standard tables as link stretch and wear occur. When chains become bent or twisted or poor welds are noticed, the chains will be taken out of service.

2.10.6. End fastenings of wire rope or cable will be inspected to determine whether resocketing in zinc is necessary. Wire rope will be kept well lubricated to reduce wear and will not be allowed to twist or kink. Wire ropes that show excessive wear, corrosion, or other defects will be rejected or taken out of service. Wire rope clips will be attached with U-bolts on the dead-end of the line.

2.10.7. Any hoisting ring or hook that shows cracks, gouges, permanent sets, or other defects will be removed from service. Safety latches will be used on hooks to prevent slings from separating from hooks while hoisting or lowering is in progress. Hooks and rings will be inspected annually by non-destructive inspection methods. Records will be maintained in the shop.

2.10.8. Pulley sheaves will be kept smooth and free from defects that could damage rope and cables. Where necessary, sheave edges will be rounded and guards installed to prevent ropes from overrunning the grooves and fouling. Sheaves with cracked or broken flanges, rims, spokes, or hubs will be immediately removed from service.

2.11. Jacks and Portable Hoists. Equipment maintenance personnel will not use hydraulic floorjacks, postjacks, portable hoists, or mechanical jacks to support equipment while repair is being accomplished. The equipment will be blocked or placed on approved axle or frame stands before repair operations are begun. Jacks used primarily in one location will be inspected every 6 months, or before and after the jack is sent out of the shop for special work. Shop personnel will not use a jack or hoist that is leaking or is faulty in its operation. Faulty jacks and hoists will be taken out of service, tagged, and not used until repaired. Load ratings will be stenciled or otherwise plainly marked on all jacks and hoists. Inspection dates will be properly documented by shop supervisors.

2.12. Material Storage. All unnecessary accumulation of materials and supplies in the shop area will be avoided. The presence of unnecessary material in the shop could cause such mishaps as tripping, falling, or slipping. This could be especially hazardous around equipment in operation. The only material in the shop area will be that actually in work. The only place materials should accumulate in quantity are in storerooms and material holding areas.

2.12.1. The storage of materials will not, of itself, create a hazard. Materials stored in tiers will be stacked, strapped, blocked or interlocked, and limited in height so they are stable and secure against sliding or collapse. Storage racks will have sufficient capacity to bear the loads imposed on them.

2.12.2. Stored materials will not obstruct fire extinguishers, alarm boxes, sprinkler system controls, electrical switch boxes, machine operations, emergency lighting, first aid or emergency equipment, or exits.

2.12.3. Storage of paints (including aerosol cans) and solvents will be according to AFOSH Standard 91-43.

2.12.3.1. Office desks or work benches will not be used for the storage of pressurized cans of spray paint or other flammable or combustible materials.

2.12.3.2. Office store rooms will not be used for the storage of pressurized cans of spray paint unless the storage area has been designated safe for the storage of flammable materials by local fire department personnel.

2.12.4. Heavy materials and equipment should be stored low and close to the ground or floor to reduce the possibility of injury during handling.

2.12.5. All passageways and storerooms will be maintained clean, unobstructed, dry, and in sanitary condition. Spills will be promptly removed.

2.12.6. Where mechanical handling equipment, such as lift trucks are used, safety clearance will be provided for aisles at loading docks, through doorways, and wherever turns or passages must be made. No obstructions that could create a hazard are permitted in aisles. Aisles for one-way traffic will be at least 2 feet wider than the widest vehicle used. Two-way traffic aisles will be at least 3 feet wider than the widest vehicle used. Department of Defense (DoD) Regulation 4145.19-R-1, *Storage and Materials Handling*, will be consulted.

2.12.7. Floor-load capacities will be posted in a conspicuous location for all floors except first floors of slab construction.

2.13. Manual Material Handling. Fixed weight limits for men or women to lift manually are difficult to prescribe because of physical differences. Also, the size and shape of the object to be lifted are influencing factors. To generalize, weights of approximately 40 pounds for the average woman and 60 pounds for the average man are the normal maximum weights that should be manually lifted. For weights greater than this, seek additional help or use mechanical assists. Proper lifting technique is as important as knowing the weight of the object to be lifted.

2.13.1. How to Lift Properly:

2.13.1.1. Position Feet Correctly. Place feet far apart for balance with one foot to the rear of the object and the other foot slightly ahead of the other and to the side of the object (**Figure 2.1.**).

2.13.1.2. Crouch Close to the Load. Crouching is preferred to squatting. Stay close to the load to minimize strain on the back muscles (**Figure 2.1.**).

2.13.1.3. Full Palm Grasp. Pick up materials with a full palm grip. Do not attempt to pick up weights with a fingertip grip. Ensure the load is free of grease or sharp points that could cause injury. Use suitable gloves when necessary.

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

2.13.1.5. **Kinetic Leg Lift.** With the arms, slide the object toward the body to give it some motion (kinetic energy). At the same time, lift the object with the legs and bring the back to a vertical position. Keep the object close to the body while lifting.

Figure 2.1. Proper Lifting Procedures.



2.13.2. **Points to Remember:**

2.13.2.1. Use gloves to protect the hands and safety shoes to protect the feet.

2.13.2.2. Inspect objects for slivers, sharp edges, rough surfaces, or slippery surfaces before attempting to lift.

2.13.2.3. Keep fingers away from pinch and shear points.

2.13.2.4. Do not carry a load that obstructs the view of the direction of travel. Make sure the path of travel is clear.

2.13.2.5. Do not turn or twist at the waist to change direction or while lowering an object.

2.13.2.6. Turn the whole body and crouch down to lower the object.

2.14. Shoring and Trenching. The walls and faces of excavations and trenches over 5 feet, where workers may be exposed to danger, will be guarded by a shoring system, sloping of the ground, or some other equivalent means. Trenches less than 5-feet deep with hazardous soil conditions also will be effectively protected. OSHA 29 CFR 1926.650, *Excavations, General Protection Requirements*, .651, *Specific Evacuation Requirements*, .652, *Specific Trenching Requirements*, and .653, *Definitions Applicable to Subpart P—Excavations, Trenching, and Shoring*, will be consulted for additional information. The following guidance is provided:

2.14.1. Appropriate trench boxes and (or) shields may be used instead of shoring or sloping.

2.14.2. Tools, equipment, and excavated material will be kept 2 feet or more from the lip of the trench. Where employees are required to be in or work in trenches 4-feet deep or more, an adequate means of exit such as ladders or steps shall be provided (within 25 feet of travel) and used.

2.14.3. Daily inspections will be made of trenches and excavations by the supervisor in charge to ensure there are adequate slopes, shoring and bracing, and no evidence of possible slides or cave-ins. More frequent inspections may be necessary as work progresses or after inclement weather conditions, such as rain, or where loose compacted or unstable materials are present.

2.14.4. Workers will take extra care when hand excavating in close proximity to utilities to preclude interruption of services, equipment damage, or injury to workers, which can result from breaking electrical, gas, or steam lines. Simple pre-planning, shoring and bracing, and hand digging around known utilities pipes and lines should prevent most mishaps associated with excavations. AF Form 103, **Base Civil Engineering (BCE) Work Clearance Request**, will be coordinated and approved before any digging commences. (OSHA 29 CFR 1926.650 through .653.)

2.15. Barricades and Traffic Signs. Whenever a common area is disturbed by civil engineering maintenance, repair, or construction operations and presents a hazard to personnel in the area (residents, other workers, or passers-by), care will be taken to warn these personnel and other engineering workers of the potential hazard. Appropriate barriers will be erected around excavations, open manholes, open electrical panels, etc., whenever they are to be left unattended. Appropriate warning signs and lighted or flashing warning lights for nighttime will be posted a sufficient distance from the hazard to give ample advance warning to approaching pedestrian or vehicular traffic. Airfield hazard warnings will comply with AFI 32-1042, *Standards for Marking Airfields*. Traffic control signs or devices will conform to the "Manual on Uniform Traffic Control Devices." Workers exposed to vehicle traffic shall be provided with and required to wear warning vests marked with or made of reflectorized or high visibility material (AFOSH Standard 91-31). In some situations, the use of flagmen to control the flow of traffic may be necessary. Workers in the equipment operations, pavement maintenance, plumbing, heating maintenance, and exterior electrical career fields should be trained in traffic control procedures.

2.16. Personal Protective Equipment (PPE)—General . Such equipment is not a substitute for feasible procedures or engineering controls. While these controls are being implemented, or if it has been determined that control methods are not feasible, PPE is required whenever there are hazards that can do bodily harm through absorption, inhalation, or physical contact. This equipment includes respiratory and hearing-protective devices, special clothing, and protective devices for the eyes, face, head, and extremities. All PPE will be a safe design and constructed for the work to be performed and will be maintained in a sanitary and reliable condition. Refer to [Attachment 2](#) for a summary of PPE required to cover most civil engineering activities. Additional guidance is furnished in AFOSH Standard 91-31.

2.16.1. Eye Protection:

2.16.1.1. Eye protection is required when there is a possibility of injury from chemicals or flying particles. Examples of operations requiring the use of eye protection include, but are not limited to:

2.16.1.1.1. Chipping, grinding, and impact drilling.

2.16.1.1.2. Breaking concrete, brick, and plaster.

2.16.1.1.3. Welding or helping in welding of any type.

- 2.16.1.1.4. Cleaning with compressed air.
- 2.16.1.1.5. Tinning or soldering lugs or large joints.
- 2.16.1.1.6. Pouring molten metals.
- 2.16.1.1.7. Riveting, grinding, or burning metals.
- 2.16.1.1.8. Handling chemicals, acids, or caustics.

2.16.1.2. Face shields will be thoroughly washed with soap and water before being worn by another person.

2.16.2. Hearing Protection. Appropriate hearing protection shall be used where employees are in designated hazardous noise areas with operating noise sources, or using tools or equipment which are labeled as hazardous noise producers. The installation BEE will be contacted for noise level surveys and guidance on the type of hearing protection required. The BEE will inspect noise hazard areas and provide supervision and the installation safety office copies of written reports. (AFOSH Standard 48-19.)

2.16.3. Hand Protection:

2.16.3.1. Rubber protective gloves will be worn by personnel working in battery shops or other areas where acids, alkalis, organic solvents, or other harmful chemicals are handled. (AFOSH Standard 91-31 will be consulted for proper glove selection.)

2.16.3.2. Electrical worker's gloves are designed (and will be used) to insulate electrical workers from shock, burns, and other electrical hazards. These gloves will NOT be the only protection provided and will never be used with voltages higher than the insulation rating of the gloves. Workers will ensure gloves being used have been tested according to AFOSH Standard 91-31.

2.16.3.3. Multi-use gloves will be worn to protect the hands from injuries caused by handling sharp or jagged objects, wood, or similar hazard-producing materials. These gloves are usually made of cloth material (such as cotton flannel) with chrome leather palms and fingers or synthetic coating. All-leather gloves are also acceptable.

2.16.4. Foot Protection. Nonskid shoes will be worn where floors may be wet or greasy. Where there is reasonable probability of foot or toe injury from impact and compression forces, safety footwear shall be provided and worn.

2.16.5. Respiratory Protection. There are various airborne hazards, e.g., organic vapors, particulates, and fumes, that workers may encounter, and respiratory protection may be required. The installation BEE will be consulted for guidance on the type of protection required. At locations where neither BEE nor occupational or environmental health personnel are readily available, supervisors will contact the support medical facility or the next higher headquarters for assistance in obtaining respiratory protection guidance.

2.16.6. Head Protection. Hard hats (helmets) will be worn by all individuals who are working below other workers or in areas where sharp projections or other head hazards exist. Hard hats will have sufficient dielectric strength (15,000 volts) to provide protection from electric shock for electrical workers or other workers exposed to overhead electrical hazards.

2.16.7. Body Protection. Natural or synthetic rubber or acid-resisting rubberized cloth aprons will be worn by employees handling irritating or corrosive substances. Aprons will normally be worn with acid sleeves and gloves for greater body protection against skin injuries.

2.16.8. Insulated Matting. Insulating matting will be used by workers for additional resistance to shock where potential shock hazards exist, such as:

2.16.8.1. Areas where floor resistance is lowered due to dampness.

2.16.8.2. Areas where high voltages (above 600 volts) may be encountered.

2.16.8.3. Areas with electrical repair or test benches (shops).

2.16.9. 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 kneeled position.

2.16.10. Other:

2.16.10.1. Shop supervisors will ensure shop personnel use the protective clothing and equipment that will protect them from hazards of the work they perform. It is the responsibility of workers to keep their PPE in a clean, sanitary state of repair and use the equipment when required.

2.16.10.2. Workers will keep their hands and face clean, change clothes when they are contaminated with solvents, lubricants, or fuels, and keep their hands and soiled objects out of their mouth. No food or drink will be brought into or consumed in areas exposed to toxic materials, chemicals, or industrial shop contaminants. After exposure to any contaminant, shop personnel will wash their hands before eating or smoking. Safe drinking water will be provided in or reasonably near all shops. Waste food from the lunch area will be kept in a receptacle that is tightly covered and kept clean. Restrooms, provided with hot and cold running water, will be kept clean and in a sanitary condition. Shop personnel required to wear protective clothing will be provided with change rooms equipped with clothing lockers having separate storage facilities for clean and soiled clothing. Clothing used daily and issued by the shop will be cleaned and stored in shop lockers or fenced areas within the building. Clothing and protective equipment will be inspected daily for satisfactory condition by using workers. In addition, supervisors or a designated employee will spot check equipment and clothing. (29 CFR 1910.141, *Sanitation*.)

2.17. Restrictions. Workers will not wear rings, earrings, bracelets, wristwatches, or necklaces in the vicinity of operating machinery and power tools. Additionally, long full beards, unrestrained long hair, frayed trouser and shirt cuffs, loose clothing (such as loose shirt tails), loose shoe laces, and torn clothing can become caught in tools or machinery and cause serious injury to workers. Personal grooming and appearance standards will be enforced to prevent serious injuries that can result when clothing, hair, or jewelry become caught in operating tools and machinery. Clothing worn will be suitable to weather conditions and work being done. While working on or around live electrical equipment or high temperature equipment, garments with exposed metallic fasteners or metal articles such as jewelry, earrings, rings, hair fasteners, bracelets, or key chains will not be worn, nor will flammable articles such as celluloid cap visors be worn. Metal eyeglasses will be secured by a band or cord to prevent them from falling into energized electrical circuits. Highly combustible garments or coveralls made of material such as nylon will not be worn in or around high-temperature equipment or operations such as boiler operations, hot-tar roofing, welding, or any other work with open-flame devices.

Chapter 3

EQUIPMENT OPERATIONS, PAVEMENT, AND LANDSCAPE AND GROUNDS MAINTENANCE

3.1. Equipment Operations and Pavements . The equipment discussed below is representative of that typically found at an Air Force installation. Because of the manner in which civil engineering construction equipment is purchased, the equipment varies considerably in size, age, capabilities, and operating characteristics. The training outlines for operator qualification will be tailored to the particular equipment possessed and will be updated as new equipment is received. Equipment manufacturers will normally provide copies of their training guides and operator manuals to be used in developing training outlines. ANSI standards on lifting devices have additional information about some of the following types of equipment. Appropriate PPE (e.g., hard hats, as required), will be used. OSHA 29 CFR 1926.600, *Equipment*, .601, *Motor Vehicles*, .602, *Material Handling Equipment*, .603, *Pile Driving Equipment*, .604, *Site Clearing*, .605, *Marine Operations and Equipment*, and .606, *Definitions Applicable to Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations*, contain general requirements applicable to all construction equipment.

3.1.1. Backhoes. The front bucket, if so equipped, and outriggers will be fully down before attempts to dig are made. The entire area through which the digging arm can swing will be clear of people and equipment that could be struck. The operator will check overhead and lateral clearance for fixed obstructions such as trees, poles, wires, etc. Operation under energized electrical lines will be permitted only where absolutely necessary. These operations will be approved by the commander, and a spotter will be used to constantly check clearance. When traveling to and from job sites, the backhoe will be completely folded, secured, and centered and the front bucket raised only high enough to provide adequate ground clearance.

3.1.2. Mobile Cranes:

3.1.2.1. Operators. Mobile cranes will be operated only by authorized and qualified operators possessing a valid Operator's Identification Card, or by persons in training under the direct supervision of a qualified operator. The only other personnel who will enter a crane cab are persons such as oilers, supervisors, and inspectors whose duties require them to do so. A list of qualified crane operators will be kept by the using organization with appropriate entries made in the individual's training record or on the applicable form.

3.1.2.2. Operator Qualifications:

3.1.2.2.1. Potential crane operators will pass a written examination containing the safety requirements of this standard and AFOSH Standard 91-46. The operators will also be given a practical operating examination to demonstrate they are qualified to operate the crane safely. These examinations will be developed by the using activity according to AFI 24-301 and AFMAN 24-309, *Vehicle Operations*, coordinated by the Vehicle Transportation operations and maintenance officers, and approved by the unit commander. The examination will be administered by examiners appointed by the using activity.

3.1.2.2.2. Prior to assignment operators will be evaluated to determine their physical and mental capability to operate cranes. This examination shall include visual acuity, depth perception, hearing, peripheral vision, color vision, reaction time, and knowledge of crane operations. The transportation officer will ensure this testing is conducted. Medical examinations

will be requested any time supervisors feel that inadequate operator performance may be due to physical or mental problems.

3.1.2.3. Operating Practices:

3.1.2.3.1. Operators will not divert their attention elsewhere while operating the crane. They will first stop the crane, then proceed with the new task.

3.1.2.3.2. Operators will respond to signals only from the appointed signal person. A stop signal will be obeyed at any time no matter who gives it.

3.1.2.3.3. Operators will be responsible for those operations under their direct control. Whenever there is any doubt as to safety, the operator shall have the authority and responsibility to stop and refuse to handle loads until safety has been ensured.

3.1.2.3.4. If an audible warning signal is furnished, the operator will sound it each time before traveling and when approaching workers or other congested areas.

3.1.2.3.5. Before leaving the crane unattended, the operator will:

3.1.2.3.5.1. Land (set down) any suspended load, bucket, lifting magnet, or other device.

3.1.2.3.5.2. Disengage clutch.

3.1.2.3.5.3. Set travel, swing, boom brakes, and other locking devices.

3.1.2.3.5.4. Put controls in the "OFF" or neutral position.

3.1.2.3.5.5. Stop the engine.

3.1.2.3.5.6. Secure crane against accidental travel.

3.1.2.3.6. During periods of non-use or weather alerts, the operator will lower the boom to ground level, to a resting platform, or otherwise ensure the boom is secure against displacement from wind loads or other outside forces.

3.1.2.3.7. If there is a warning tag on the switch or engine starting controls, the operator will not close the switch or start the engine until the warning tag has been removed by an authorized person.

3.1.2.3.8. Before closing the switch or starting the engine, the operator will ensure all controls are in the "OFF" position and all personnel are in the clear.

3.1.2.3.9. If power fails during operation, the operator will:

3.1.2.3.9.1. If practical, land the suspended load under brake control.

3.1.2.3.9.2. Set all brakes and locking devices.

3.1.2.3.9.3. Move all clutch or other power controls to the "OFF" position.

3.1.2.3.10. Operators will familiarize themselves with the equipment and its proper care. The operator will conduct a pre-operational inspection before using the crane. If adjustments or repairs are necessary, or any damage is known, the operator will report them promptly to the supervisor and will record them on Air Force Technical Order (AFTO) Form 89, **Daily Inspection Worksheet for Locomotive Cranes Other Than Steam**, or other appropriate inspection and maintenance forms.

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

3.1.2.3.12. Booms that are being assembled or disassembled on the ground, with or without support of the boom harness, will be securely blocked to prevent dropping the boom and boom sections.

3.1.2.3.13. Booms that are being manually telescoped will be carefully repositioned prior to pinning to prevent injury to personnel.

3.1.2.3.14. When rotating the crane, sudden starts and stops will be avoided. Rotational speed will be such that the load can be controlled. A tag or restraint line will be used when rotation of the load is hazardous.

3.1.2.3.15. When a crane is to be operated at a fixed radius, the boom hoist pawl or other positive locking device will be engaged on rope-supported booms.

3.1.2.3.16. Ropes will not be handled on a winch head without the knowledge of the operator. While a winch head is being used, the operator will be within convenient reach of the power unit control level.

3.1.2.3.17. On cranes having a powered telescoping boom, the hook is drawn closer to the boom head when hoisting, extending the boom, or lowering a boom on machines where the winch is mounted stationary to the rear of the boom hinge. If the machine is not equipped with a "two-blocking damage prevention feature", the rope must be "let-out" from the load hoist mechanism so the hook will not be jammed (two-blocked) against the boom head. The jammed condition may cause overload and result in rope and (or) other component failure.

3.1.2.3.18. Telescoping boom sections will be telescoped in the manner and sequence specified by the manufacturer.

3.1.2.4. Handling the Load:

3.1.2.4.1. No crane will be loaded beyond its rated load. The weight of all loads will be determined before lifting. Outriggers will be set before lifting, telescoping the boom, or turning a load within the ratings.

3.1.2.4.2. A load will not be transported on a crane unless the crane is designed for that purpose. Normally, the load will be placed on a vehicle designed and rated to handle the particular load and transported to the new location, where it can be off-loaded and placed by the crane without movement of the vehicles.

3.1.2.4.3. When attaching the load, the hoist rope will not be wrapped around the load. The load will be attached to the hook by means of slings or other approved devices of proper capacity.

3.1.2.4.4. When moving the load, the supervisor directing the lift will ensure:

3.1.2.4.4.1. The crane is level and, where necessary, blocked properly.

3.1.2.4.4.2. The load is well secured and properly balanced in the sling or lifting device before it is hoisted more than a few inches.

3.1.2.4.5. Before starting to hoist, the operator will ensure:

- 3.1.2.4.5.1. The hoist rope is not kinked.
- 3.1.2.4.5.2. Multiple part lines are not twisted around each other.
- 3.1.2.4.5.3. The hook is brought over the load in a way that prevents swinging.
- 3.1.2.4.5.4. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves.
- 3.1.2.4.6. During hoisting the operator will take care that:
 - 3.1.2.4.6.1. There is no sudden acceleration or deceleration of the moving load.
 - 3.1.2.4.6.2. Load and boom do not contact any obstructions.
- 3.1.2.4.7. Side loading of booms will be limited to freely suspended loads. Cranes will not be used for dragging loads sideways.
- 3.1.2.4.8. The crane will not be operated while anyone is on the load or hook. **WARNING:** Riding on the hook or load is **ABSOLUTELY** forbidden.
- 3.1.2.4.9. The operator will not carry loads over personnel.
- 3.1.2.4.10. On truck-mounted cranes, loads will not be lifted over the front area unless specifically allowed in the manufacturer's operating instructions.
- 3.1.2.4.11. The operator will test the brakes each time a load is handled by raising it a few inches and applying the brakes.
- 3.1.2.4.12. Outriggers will be used when the load to be handled at that particular radius exceeds the rated load without outriggers, as given by the manufacturer for that crane or if the ground where the lift is to be made is soft or otherwise unstable. Where floats are used they will be securely attached to the outriggers. Blocking used to support outriggers will be strong enough to prevent crushing, be free from defects, and be of sufficient width and length to prevent shifting or toppling of the crane under load.
- 3.1.2.4.13. Neither the load nor the boom will be lowered beyond the point where less than two full wraps of rope remain on their respective drums.
- 3.1.2.4.14. When two or more cranes are used to lift one load, one designated person will be responsible for the operation. They will analyze the operation and instruct all personnel involved about proper positioning, rigging of the load, and the movements to be made.
- 3.1.2.4.15. While holding the load:
 - 3.1.2.4.15.1. The operator will not leave the position at the controls when the load is suspended.
 - 3.1.2.4.15.2. No person will be permitted to stand or pass under a load on the hook.
 - 3.1.2.4.15.3. If the load hoist mechanism is not equipped with an automatic brake and the load must remain suspended for a considerable length of time, the operator will hold the drum from rotating in the lowering direction.
- 3.1.2.5. Cranes in Transit. Before any crane, except for small truck cranes, is moved to a new job site, the route of travel will be checked to determine that adequate clearances exist along the entire route. This survey will be conducted by the vehicle heavy-equipment supervisor and crane opera-

tor. Normal routes for assigned cranes will be designated on an installation map and shall be approved for clearances by safety. The empty hook will be secured to prohibit swinging and the boom will be lowered to the boom rest or travel position. A red cloth or warning flag (at least 12 inches square) or a warning light will be carried at the end of any boom that extends more than 4 feet beyond the truck platform. At night a warning light (color according to local and state traffic codes) shall be used. The superstructure will be secured to prohibit rotation except when there is an operator in the cab to ensure proper boom clearances around tight spots and corners. Additional vehicles will be used to aid in warning other motorists if the crane boom or wide load poses a hazard to the front or rear.

3.1.2.5.1. A designated supervisor will be responsible for safe movement before a crane travels with a load. Decisions such as position of load, boom location, ground support, designated travel route, and speed of movement will be made by the supervisor. Specified manufacturer's tire pressures will be maintained. The boom will be carried in line with the direction of motion, sudden starts and stops will be avoided, and tag or restraint lines will be used to minimize the swinging of the load.

3.1.2.5.2. A crane will never be moved with the boom so high that it may bounce back over the cab.

3.1.2.6. Signals:

3.1.2.6.1. Standard hand signals to the operator will be used unless voice communication equipment is used. The operator will not respond to any signal (except an emergency stop) unless it is clearly understood.

3.1.2.6.2. When moving the crane, the following audible signals will be used:

3.1.2.6.2.1. STOP. One audible signal.

3.1.2.6.2.2. GO AHEAD. Two audible signals.

3.1.2.6.2.3. BACK-UP. Three audible signals.

3.1.2.6.3. If it is necessary to give instructions to the operator other than those provided herein, the crane motions will be stopped.

3.1.2.7. Operating Near Electric Power Lines:

3.1.2.7.1. Overhead power exterior lines will always be considered energized unless checked and certified by the electrical supervisor to the operator and supervisor that the lines are de-energized (use AF Form 103).

3.1.2.7.2. No part of a crane or its load will be permitted to come within 10 feet of any energized electrical power line. When this is impractical, the electrical power line will be de-energized and visibly grounded.

3.1.2.7.3. For lines rated over 50 kilovolts (kV), minimum clearance will be 10 feet plus 0.4 inch for each kV over 50 kV. AF Form 103 will be used and any additional clearance requirements, as identified and listed on the AF Form 103 by the exterior electric supervisor (but never less than 10 feet), will be followed.

3.1.2.7.4. A permanent sign will be posted in the cab of the equipment in full view of the operator. This sign will read: **“DANGER—HIGH VOLTAGE—Do Not Operate Within 10 Feet of Electric Power Lines.”**

3.1.2.7.5. A dielectric boom shield and insulated link installed in the lifting line at the hook will provide some protection against electric shock if the crane accidentally comes in contact with energized electric lines. Proximity warning devices are not fail-safe and will be used in addition to and not as a replacement for other controls. Even though shields, insulated hooks, and proximity warning devices are used, the clearance criteria specified in paragraphs [3.1.2.7.2.](#) and [3.1.2.7.3.](#) shall be followed.

3.1.2.7.6. If the boom of a rubber-tired crane contacts an electric power line, the entire piece of equipment will be energized since the rubber tires insulate the crane from the ground. Operators will not attempt to leave the crane until they are certain that either the line is clear of the crane or that the line is de-energized, because to do so could result in electrocution. If the fuel tank or vehicle ignites, and operators cannot remain on the crane, they should jump, ensuring all parts of their body clear the crane before their feet touch the ground.

3.1.2.8. Night Operations. Cranes operated during darkness shall have clearance lights installed. Working areas will be illuminated so the signal person, loads, rigging, obstructions, etc., are readily visible.

3.1.2.9. Clearance and General Requirements of Lifting Devices. Except as otherwise stated herein, mobile cranes will maintain at least 2 feet of clearance from all walls, overhead trestles, columns, and other structures. In operations where motorized and (or) pedestrian traffic is anticipated or encountered, the working area will be blocked off or controlled to keep people and vehicles away (refer to AFOSH Standard 91-46).

3.1.2.10. A carbon dioxide, dry chemical, or equivalent fire extinguisher shall be kept in the cab.

3.1.3. Dump Trucks. Dump trucks will not be operated with loads exceeding the manufacturer's rated capacity. Different materials have different specific weights (e.g., wet sand versus bark mulch) and, although the truck may have the volumetric capacity for the load, it may not have the weight capacity. Before dumping the vehicle's load, operators will always check overhead clearance both directly over the vehicle and ahead of it in the direction to be traveled while the body is still raised. Distances traveled with the bed raised will be kept to a minimum. Workers will not be permitted in the bed while it is being raised. The cab floor will be kept clear of debris that could interfere with controls. The number of people carried in the cab will never exceed the number of seat belts installed.

3.1.4. Motor Graders. Operators will follow manufacturer's instructions relative to the operation of the particular equipment in use. Although relatively standardized in design, the variations in capabilities and operating characteristics are as numerous as the number of manufacturers. Clearances around machines can vary as much as several feet depending on the position of the mold board and circle, tilt of wheels, etc., and the operator will know these limits. Graders are noisy and are often operated in dusty conditions. Proper hearing, respiratory, and eye protection will be provided, when required.

3.1.5. Wheeled Loaders. As with motor graders, the variety of wheeled loaders available to Air Force personnel is extremely varied. Operators will become intimately familiar with the operating characteristics of each vehicle and its limits. Such things as control positioning, turning radius, and capacity vary widely. Solid frame equipment and articulated units are extremely different in handling charac-

teristics, especially when being transported over the road. When traveling empty at excessive speed, a loader will bounce, weave, or road walk. Loaders are noisy, and are frequently operated in dusty conditions. Proper hearing, respiratory, and eye protection will be provided, when required.

3.1.6. **Bulldozers and Tracked Loaders.** This equipment is available in a range of sizes from very small to reasonably large with a wide variety of attachments, e.g., swing blades, ripper teeth, and combination bucket. Bulldozers and tracked loaders are relatively slow moving; few of them are suitable for driving on streets and all of them are noisy. Each operator will be thoroughly familiarized with the particular equipment possessed before being allowed to operate it without supervision. Proper hearing, respiratory, and eye protection will be provided and used, when required.

3.1.7. **Sweepers.** As with other construction equipment there is a great variety of street, airfield, and combination sweepers in the Air Force inventory. All, however, share some common traits in that they are noisy, can create great quantities of dust, and have extremely poor rearward visibility. In vehicles equipped with air conditioning, the dust is less of a factor. In vehicles not so equipped, respiratory protection may be required. Sweepers operating on the airfield will be radio-equipped and will have the headset-type radio due to the high volume of noise from the rear engine and blower. When operating on active airfields, these vehicles will be in direct contact with the control tower or escorted by a vehicle that is in contact with the control tower. Extreme caution will be exercised when backing this equipment; the use of a spotter is mandatory. Hearing protection will be worn when required.

3.1.8. **Rollers.** Self-propelled rollers are heavy equipment and are difficult to stop once put into motion. The operator will be intimately familiar with the equipment, especially the turning arc and stopping distances. When it is necessary to transport a roller over the road under its own power, its slow speed can present a hazard to other vehicle operators. Supervisors will attempt to make all such movements during non-peak traffic periods. Since few rollers are equipped with lights, movement during periods of reduced visibility (for example, nighttime) will be avoided unless escort vehicles are provided front and rear.

3.1.9. **Concrete Saw.** Personnel will stay clear of the front and blade operating side of the saw during operation. Cutter blades will be in good condition and not excessively worn, warped, or broken. A good water supply will be maintained to cool the cutting blade. Safety-toe shoes, goggles, and hearing protection will be worn during operation.

3.1.10. **Pavement Breaker (Jackhammer).** The tool will always be worked away from the body. Proper lifting techniques will be used and personnel cautioned not to twist the upper body while moving the tool. Sound footing will be used and a firm grasp will be kept on the tool at all times. The operator and personnel in the hazard zone of the operating site will wear appropriate safety shoes, goggles, and hearing protection; the operator will wear gloves. A respirator or dust shield will be worn when operations create dust.

3.1.11. **Router.** Workers will keep their hands and feet clear of the cutting tool and maintain a firm grasp on the handle during operation. Safety shoes, goggles, hearing protection, and gloves will be worn during operation. All personnel exposed to hazards of the equipment will wear appropriate PPE.

3.1.12. **Concrete Mixer.** Workers will keep their hands and arms clear of moving parts of the mixer. The mixer will be supported in a stable position before operation. The hopper will not be overloaded since this could cause equipment damage as well as injury to employees. Safety shoes, goggles, and

hearing protection will be worn when operating or working near the equipment, when required, and a respirator used if heavy concentrations of airborne cement dust are created during operation.

3.1.13. Concrete Spall Repairs Using Polymer. Polymers are used extensively on airfields because of their quick setting properties. Most are two components and are hazardous to mix and place. Manufacturer's recommendations will be followed for safe handling.

3.1.14. Joint Seal Kettle-Melter:

3.1.14.1. Kettles shall not be operated in the vicinity of buildings without fire department approval.

3.1.14.2. Serious burns can result from improper operation. Clothing that is loose fitting will be worn. Pants will completely cover the legs to below the tops of shoes. Shirts will be long sleeved. Loose-fitting gloves will be worn.

3.1.14.3. Safety-toe shoes and a face shield will be worn. The operator and personnel handling the heated kettle product will wear face shields and gloves. All tripping hazards will be removed from the vicinity of the worksite.

3.1.14.4. Containers will not be overfilled and will be allowed sufficient room for the bitumen (tar) to slosh without spilling when the container is moved.

3.1.14.5. An appropriate fire extinguisher will be kept near the kettle.

3.1.14.6. When adding bituminous or joint sealant materials to the kettle, the product will be eased into the kettle to prevent splashing of heated materials on the operator. The kettle will be watched closely and the products not heated above the safe heating temperature as specified by the product manufacturer.

3.1.14.7. Workers will never use direct heating of the materials. No open flame or source of ignition will be permitted near an asphalt material that is heated to a temperature near its flashpoint. Wherever heating kettles are in use, the temperature of the product will be controlled by thermostatic devices or checked at frequent intervals with an accurate thermometer to prevent overheating. **WARNING:** Gasoline or other highly volatile solvents will **NEVER** be used for cleaning.

3.1.15. Pavement Grinders (Line Eradicator or Paint Scraper). Workers will keep their hands and feet clear of the cutting wheels. The operator and personnel within the immediate work area will wear safety shoes, goggles, and hearing protection.

3.1.16. Tampers. Workers will keep their hands and feet clear of the tamping tool. A firm footing will be maintained while using this equipment. Safety shoes and hearing protection are required when tampers are operated.

3.1.17. Compressed Air and Pneumatic Tools. Compressed air shall **NEVER** be used to blow debris from a person. When used for cleaning purposes, the nozzle pressure at the discharge end of the air line will be as low as practical, but will not exceed 30 psi, and will only be used when effective chip guarding and eye protection are used. Goggles and hearing protection will be worn when working around an operating air compressor and pneumatic tools.

3.1.17.1. Air supply lines should be protected from damage by vehicles, tools, and equipment. They will be inspected regularly and maintained in good condition. Air supply lines will be marked or tagged to identify the maximum psi on the lines.

3.1.17.2. Tools will never be raised or lowered by the air hose.

3.1.18. Pneumatic Drill. Safety shoes, goggles, and hearing protection will be worn during operation. A firm grasp will be maintained on the tool. It will be kept aligned with the hole to prevent binding. The tool will NOT be forced.

3.2. Landscape and Grounds Maintenance:

3.2.1. Portable Powered Equipment. The various types of portable powered landscaping equipment usually have high-speed cutting edges, produce high noise levels, and wedge in the material they are cutting.

3.2.1.1. Gasoline powered augers should be inspected twice a day when being used. Shear pins, cutting bits, fuel systems, and shutoff switches should be in good working condition. A foreign object such as a bolt should **NEVER** be used as a substitute for a shear pin. The engine should be operated at three-quarters throttle and be shut off whenever the cutting bit becomes wedged. Operators will be sure the engine is cool before refueling and started no less than 10 feet from the refueling point. The cutting bit will be kept away from the legs and feet. Safety boots and eye and hearing protection will be worn at all times during operation. Operators will **NOT** wear loose fitting clothing. One operator should **NEVER** try to operate an auger designed for two workers.

3.2.1.2. Chain saws are covered in [Chapter 2](#).

3.2.1.3. Electric hedge clippers will be inspected, cleaned, oiled, and sharpened as required when in use. A grounded power cord shall be used if the tool is not double insulated. The cord will be inspected before use and daily for condition. The cord will be kept away from the cutting surface and out from under the feet of the operator. The cutting teeth of the clipper will not be pointed toward the body of the operator. The unit will be shut off and unplugged while moving from job to job. Gloves will be worn when operating hedge clippers. No electric power tool will be operated in rain, sprinklers, or any kind of precipitation.

3.2.2. Tire Removal and Mounting. Workers will use wheel jacks when mounting or removing large single or dual wheels. Tire or wheel chocks will be used, as required. Multi-piece or split-rim tires will be gauged prior to installation. Wheels having more than 80 percent of the recommended pressure may be inflated while on the vehicle if remote control inflation devices are used and no one is in the trajectory. Tires with less than 80 percent of the recommended pressure will be removed from the vehicle and inflated in a cage. Tires that have been driven underinflated at 80 percent or less of their recommended pressure will be deflated by removing the valve core before the wheel is removed. This same precaution applies when mounting or removing these type wheels. Repair of split rim or lock ring tire assemblies will be accomplished by qualified vehicle maintenance personnel with tire inflation accomplished inside a safety cage designed for that purpose. Split rim or lock ring tires can seriously injure or kill workers when the rings explode outward during attempted repairs or inflation outside a safety cage. Any area where the repair of split rim or lock ring tires takes place will have an OSHA Rim Chart posted in a conspicuous location. (OSHA 29 CFR 1910.177.)

3.2.3. Mowing. Maintenance of installation grounds involves the use of various sizes and types of lawnmowers. The two basic industrial types are reel and rotating that may be pushed, self-propelled, ridden, or towed. The most significant dangers are being struck by the blade or a foreign object thrown by the high speed blades and noise-induced hearing loss.

NOTES:

1. All personnel shall observe the safety precautions in this standard and those recommended by the manufacturer of the equipment. Always read the owner's manual before operating the equipment. See TO 47C1-1, *Safety Instructions for Lawn Care Equipment*, for additional guidance.
2. Ensure electric mowers, trimmers, and attached extension cords are effectively grounded. However, listed or labeled portable tools protected by an approved system of double insulation, or its equivalent, need not be grounded.
3. Never use electric mowers and grass trimmers while it is raining or the grass is wet, excluding light dew.

3.2.3.1. Personal Protective Equipment (PPE) and Safeguards:

3.2.3.1.1. Foot Protection. Workers will wear safety-toe shoes or metal toe-guards when operating powered push mowers or edgers. When using mowers equipped with an installed rear drag plate or edgers with nylon filament line cutters (and requirements of paragraph 3.2.3.2. are followed) the use of safety-toe shoes or metal toe-guards is optional. In all instances, workers operating this equipment will wear shoes of sturdy construction. Open-toed sandals, tennis shoes constructed of cloth or canvas, etc., are not appropriate for wear during mowing tasks.

3.2.3.1.2. Eye Protection. Use suitable eye protection (safety glasses, goggles, face shields, or a combination) when operating powered edgers or weed eaters. When mower operators are exposed to flying rocks, dirt, or other hazards, they will wear appropriate eye protection.

3.2.3.1.3. Hearing Protection. If hazardous noise levels are produced by the equipment being operated, workers will wear hearing protection. Coordinate with the installation BE staff for guidance. If equipment is identified as producing hazardous noise levels, place a decal or stenciled warning in view of the operator stating: **“WARNING—THIS MACHINE CREATES HAZARDOUS NOISE LEVELS. EAR PLUGS OR MUFFS SHALL BE WORN.”** See AFOSH Standard 48-19 for additional guidance.

3.2.3.1.4. Other. Workers may wear gloves when using walk-behind mowers. In addition, they should wear bump caps when using a riding or towed mower around tall brush and low hanging tree limbs. Guard all mower discharge chutes with shields or approved grass catchers to deflect or stop foreign objects thrown and to prevent the operator's inadvertent contact with the blade during operation. Place a readable safety message indicating **“CAUTION,” “WARNING,”** or **“DANGER—DO NOT USE WITHOUT GUARD OR GRASS CATCHER IN PLACE”** on or near the mower's discharge opening. **NOTE:** Push and self-propelled mowers manufactured according to ANSI B71.1, *Lawn Mowers, Lawn and Garden Tractors, and Lawn Tractors*, are equipped with a rear protective guard.

3.2.3.2. Operating Practices Applicable to Powered Push Mowers:

3.2.3.2.1. Prior to mowing, operators will clear the area to be mowed of all people and inspect for foreign objects, raised sprinkler heads, holes, soft ground, obstructions or any other condition that has the potential to impact the safety of the operation.

3.2.3.2.2. Personnel operating this equipment should never pull the mower backwards while the engine is running because the safety guard on the back may cause the mower to lift off the ground subjecting the operator to serious injury.

3.2.3.2.3. Always mow in a horizontal direction across the face of a steep slope, e.g., hills or banks exceeding a 30-degree angle, and keep firm footing at all times.

3.2.3.2.4. Stay clear of the front of self-propelled mowers during and after starting. Control the mower by hand pressure on the handle, not by foot pressure on the housing.

3.2.3.2.5. Do not attempt to clean grass from the chute when the mower is running. Disconnect the spark plug or if electrical—the power—when cleaning, repairing, or inspecting the mower.

3.2.3.2.6. Do not leave the mower running unattended.

3.2.3.2.7. Set mower blades cutting height as near to 2 inches as possible. Never set blades lower than 1-1/2 inches. Special equipment that allows mowing lower than the 1-1/2 inch blade setting is available when performing lawn maintenance on golf course fairways and greens.

3.2.3.3. Powered Mowers—Walk-Behind, Riding-Rotary, Converted Sulky, and Reel Power Lawnmowers. These mowers shall meet the design specifications noted in OSHA Standard 29 CFR 1910.243, *Guarding of Portable Powered Tools*. (For example: “Deadman controls shall automatically interrupt power to a drive when the operator’s actuating force is removed, and may operate in any direction to disengage the drive.”)

3.2.3.3.1. Follow manufacturer’s requirements during vertical or horizontal mowing of grades with riding or towed mowers.

3.2.3.3.2. 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 workers can cut by hand using manual tools.

3.2.3.4. Edgers. Check to make sure the guard is in place. Never use the edger when people are in line with the blade. Use proper PPE. Always disconnect power when inspecting or repairing the edger.

3.2.3.5. General Rules for Maintaining Lawn Care Equipment:

3.2.3.5.1. Always refuel with the engine off and allow the engine to cool first. Do not permit smoking in the area. Refuel mowers prior to use instead of refueling before storing inside a building. Complete refueling outside at least 10 feet away from the building or any open flame source.

3.2.3.5.2. Use boards or ramps to load and unload mowers from vehicles. Ensure the engine is off and the spark plug wire is disconnected. Always shut off the fuel supply line when parking mowers inside or outside at the end of the duty day. As storage space permits, leave 1- to 3-foot separation space between parked gasoline-operated riding mowers.

3.2.3.5.3. Clean mowers or perform other maintenance on mowers only after turning the engine off and disconnecting the spark plug wire.

3.2.3.5.4. Use manufacturer’s guidelines for operation and use of mowers.

3.2.4. Batteries:

3.2.4.1. Protective clothing will be used when servicing batteries. As minimum, safety-toe shoes, suitable eye and face protection, a rubber apron, and rubber gloves will be worn.

3.2.4.2. Personnel will use battery straps and PPE when lifting and carrying batteries. Where straps cannot be used, workers will practice correct lifting procedures to prevent strains from improper lifting. Batteries that cannot be carried with straps will be transported with carts or other material handling equipment.

3.2.4.3. Nickel-cadmium and unsealed lead-acid batteries will be separated to keep the lead-acid fumes away from the nickel-cadmium batteries.

3.2.4.4. Tools or metal parts will not be laid on a battery or stored where they may fall on a battery.

3.2.4.5. Workers will not wear rings, watches, bracelets, or other jewelry when working with batteries. Metal eyeglasses will be secured by a band or cord.

3.2.4.6. Battery charging will be done in specifically designated areas. Where batteries are serviced, methods will be provided for flushing and neutralizing spilled electrolyte. Adequate ventilation will be provided to prevent hydrogen gas buildup (unsealed lead-acid batteries) and an ample supply of water will be available for quick drenching of the work area if acid is splashed or spilled. Personnel assigned to work with batteries will be instructed in emergency procedures such as coping with electrolyte spills. Where required, a serviceable emergency eyewash will be present in the shop area (refer to AFOSH Standard 91-32, *Emergency Shower and Eyewash Units*).

3.2.5. Tractor Operations. There are regulatory OSHA standards covering agricultural tractors. While limited in scope, these standards do contain some provisions applicable to tractors used in landscaping operations. Regulatory OSHA requirements from OSHA 29 CFR 1926.1002, *Protective Frames (ROPS) Test Procedures and Performance Requirements for Wheel-Type Agricultural and Industrial Tractors Used in Construction*, are covered in paragraphs [3.2.5.1.](#) and [3.2.5.2.](#)

3.2.5.1. Roll-over protective structures (ROPS) are required on tractors used for landscape maintenance. Seat belts shall be installed on all ROPS-equipped tractors and used whenever the vehicle is in motion.

3.2.5.2. Commercially purchased ROPS will satisfactorily pass the field upset tests (side and rear) specified in OSHA 29 CFR 1926.1002. A label indicating this is permanently attached by the manufacturer to the ROPS.

3.2.5.3. When pulling a load, operators will hitch only to the draw bar. The draw bar hitch will be kept at least 13 inches, but less than 17 inches, off the ground.

3.2.5.4. When moving a front load, the load will be kept low to the ground and the rear wheels as level as possible.

3.2.5.5. Operators will avoid holes and obstacles; both on the ground and overhead. Speed will be reduced with heavy loads when vision is limited or when operating on rough terrain.

3.2.5.6. When stuck, operators will try carefully to back out. Increasing engine speed or fastening a post to the rear wheels greatly increases the chances of tipping over backward; therefore, these methods will not be used. Operators will get help if needed.

3.2.5.7. When traveling on highways, operators will abide by local traffic rules. They will avoid travel during heavy traffic periods and check brakes for equal application for highway use. The lighting and markings required by local state vehicle codes will be used. Slow-moving vehicle emblems will be used.

3.2.5.8. Grass will not be mowed with a tractor on slopes greater than a 4-inch rise or drop per foot of travel. Lower gears will be used when going down hill and the wheels will be allowed to control the tractor speed.

3.2.5.9. When using a sickle-bar mower, the sickle-bar blades will not be positioned downhill. They will be positioned on the upper side of the slope so the pull of gravity will not cause the tractor to turn over.

3.2.5.10. The engine will be shut off before the operator dismounts from the tractor or makes adjustments to either the tractor or towed equipment.

3.2.5.11. Riders will not be allowed on tractors, the draw bar, or towed equipment, except where the equipment is specifically designed to allow riders or passengers.

3.2.5.12. Fenders are guards for the worker's protection. Fenders will be kept in place at all times.

3.2.5.13. Tractors will only be left on an incline after the engine has been turned off, gear shift has been placed in park position (or the lowest gear if standard transmission), and the wheels have been braked and blocked. Where possible, tractors will be parked on level ground.

3.2.5.14. The power take-off guard will always be in place.

3.2.5.15. An operator will dismount or mount a tractor only when it is stopped. The steps and platform will be kept clean of debris.

3.2.5.16. Hearing protection and safety-toe shoes will be worn by the operator, when required. When operating in an overhead hazard area, hard hats will be worn. The installation BEE will be consulted to determine the need for respiratory protection.

3.2.6. Maintenance of Irrigation Systems:

3.2.6.1. Gases, low oxygen levels, high water levels, and in some cases, pressure are some hazards that exist in irrigation pits. Before entering an irrigation pit, oxygen and combustible gas levels shall be tested. Potential cracks, leaks, and weak pipes may be discovered. Upon finding any of these conditions, the pit will be ventilated and the worn or broken parts replaced before use of the pit is permitted. Before commencing repair work, the worker will ensure the water and electrical power have been turned off.

3.2.6.2. Only qualified electricians will work on electrical systems.

3.2.6.3. Transformers and other electrical equipment will be protected in waterproof boxes. Timing mechanisms will be mounted in a locked box.

3.2.6.4. Safety glasses or goggles and safety-toe shoes or boots will be worn during maintenance operations. Orange reflective safety vests will be worn when working within 15 feet of a roadway

or parking lot. The safety vest should contain at least 30 square inches of reflective material. When working on or at the edge of a roadway, cones or barricades with lights and traffic warning signs will be used.

3.2.7. Tree Maintenance:

3.2.7.1. A full-time professional tree trimmer may be used to perform scheduled tree maintenance on an installation. Routine, unscheduled, and emergency conditions will normally require tree maintenance throughout the year. Workers shall be fully trained to perform these duties at a satisfactory level. Only those in good physical condition and who are fully trained will be used to perform under adverse weather conditions. All workers will receive training in emergency rescue and life saving first aid techniques.

3.2.7.2. Two or more workers and an on-site job supervisor, fully qualified in tree maintenance, shall be assigned when tree maintenance involves climbing, working from a high reach lift, and while cutting down any tree other than small low trees that would pose no hazards to people, facilities, and utility lines. The area around trees that are being trimmed or cut and in the vicinity of operating chippers and stump grinders shall be effectively marked with cones, streamers, or barricades and controlled to warn personnel against the danger of entry.

3.2.7.3. Safety belts, saddles, ropes, D-rings, cutting tools, equipment, and all other related climbing gear will be inspected to ensure it is in safe condition prior to each use. Any equipment or climbing gear that is frayed, worn, broken, or defective shall be removed from service immediately. Each climber will have at least one lifeline and one handline, normally nylon, one-half inch by 125 feet. At least two, three-fourths of an inch polypropylene or equivalent lines (250 feet long each) will be provided for each crew. The nominal breaking strength of one-half inch ropes used for climbing shall not be less than 2,385 pounds. Climbing and safety ropes shall not be spliced for repair or added length. The ends of ropes will be wrapped to prevent fraying. A climbing rope shall always be used, even when work is performed from a ladder or lift device.

3.2.7.4. Workers involved in tree maintenance shall wear hard hats, gauntlet gloves, eye protection, and high-top safety boots when operating power saws or equipment. Hearing protection will be worn where hazardous noise level sources, such as power chain saws, chippers, and stump grinders, are operating. Ballistic nylon patch leg coverings should be used while operating power chain saws. Clothing for tree-climbing operations will be long sleeve shirts, pants, and clothing that is not baggy or loose.

3.2.7.5. Supervisors will complete (and have available for use) a job safety analysis and local operating instructions (OI) for both routine and emergency tree maintenance operations. Critical elements with serious potential to affect workers' safety, such as tree climbing, tree cutting and removal, trimming near electrical lines, use of chain saws, use of high-reach lifts, and use of cutters or chipper equipment, will be included.

3.2.7.6. Additional general safety requirements for tree care operations can be found in ANSI Z133.1-1994, *Tree Care Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush—Safety Requirements*.

3.2.8. Flower Bed and Shrub Maintenance:

3.2.8.1. All flowers and shrubs will be planted and maintained at a height that will not interfere with the vision of vehicle operators. Workers will wear clothing and gloves that will protect their

hands and arms from thorns and leaves which may cut or puncture the skin. Dust masks may be required to prevent reactions to fine dust or pollen. Personnel will not work on flower or shrub beds within 24 hours after application of herbicides.

3.2.8.2. Rototillers and other machines used for preparing or maintaining beds will be fueled, lubed, and inspected daily to ensure safe operation. Workers will keep their feet and hands clear of moving parts and will not wear loose clothing. Shovels, hoes, and cultivators will be kept sharp, used in moist soil, and placed where stepping on the cutting surface will not cause the handle to strike a person. Poisonous plants will not be planted.

3.2.9. Edging. Edging is done either by hand or with a machine. This standard primarily covers edging with a machine because of the hazards involved. TO 47C-1-1 will be consulted for use and other safety requirements.

3.2.9.1. Be familiar with the machine before attempting to operate it. Keep the area clear of all persons and pets. Inspect the area and remove all foreign objects. Ensure the edging is not of a depth along walks to create a hazard for pedestrians.

3.2.9.2. Wear goggles, gloves, and safety-toe boots when operating a powered edger. Only gloves are required for using a manual edger. Wear the orange safety vest when edging requires the worker to be in the roadway or near the edge of a non-curb protected road.

3.2.9.3. Exercise caution to avoid slipping or falling on slopes.

3.2.9.4. Stop the engine and let it cool before adding fuel. If some fuel is spilled, wipe it off before restarting the engine and replace fuel caps securely. Never store the edger with fuel in the tank inside a facility where open flame or an ignition source may be present

3.2.9.5. Use a grounded three-wire cord for electrical driven edgers that are not double insulated.

3.2.9.6. Do not make adjustments when the engine is running.

3.2.9.7. Stay alert for hidden hazards. After striking a foreign object, stop the engine, remove the wire from the spark plug, and repair the damage before resuming operations. Remove the spark plug wire whenever it is necessary to put the hands close to parts that move.

3.2.10. Reseeding:

3.2.10.1. Seeders and rototillers have moving parts and create large amounts of dust. Safety protectors such as gloves, respirators, safety glasses or goggles, and safety-toe shoes or boots will be worn.

3.2.10.2. When working on slopes, the worker will have firm footing at all times. Orange safety vests will be worn when working next to any non-curb protected type of roadway.

3.2.11. Sodding:

3.2.11.1. Back strains, twisted ankles, and cuts can result from this type of operation. When sod is too bulky to allow two workers to handle, use a wheelbarrow or other equipment. Follow the lifting guidelines in paragraph 2.13. of this standard. When cutting sod, cut away from yourself and do not make hacking motions.

3.2.11.2. Powered rollers and hand rollers are both used in sodding. Powered rollers are heavy and slip easily on slopes. When using a powered roller, avoid steep slopes so the roller does not tip or slide. Keep hands and feet away from moving parts. Push or pull hand rollers. When rolling sod on a slope, tie a rope to the handle, pull the roller up the hill, and let it roll down the hill by gravity. Do not walk on the slope while using a hand roller.

3.2.12. Fertilizer Storage and Handling:

3.2.12.1. Fertilizer can become a very combustible material and, at temperatures in excess of 130 degrees F, it may explode. When fertilizers become wet and start to decompose, they give off a gas that will burn. Some fertilizers give off a very toxic gas when burning. When fertilizer has started to burn, a large quantity of water should be applied to the burning surface to extinguish the flame and cool the rest of the fertilizer. The fire department will be called for all fertilizer fires. No more than 2,500 tons of fertilizer will be stored in a building unless the building is equipped with an automatic sprinkler system.

3.2.12.2. When spreading fertilizer, pellets will not be directed toward other people. If personnel enter the area, the spreader will be turned off. Fertilizer spreaders will be cleaned and lubed daily. Safety glasses and gloves will be worn during fertilizing spreading operations.

3.2.13. Herbicides. The use of herbicides for weed control poses a significant potential safety and health hazard. Herbicides shall be applied per manufacturer's instructions and used only by certified personnel. Due to the absorption properties of herbicides, coveralls will be worn during application, in addition to safety goggles and appropriate respiratory protection, as required.

Chapter 4

CARPENTRY AND STRUCTURAL MAINTENANCE

4.1. Hazards and Human Factors . Personnel performing duties in carpentry and structural maintenance are potentially exposed to a wide variety of hazards in many different environments and locations. Potential hazards include exposure to flammable and combustible adhesives, dusts, hazardous noise, eye hazards, working at heights above ground level, lifting hazards, electric and pneumatic power tools, powder-actuated tools, and working with unfinished material that contains splinters. Many tasks are performed in areas of high pedestrian traffic; therefore, an additional hazard of possible distraction from the job task arises. Potential physical and health hazards can be effectively controlled by following the guidance in this chapter, by proper work procedures and controls, and by using required PPE.

4.2. General Carpentry:

4.2.1. Workers will not leave a woodworking machine running unattended nor attempt to clear, clean, or repair the machine while it is operating. When maintenance is necessary, the machine will be completely shut down and its control switches locked and tagged in the "OFF" position according to instructions in AFOSH Standard 91-12. Supervisors will ensure periodic inspections are accomplished on all shop equipment. Chips or dust will never be removed from machinery by hand. Machine guards will not be removed nor made inoperative except for authorized maintenance. When guards are removed during machine repair, power control switches will be locked in the "OFF" position and properly tagged (AFOSH Standard 91-45, *Hazardous Energy Control and Mishap Prevention Signs and Tags*). The machine will remain locked until the guards are replaced.

4.2.2. PPE worn while operating machinery, equipment, and saws at shop and job sites normally consists of eye protection (full face shield or fully enclosed goggles), safety-toe boots, and hearing protection (ear muff and [or] plugs depending on noise exposure). Other safety-related PPE includes dust masks where workers are exposed to dust at the point of operation and kneepads to protect the knees where workers must kneel while working. The installation BEE will be consulted to determine the need for dust masks. Hard hats are required in lumber storage areas and on job sites where the potential exists from being struck by falling objects, for example, roofing and construction.

4.2.3. See [Chapter 2](#) for general guidance that applies to both carpentry and structural maintenance work methods or tools. The following specific guidance applies to table saws:

4.2.3.1. Keep hands out of the line of cut when feeding table saws. Use a push stick when close to the blade.

4.2.3.2. Adjust saw to expose the least amount of saw blade above table and material being cut.

4.2.3.3. Always stand out of line of stock being ripped.

4.2.3.4. Hold stock being cut against a gauge when cutting with a circular table saw.

4.2.3.5. Always use the appropriate saw for the cut (it would be unsafe to rip with a crosscut saw or to crosscut with a rip saw).

4.2.3.6. Avoid crosscutting long boards on a table saw (normally, long stock may be crosscut on a swing pull saw).

4.2.3.7. Never adjust the saw or fence gauge while the saw is operating. Designate the line of cut on the table top with a permanent mark when setting the gauge of a table saw without removing the guards.

4.2.3.8. Always use a brush or stick to clean or scrape sawdust from a saw.

4.3. Ventilation Systems:

4.3.1. Ventilation. Only essential safety, fire prevention, and occupational health items are included. For more details, including information on flow rate requirements, the installation BEE will be contacted. Ventilation and exhaust systems will be according to the provisions of this section and AFOSH Standard 161-2.

4.3.2. Application. Machines that develop fine dust or other airborne contaminants will be equipped with effective industrial exhaust ventilation. In shops where small numbers of installed machines are not continuously in operation, portable collection systems may be used. Hoods and exhaust systems will be constructed and installed to meet requirements in AFOSH Standard 161-2. Also reference AFOSH Standard 91-12.

4.3.3. Exhaust Ducts and Pipes. These will be constructed and sized to minimize clogging. They will discharge into an enclosed container.

4.3.4. Refuse. Refuse will be removed daily in all operations that are not required to have an exhaust system or where the refuse cannot be handled by an exhaust system.

4.4. Storage and Handling of Lumber:

4.4.1. Storage areas for lumber and other building materials can be potentially hazardous. For example, when lumber is stored upright, precautions will be taken to prevent it from falling into aisles or passageways. Lumber stored in tiers will be stacked, blocked, and interlocked. The stacks will be limited in height so they are stable and secure against sliding or collapse. Storage areas will be kept free of accumulations of materials that constitute tripping, fire, or explosion hazards. Smoking will not be permitted in outside or inside storage areas, and signs to this effect will be posted. Specific storage requirements are contained in DoD Regulation 4145.19-R-1.

4.4.2. When heavy stock cannot be safely handled by workers, suitable mechanical lifting devices will be used.

4.4.3. Gloves will be worn by workers to reduce injury potential to the hands from splinters or from being pinched between the stacks. The accidental movement of the stacked material can cause serious injuries. Caution will be taken not to disturb other tiers when removing partial stacks for use.

4.4.4. Manual handling is relatively safe if the proper lifting and carrying positions are used. Balanced handling is the key to safe handling. However, disregard of accepted safe practices can result in injuries such as hernias, back strains, crushed hands and feet, broken bones, and severe lacerations.

4.5. Installed Equipment . See AFOSH Standard 91-12 for specific operations of the following:

4.5.1. Saws.

4.5.2. Jointers.

4.5.3. Power-Fed Planers.

- 4.5.4. Shapers.
- 4.5.5. Lathes.
- 4.5.6. Sanding Machines.
- 4.5.7. Boring and Mortising Machines.
- 4.5.8. Tenoning Machines.
- 4.5.9. Glue Spreaders.

4.6. Powder-Actuated Fastening Tools : (Also consult paragraph 2.6.6. and the applicable manufacturer's operating manual.)

4.6.1. A powder-actuated tool requires a specific size explosive powder charge to drive a stud, pin, or other fastener. This tool is used for attaching various building materials quickly and easily to concrete, masonry, or structural steel. Use of these tools for attaching materials to soft construction material such as wood, plaster, tar, or dry wallboard is prohibited.

4.6.2. Powder-actuated fastening tools that meet all requirements of ANSI Standard A10.3, *Powder-Actuated Fastening Systems* have a manufacturer's label and model identification, and include the manufacturer's instructions. These are the only tools that will be used in Air Force operations.

4.6.3. Qualified operators who have been trained and issued a qualified operator's card, which they have in their possession, will be permitted to use powder-actuated tools. ANSI Standard A10.3 and National Safety Council (NSC) Data Sheet 236, *Powder-Actuated Hand Tools*, may be consulted for guidance and information concerning Powder-Actuated Tool Manufacturer's Institute (PATMI). Operator and instructor cards may be obtained from manufacturers of PATMI.

4.6.4. Operators, assistants, and adjacent personnel shall wear eye or face protection when the powder-actuated tool is in use or about to be used just prior to loading. Hearing protection will be worn by all workers involved as required by AFOSH Standard 48-19.

4.6.5. The tool will be used for its intended purpose only. Workers will know the material being fastened and the base material being fastened into.

4.6.5.1. Operator Instructions:

- 4.6.5.1.1. Always wear safety goggles (operators and co-workers).
- 4.6.5.1.2. Use hearing protection, when required, when making fastenings in confined areas such as small rooms, tanks, vaults, or enclosed compartments.
- 4.6.5.1.3. Never let bystanders gather around when the tool is being used.
- 4.6.5.1.4. When working on ladders and scaffolds, maintain good balance and properly brace yourself at all times.
- 4.6.5.1.5. Never load the tool until ready to make a fastening.
- 4.6.5.1.6. Always keep the tool pointed in a safe direction.
- 4.6.5.1.7. Never carry a loaded tool from job to job.

4.6.5.2. Tools—Care and Servicing:

4.6.5.2.1. All tools will be cleaned and maintained according to the tool manufacturer's specific instructions.

4.6.5.2.2. The operator will always check all tools before each day's use to ensure they are in proper working condition. Defective tools will be removed from service until they are repaired.

4.6.5.2.3. Operators will ensure the tools are inspected and serviced at regular intervals by the manufacturer's authorized service personnel.

4.6.5.2.4. Powder-actuated tools will not be altered or repaired with any but factory replacement parts; such action could destroy built-in safety features.

4.6.5.2.5. Tools will be stored unloaded in a locked container when not in use.

4.6.5.3. Tools—Use and Limitations:

4.6.5.3.1. Ensure the tool is equipped with the proper shield or fixture for the job. Use special fixtures where the standard shield does not provide adequate protection.

4.6.5.3.2. Only use off-center positions for adjustable shields when fastening near obstructions (such as a wall) when the obstruction is used as a shield.

4.6.5.3.3. Always operate a tool at right angles to the work surface.

4.6.5.3.4. Always check the chamber for foreign matter before loading.

4.6.5.3.5. Do not use the tool in an explosive or flammable atmosphere.

4.6.5.3.6. Never place your hand over the front (muzzle) end of a loaded tool.

4.6.5.4. Powder Loads:

4.6.5.4.1. Always check the color of each powder load before inserting it into the tool chamber.

4.6.5.4.2. Always make the first fastening with the lightest powder load recommended for the tool.

4.6.5.4.3. Never attempt to force a powder load into a tool chamber.

4.6.5.4.4. In the event of a misfire, hold the tool firmly against the work surface for a period of 30 seconds and then closely follow the manufacturer's instructions. Do not throw unfired powder loads into trash containers or otherwise carelessly discard them.

4.6.5.4.5. Never carry fasteners or other metal objects in the same container, apron pocket, or pants pocket with tool powder loads.

4.6.5.4.6. Ensure storage of powder loads complies with AFMAN 91-201.

4.6.5.5. Materials—Base Materials and Materials To Be Fastened:

4.6.5.5.1. Before fastening into any unidentified material, check it by using a fastener as a center punch to determine if the material is too soft, too hard, or brittle.

4.6.5.5.2. Always follow the rules for edge distance, fastener spacing, and material thickness.

4.6.5.5.3. Do not attempt to install a fastener through an existing hole in steel or any other material unless a positive guide is used to ensure accurate location.

- 4.6.5.5.4. Never attempt to fasten into a spalled or cracked area in concrete or masonry or into any area where a previous fastener has failed.
 - 4.6.5.5.5. Never overdrive a fastener.
 - 4.6.5.5.6. Do not use a fastener to draw down a steel member.
 - 4.6.5.5.7. Never over-tighten a nut on a threaded stud.
 - 4.6.5.5.8. Do not attempt to install fasteners into very hard or brittle materials such as (but not limited to) cast iron, tool steel, spring steel, glazed tile, hollow tile, glass block, and most brick and natural rock.
 - 4.6.5.5.9. Never fasten wood, fiberboard, plaster, or other soft materials unless backed by a material that will prevent the fastener from passing completely through.
 - 4.6.5.5.10. Always know the material you are fastening into, especially in older buildings where the base material may be concealed. Check continually to avoid fastening into unsuitable material.
- 4.6.5.6. Warning Sign. Post a sign, at least 8 by 10 inches (20 by 25 centimeters [cm]) using boldface type no less than 1-inch high (2.5 cm), in plain sight on all projects where powder-actuated hand tools are used. The sign should be worded similar to the following: “**POWDER-ACTUATED TOOL IN USE.**”
- 4.6.6. Projectile firing tools will be constructed to prevent discharge when dropped. (29 CFR 1910.243 and 1926.302, *Power Operated Hand Tools.*)
- 4.6.7. Due to the hazard of fasteners passing through materials, the operator will ensure no personnel are located on the opposite side of the wall, structure, or material prior to firing a fastener into it.

4.7. Roofing Operations:

- 4.7.1. Roof work because of its nature, the environment, and sometimes infrequency may have a higher than normal mishap potential. Pre-planning, refresher worker training through pre-job briefing, and following the safeguards required can prevent this operation from resulting in minor to serious mishaps.
- 4.7.2. Roofing materials will be segregated by type and size in stable stacks that are safe from falling.
- 4.7.3. Ladder requirements are included in [Chapter 2](#). Chicken ladders or crawling boards will have the cleats spaced at equal intervals not to exceed 24 inches.
- 4.7.4. A catch or scaffold platform, extending at least 2 feet beyond the eaves and equipped with guardrails, will be provided on roofs without parapet walls, where the slope is greater than 3 inches per foot, and the distance from the eaves to the ground is more than 16 feet. A safety harness attached to a lifeline that is securely fastened to a safe anchorage may be substituted for the platform. Additional guidance on scaffolding is included in chapter 2. (See: ANSI Standard A10.8, *Scaffolding* and OSHA Standards 29 CFR 1926.500, *Guardrails, Handrails, and Covers*, and 1926.451, *Scaffolds, General Requirements.*)
- 4.7.5. To avoid splashing, asphalt and drip-dried material pieces will be slipped rather than pitched into kettles containing melted bitumen.
- 4.7.6. Workers shall not stand or work below any hoisted materials or hot substances.

4.7.7. All housekeeping standards will be followed to prevent injuries to workers and others who may pass near the roofing work site. Unsupervised open-flame devices, improper storage, and improper disposal of waste materials can cause a fire.

4.7.8. PPE will consist of eye and face protection, foot and leg protection, proper clothing and gloves, and hard hats for working with hot or cold application roofing maintenance or where overhead work is being performed.

4.7.9. Tar kettles and pots, when used, will be located so they will not be a fire threat to surrounding buildings or other structures. Tar kettles and pots (when in operation) will not be left unattended for extended periods of time, due to the possibility of fire. After use of the kettle, heavy tar buildup will be cleaned from plumbing pipes.

4.8. Masonry:

4.8.1. Mixing Concrete and Mortar. Mixing concrete and mortar, whether performed manually or by motorized mixers, is a very strenuous and often hazardous operation. During the operation, it is inevitable that masonry shop workers will come in contact with Portland Cement. Workers will use every means possible to prevent inhalation, ingestion, or body contact with cement dust. Once Portland Cement dust is inhaled or ingested, it is almost impossible to purge the substance from the body's system. Portland Cement will cause chemical burns and rashes when it comes in contact with parts of the body. One of the frequent mishaps caused from contact with Portland Cement is allowing it to seep inside worker's shoes. Generally, once detected, feet and toes have already suffered permanent damage that may require hospitalization. Protective clothing and boots shall be worn when mixing concrete and mortar. The installation BEE will be consulted for evaluation of the need for respiratory protection. Shop supervisors shall train new employees in the proper techniques that will be used.

4.8.2. Brick and Concrete Block Work. Brick and concrete block operations include carrying brick, concrete or cinder block, and mortar from place to place on the job site as well as putting them in place. Shop supervisors will ensure proper lifting and carrying techniques are used. They will also ensure workers, when carrying materials up and down ladders and on scaffolding, carry no more than they can safely transport at any one time.

4.8.3. Cleaning and Etching Old and New Brick and Concrete Work. As a part of brick and concrete work, masonry workers will be required to clean or etch old and new work. Some of the agents used in this operation, depending on the scope of the work are: tri-sodium phosphate, muriatic acid, and potassium or sodium hydroxide. Shop personnel will be aware of the hazards associated with this work. Workers, when diluting muriatic acid, **will never add water to the acid;** they will always add the acid to water. Proper PPE will be worn.

4.8.4. Fiberglass Work. When repairing fiberglass components such as tanks, bathtubs, shower stalls, and lavatories, workers may be exposed to fiberglass filler, epoxies, resins, accelerating agents, and ketones or acetone. Workers will be aware of fire hazards associated with mixing epoxies and resins with accelerating agents and ketones. Workers will be aware that ketone mixers are highly toxic and narcotic and could result in dizziness and nausea when inhaled. The supervisor will consult with the installation BEE to ensure worker exposure is monitored and appropriate respiratory protection requirements are established.

4.8.5. Storage and Handling of Sand, Grout, and Cement. Sand and aggregate materials are often delivered in fairly large quantities to bulk storage areas for shop use. Sand will be covered to prevent

its becoming wet during inclement weather. Also, grout and cement will be kept in a dry place to prevent hardening. Workers shall wear the proper respiratory protection (as required), eye protection, clothing, and shoes when handling cement and grout compounds.

4.8.6. Care and Use of Power Mixers and Trowels. Cement mixers are operated either with electric or gasoline motors or engines and are chain or belt driven. Gears, pulleys, chains, or belts on power mixers will be guarded to prevent workers from being caught in them. The power source for electrically operated mixers will be grounded. Power cords will not be allowed to fray or break, exposing bare wires. The area surrounding electrically operated mixers will be kept as dry as possible to prevent electrocution of the operator if there is an electrical malfunction. On those mixers operated by gasoline engines, workers will not smoke during refueling operations. Hot engines will not be refueled until they cool. All mixers, both electrically and gasoline operated, will be cleaned thoroughly after each use. Powered trowels or screens used to compact and smooth concrete will be cleaned after each use and inspected for damage and serviceability prior to each use.

4.8.7. Preparation of Footings. Precautions that will be taken by workers in preparation for pouring footings to prevent injury and property damage are:

4.8.7.1. Identify the location of underground utilities such as gas, electric, or water.

4.8.7.2. Study pre-excavation conditions such as soil conditions and hydrostatic pressure to evaluate changes that might occur or situations that might develop. Generally, masonry shop workers will not arrive at the job-site to pour footings until after all preparations have been made and they will be made aware of existing hazards.

Chapter 5

PROTECTIVE COATING MAINTENANCE

5.1. General Requirements . Interior spray, airless, and electrostatic painting facilities and requirements are addressed in AFOSH Standard 91-17, *Interior Spray Finishing*. Other sources of guidance for painting operations are AFM 85-3, *Paints and Protective Coating*, and NSC Data Sheets 468, *Electrostatic Paint Spraying and Detearing*, and 548, *Airless Spray Painting*. General safety requirements of chapter 2 address ladders, scaffolds, lifelines, housekeeping, and fire prevention that apply to painting maintenance operations.

5.1.1. Personal Protective Equipment (PPE). PPE worn during painting operations will consist of protective clothing (coveralls), eye or face protection, gloves or protective cream, and respiratory protection during certain spray painting or mixing operations. Eye or face protection is required during scraping or paint preparation. Additionally, ventilated lockers for clothing and shower facilities located separately from the shop shall be provided.

5.1.2. Flammable and Combustible Liquids:

5.1.2.1. Flammable and combustible liquids are categorized by their ease of ignition. Flammable liquids are more easily ignited than combustible ones. Some examples of flammables are gasoline, acetone, and lacquer thinner. Examples of combustibles are kerosene, fuel oil, Stoddard solvent, etc.

5.1.2.2. The connections on all drums and piped systems of flammable and combustible liquids will be vapor- and liquid-tight.

5.1.2.3. When flammable liquids are transferred from one container to another, (e.g., bulk container to a portable container), the containers will be effectively bonded and grounded. This practice prevents electrical discharge (e.g., sparks) from the accumulation of static charge because of the transfer process.

5.1.2.4. All spills of flammable or combustible liquids will be cleaned up promptly. With major spills remove ignition sources, evacuate, and ventilate the area, and provide appropriate protective equipment to the cleanup crew. These liquids will not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

5.1.2.5. Supplies of flammable and combustible liquids will be stored in approved fire-resistant safety containers equipped with flash screens and self-closing lids.

5.1.2.6. Combustible waste materials, such as oily shop rags, paint rags, etc., will be stored in covered metal containers and be disposed of daily. No storage of open containers of solvents is permitted. Open containers may only be used for cleaning of painting materials after which the solvent shall be transferred back to a closed container for retention or disposal.

5.1.2.7. Not more than 120 gallons of Class I, Class II, and Class IIIA liquids may be stored in a storage cabinet. Of this total, not more than 60 gallons may be Class I and II liquids. Not more than three such cabinets (120 gallons each) may be located in a single fire area except in an industrial area. Cabinets will be distinctly designated "**FLAMMABLE-KEEP FIRE AWAY**" and be able to withstand a 10-minute fire test, the internal temperature remaining at 325 degrees F or less. Metal cabinets will be constructed of at least Number 18-gauge sheet steel, and will be dou-

ble-walled with 1-1/2 inch of air space in-between. Doors will have three-point locks with the sill raised at least 2 inches above the cabinet floor. Wooden cabinets will be constructed of at least 2-inch plywood with rabbeted joints fastened two-directionally with flathead screws. AFOSH Standard 91-43 will be consulted for further guidance.

5.1.2.8. Adequate venting should be provided in all areas where flammable liquids are stored. Roof venting is very important in the event of a fire. The use of roof vents allows smoke and heat to escape. Thus, in the event of a fire, fire fighters can get nearer to the fire. A storage area for flammables will be prominently posted as a “**NO SMOKING**” area and openings to other rooms or buildings will be provided with noncombustible, liquid-tight, raised sills or ramps at least 4 inches in height. A permissible alternative to a sill or ramp is an open-grated trench that drains to a safe location. General exhaust ventilation will be installed according to AFOSH Standard 161-2 and meet design standards.

5.1.2.9. If flammable and combustible liquids are stored outside, the area should be graded so spills are diverted away from the building. The storage area should be kept free of combustible material not necessary for storage, such as weeds and other debris. Smoking will be prohibited in flammable storage areas.

5.2. Occupational Health and Toxic Materials:

5.2.1. Pigments, Extenders, and Fillers. The dry constituents of paints such as pigments, extenders, and fillers should be handled carefully in the receiving and storage areas as well as in product formulations to prevent overexposure of workers to airborne dusts. Spills should be promptly cleaned up before the material is spread throughout the area. If during the addition of the pigments or extenders employees could be overexposed to toxic dusts, controls will be instituted. If controls (ventilation, enclosure, automation, etc.) are not feasible or while they are being instituted, approved respirators will be provided. All inorganic pigment should be considered as potentially toxic. Not only do these hazards potentially exist in the application of new paints, but also in the removal of old paints.

5.2.1.1. Special care should be given to avoid overexposure of workers when pigments containing lead and metallic chromates (corrosion inhibitors), cadmium, copper, or cobalt are used.

5.2.1.2. Arsenic and mercury compounds used in anti-fouling marine paints should also be handled carefully. Employees may inhale these materials and, if good personal hygiene is not observed, employees may ingest significant amounts through contact of dirty hands with food or cigarettes.

5.2.1.3. Extenders or fillers such as silica, asbestos, talc, or mica, when breathed in excessive amount, will cause an increase in the amount of fibrous connective tissue (fibrosis) in the lungs. The symptoms associated with overexposure to silica may not be clinically apparent for 10 or more years depending on the exposure levels and duration.

5.2.1.4. Asbestos is a generic term that applies to a number of naturally occurring fibrous hydrated mineral silicates such as chrysotile, amosite, crocidolite, etc. Overexposure to these substances will lead to asbestosis, a fibrosis of the lung that may not become apparent for 10 to 20 years after initial exposure. Every establishment where asbestos may become airborne will be surveyed at least initially to determine whether exposure of employees to asbestos fibers is in compliance. No asbestos-containing material (sometimes used as a paint extender) shall be removed from bags, cartons, or other shipping containers without being either wetted, enclosed, or venti-

lated to effectively prevent the release of airborne asbestos fibers. Compliance may be achieved by the use of respirators or shift rotation only during the installation of engineering controls, emergencies, or when control methods are not technically feasible. Employees exposed to asbestos will be examined per requirements in OSHA 29 CFR 1910 and 1926

5.2.1.5. Fillers containing talc or mica, although not as hazardous as free silica or asbestos, can also lead to lung damage and employee exposure will be controlled.

5.2.1.6. A pigment such as titanium dioxide or a filler such as gypsum is considered to be a “nuisance” dust. Dust levels must nevertheless be controlled to ensure good visibility, a lack of eye irritation, and to prevent massive lung deposition.

5.2.2. Organic Solvents:

5.2.2.1. There is a wide application of organic solvents in painting. Solvents are used to suspend pigments, dissolve film-forming oil materials, and as thinners to dilute paints and reduce paint viscosity. All organic solvents have some effect on the central nervous system and the skin. The principal modes of exposure are inhalation of vapors and skin contact. Excessive solvent vapor inhalation may cause impairments that have no discernible permanent effects on health, such as lack of coordination and drowsiness, but which may increase the risk of accidents. In other cases, exposure may result in serious damage to the blood, lungs, liver, kidneys, and gastrointestinal tract. Supervisors should acquaint themselves and their employees with the properties and hazards of the solvent they use. Skin contact with solvents may cause dermatitis, ranging in severity from a simple irritation to actual damage to the skin. Even the most inert solvents can dissolve the natural protective barriers of fats and oils, leaving the skin unprotected. When these natural lubricants are removed, the skin becomes subject to disabling and possibly disfiguring dermatitis and opens the way to serious infection.

5.2.2.2. Measures to control exposures to solvents include the substitution of a less toxic solvent, mechanical exhaust ventilation, and the use of protective clothing. Substitution of a less toxic or less volatile solvent is effective in controlling solvent exposure and reducing the hazard potential. However, this control method is more easily instituted when the actual function of the solvent is less specific than it is in paint formulating, such as in metal cleaning or degreasing operations. Nevertheless, the principle of substitution should be followed, where possible, to reduce the hazard potential to the one who applies the product. The substitution of a less toxic solvent does not imply that a health hazard has been eliminated; it only means that a worker is less likely to suffer ill effects. The use of closed systems and local exhaust ventilation is an effective way of preventing solvent vapors from entering the breathing zone of the worker. Containers of flammable solvents will be covered when not in use. Local exhaust ventilation can remove vapors at their point of origin and thus prevent toxic concentrations in the workplace. If good personal hygiene is not observed, employees may ingest significant amounts of toxins through contact of dirty hands with food or cigarettes. The skin should always be protected from contact with solvents. Gloves, face shields, goggles, and other protective clothing may be used. Similarly, barrier creams may offer some degree of protection. The skin should never be washed with any raw organic solvent. Although some solvents are less toxic than others, good safety practices dictate that care be exercised in the use of any organic industrial solvents.

Chapter 6

PLUMBING MAINTENANCE

6.1. Hazards and Human Factors. Plumbing maintenance normally includes the installation, preventive maintenance, and repair of water supply systems, sewage and water disposal systems, natural, liquefied petroleum gas (LPG) or other gas supply systems (to include gas appliances), and oxygen supply systems. These systems and the maintenance of them contribute to the total well-being of the installation. Hazards that may be encountered during plumbing maintenance include, but are not limited to, entry into an oxygen-deficient atmosphere (confined space), fire or explosion by introducing an ignition or flame source into a hazardous environment, falls, cave-in of excavated area, burns from heat-producing equipment, strains and sprains of the back or other muscle group, cuts, and bruises. Working in confined spaces, handling heavy and awkward materials, being subjected to numerous obstructions in limited working space, and health related hazards are conducive to producing mishaps. Plumbing maintenance workers need to be knowledgeable of these potential hazards and conditions and take reasonable actions to prevent mishaps before they occur. AFOSH Standard 91-25 will be consulted for confined space entry procedures and requirements.

6.2. Personal Protective Equipment (PPE). PPE worn during plumbing maintenance operations normally consists of eye and (or) face protection, work or chemical-resistant gloves, and safety-toe boots. A bump cap or hard hat may be required under conditions that could result in head injuries (e.g., work in manholes and in close spaces with low overhead pipe or other obstructions). Knee pads may be worn during jobs requiring kneeling. Eye or face protection is required while working plumbing connections, with chemicals, or where an eye hazard could exist while using tools or machines, and while working on pressure systems. Protective clothing normally consists of coveralls. Ventilated clothing lockers, shower facilities separate from the shop, and clean towels shall be provided.

6.3. General Safety, Fire Prevention, and Occupational Health Requirements . Requirements that apply to plumbing maintenance are in [Chapter 2](#). Other sources of guidance may be found in AFI 32-1066, *Plumbing Systems*, AFM 91-6, *Maintenance and Operation of Gas Systems*, ANSI Standard B208.1, *Portable Pipe Threading Machines and Portable Power Drives*, and NSC Data Sheets 445, *Soldering and Brazing*, 470, *Blowtorches and Plumber's Furnaces*, 550, *Atmospheres in Sub-Surface Structures and Sewers*, 577, *Sewer Pipe Cleaning*, 613, *Application of Protective Coatings for Water Pipes, Valves and Fittings*, and 623, *Handling and Storage of Water Transmission Pipes and Fittings*.

6.4. Hot Operations:

6.4.1. Torches and Furnaces. Only essential fire prevention items pertaining to the operation of blowtorches and plumber's furnaces are included. Work and storage areas for this equipment will be well ventilated. For related guidance, refer to AFOSH Standards 91-5, *Welding, Cutting, and Brazing*, 91-38, *Hydrocarbon Fuels General*, and 91-43. Additional information may be found in NSC Data Sheet 470 and NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*.

6.4.1.1. No one will be permitted to use a torch or furnace until the user is trained on its use and is familiar with the operating instructions.

6.4.1.2. Where flammable or explosive vapors or dust may be present, torches and furnaces will not be used until the atmosphere has been vented and the sources of such vapors or dust removed.

6.4.1.3. Gasoline blowtorches and furnaces will not be used in small, unventilated spaces since they could cause explosions. Acetylene gas will never be brought in contact with metal powders such as copper or silver as the combination may produce flashes that can ignite explosive atmospheres.

6.4.1.4. Heating pots will be heated slowly to prevent overflow or ignition of material in them. Material will be broken into small pieces before being placed into heat pots.

6.4.1.5. Combustible materials in locations where torches or furnaces are to be used will be protected or kept far enough away to prevent their being subjected to sparks or dangerous temperatures. Appropriate type fire extinguishers will be available. Refer to AFOSH Standard 91-5 for complete requirements and required permit.

6.4.2. Soldering and Brazing. Soldering and brazing is the joining of metal parts by melting a fusible alloy. When solders used have a melting point above 800 degrees F, the procedure is called brazing.

6.4.2.1. Improper equipment and (or) unsafe practices may cause lead poisoning, irritation from fluxes, burns, electric shock, or fires.

6.4.2.2. The concentration of toxic fumes and irritants at the breathing level of the operation will be checked. Where required because of toxic fumes, a respirator or adequate ventilation will be provided. Lead-tin, zinc, silver, cadmium, and antimony-tin solders can pose moderate to serious health hazards. Soldering, particularly with lead-tin, in a confined space where ventilation is not adequate to remove toxic fumes may require the use of a self-contained breathing device. The installation BEE will be consulted for evaluation of potential health hazards and recommendations on respiratory protection during welding, soldering, and brazing operations.

6.4.2.3. Electric soldering irons will be grounded unless of double-insulation construction. All soldering irons will be placed in suitable non-combustible receptacles when not in use.

6.4.2.4. When required, "Open Flame" permits shall be obtained for these operations.

6.4.2.5. Appropriate safety eyewear will be worn during all soldering and brazing operations.

6.5. Industrial Waste Drains. Industrial waste drains carry (among other things) metals, organic solutions, and cyanides. Industrial waste manholes will be entered the same as other manholes, plus special consideration will be given to the specific material carried by the system. The installation BEE and ground safety staff will be contacted for guidance concerning PPE and specific hazards.

6.6. Open Storm Drains. Plumbing personnel are not likely to come in contact with the hazards associated with sewer systems while working on open storm drains. However, there are certain hazards associated with this type of drainage system. Some of these hazards and their associated mishaps are:

6.6.1. Manhole Covers. Manhole covers are heavy and closely fitted to the manhole opening. Never attempt to lift a cover without using proper pry bar tools, special lifting tools, and additional help where needed. Ensure fingers and toes do not remain under manhole covers when putting them down.

6.6.2. Hazards. Insects, animals, and snakes have been known to nest or den in storm drains. Hazards encountered are:

6.6.2.1. Stings from wasps, spiders, and ants that could lead to toxic shock.

6.6.2.2. Bites from animals that could lead to rabies.

6.6.2.3. Bites from poisonous snakes that could be fatal or cause gangrene.

6.6.3. Requirements. Prior to working in storm drains, inspect and clear the drains of dangerous insects, animals, or snakes. Wear proper protective clothing, hard hats, boots, and gloves while working in storm drains.

6.7. Gas Systems . Maintenance of gas systems includes natural gas, LPG, oxygen, nitrogen, or nitrous oxide. Shop personnel will be familiar with the properties of the gases in the systems they maintain. Until proven otherwise, all escaping gases will be considered flammable. Prior to entering an area where a gas leak is suspected, the area will be properly vented and purged of existing gas. Personnel entering the area will be suited with proper protective clothing and self-contained breathing devices. For oxygen-deficient atmospheres, air supply systems with a special emergency escape air supply are required and shall be used. Tools used to repair leaks in or perform maintenance on gas lines will be spark-free and protective clothing will be static-free. When working on oxygen dispensing lines, workers will not use tools and equipment that are coated with lubricating substances or grease. AFM 91-6 will be consulted for other criteria and procedures for leaking gas.

6.8. Tunnels, Pits, and Sumps:

6.8.1. Where shop personnel are required to work in utility tunnels and pits and sumps, the atmospheric conditions will be checked for explosive atmosphere or oxygen deficiency before allowing them to enter. Personnel will be suited with proper protective clothing and respiratory protective devices, when required, while performing maintenance to underground utilities. All tunnels, pits, or sumps known to be contaminated will be tagged or identified for the information of work crews. Workers will be assigned in pairs for work performed on underground utilities. All known contaminated tunnels, pits, and sumps will be ventilated while work is in progress. Smoking or open flames shall never be permitted in or around known or suspected contaminated tunnels, pits, or sumps.

6.8.2. When manhole covers are removed, barriers will be installed to prevent injury to personnel not associated with the hazard.

6.8.3. When a manhole or vault is open, at least one member of the crew will be stationed at the surface. This person will remain at the attendant's post and not leave for any reason (except self-preservation) unless replaced by an equally qualified individual. The attendant will order the entrants to exit the space if the attendant must leave and there is no replacement. **UNDER NO CIRCUMSTANCES WILL A PERSON ENTER A SUBSURFACE STRUCTURE FOR ANY REASON WITHOUT A SECOND PERSON TO ACT AS A GUARD AND TO OBTAIN ASSISTANCE IN THE EVENT OF A MISHAP.** In areas where removal of a victim would be difficult, an approved lifeline equipped with a wrist harness will be worn by the person entering the area to facilitate rapid removal in case of an emergency. (Refer to AFOSH Standard 91-25.)

6.9. Compressed Air . Plumbing workers should be trained and authorized to inspect, maintain, or install compressed air systems. Before opening a compressed air line, workers will ensure the line has been completely drained of existing air to prevent a sudden release of air that will cause the line to whip. The reverse is also true; when personnel have installed a new compressed air system, all parts of the sys-

tem will be secured together before air is put into the system. Workers will wear eye and face protective equipment while working on compressed air systems. Workers will not engage in horseplay or use compressed air above 30 psi to clean shop machinery. When workers use compressed air to clean shop machinery, they will wear eye protection.

Chapter 7

METAL FABRICATION AND WELDING MAINTENANCE

NOTE: This chapter contains many of the requirements of AFOSH Standard 91-5 for application in civil engineering maintenance; therefore, refer to AFOSH Standard 91-5 for further guidance and information. Refer to AFOSH Standard 91-31 for more information on PPE requirements.

7.1. Inert Gas Brazing and Welding . When inert gas brazing and welding are done in large chambers or furnaces, welders will be instructed on the dangers of inert gas asphyxiation. Supervisors will ensure chambers have been completely ventilated and cooled prior to entry. They will also ensure mechanical ventilation or approved air-supplied respiratory protection is provided.

7.2. Electron Beam Welding . Welders will refer to manufacturer's instructions and to applicable TOs. Centers, bases, or installations performing electron beam welding will develop OIs covering the specific equipment used.

7.3. Plasma Arc Cutting . Plasma arc-cutting operations are hazardous because of the high heat, brilliant light, and the toxic fumes given off. Molten metal splatter and potential noise problems also require consideration during equipment installation. Because of the potential hazards involved, locations and shops where plasma arc-cutting operations are accomplished will, as a minimum:

7.3.1. Be provided with the required shielding and have nonreflective surfaces (walls, floors, ceilings, etc.).

7.3.2. Have adequate ventilation or be equipped with approved respiratory protective devices. (Install equipment of this type in an isolated area to prevent exposing workers at other operations or visitors from being unduly exposed to the associated hazards.)

7.4. Air Carbon Arc Cutting . In addition to normal protective equipment required for welding and cutting, shielding will be provided so molten slag will not be blown onto personnel or combustibles.

7.5. Induction (Spot) Welding and Brazing . Because of potential burns, induction welders will replace filler materials within induction coils and will not attempt to adjust the placement while the welding or brazing equipment is activated. Induction coil insulation will be inspected before use to ensure serviceability. Damaged or deteriorated insulation will be replaced or repaired.

7.6. Magnesium-Thorium Welding, Cutting, and Grinding . Prior to welding, cutting, or grinding operations on magnesium-thorium and other potentially radioactive materials, proposed operations will be coordinated in advance with the Installation Radiation Protection Officer (AFI 40-201). All personnel will comply with the Air Force requirements for handling and processing of radioactive materials.

7.7. Welding and Cutting Tanks, Cylinders, or Containers . The procedures described below apply only to tanks too small to be entered. Compressed gas cylinders are excluded as are pipelines. Cutting and welding on containers that have held flammable liquids or gases will be under the direct supervision of knowledgeable personnel.

7.7.1. Inspection. **BEFORE** any tank, cylinder, or other container is cut, welded, or other hot work is performed, the item will be purged or made inert. **CAUTION:** New containers will also be made inert. They may contain a flammable preservative that could form explosive vapors when heated. Welders will also ensure there are no substances such as grease, tars, or acids which (when subjected to heat) might produce explosive or toxic vapors. Any pipe lines or connections to the drums, cylinders, tanks, or other containers shall be disconnected or blanked.

7.7.2. Purging and Inerting:

7.7.2.1. Purging With Steam. Steam may be introduced into the tank or container through a pipe inserted through an opening and bonded to the container, or by connecting a steam hose directly to one of the vessel nozzles. The rate of supply of steam should be sufficient to exceed the rate of condensation so the whole tank or container is heated close to the boiling point of water. The vessel must be steamed long enough to vaporize the residues from all portions of the walls (shell and heads). When testing the atmosphere in the vessel with a combustible gas indicator, the sample should be drawn through a drying tube filled with calcium chloride or other drying agent to ensure 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. (Refer to NFPA Standard 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*. Hazards inherent with steam operations require the use of PPE; supervisors must ensure PPE is serviceable and enforce its wear.

7.7.2.2. 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. When hot work is performed on containers filled with water, extreme care will be used to eliminate any vapor accumulation by proper venting or positioning of the container during the filling operation.

7.7.2.3. Purging With Air. Hazardous vapors may be displaced from inside containers by purging with air. A safe atmosphere will be maintained by continuous ventilation.

7.7.2.4. Inerting With Gas. Inert gas may be used to displace flammable gas from the container. Adequate ventilation will be maintained during the operation to ensure gas concentrations remain below hazardous levels. Examples of inert gases are carbon dioxide and nitrogen.

7.7.2.5. Venting. All hollow spaces, cavities, or containers shall be vented to permit the escape of air or gases before and during preheating, cutting, or welding.

7.8. Portable Gas Units . Portable gas welding, cutting, and brazing equipment will be a type approved for the use intended.

7.8.1. Cylinders of compressed gas will have pressure-reducing regulators installed.

7.8.2. Cylinders in use or being transported will be stored in an upright position and secured to prevent them from falling. Cylinders in storage will be stored by type gas, will be secured from falling, and will have the cap installed. Rope and (or) other readily combustible materials will not be used to secure compressed gas cylinders to keep them from falling. Only metal racks, braces, straps, or chains will be used.

7.8.3. Gaseous systems and containers will be color coded and inspected (refer to Military Standard [Mil Std] 101B, *Color Code for Pipeline and for Compressed Gas Cylinders*, and TO 42B5-1-2, *Use*,

Handling, and Maintenance Instruction, Storage Type Gas Cylinders). Acetylene is highly flammable and, when mixed with air, is highly explosive. Acetylene cylinders will be stored and used only in an upright position. If a cylinder is found stored horizontally, a minimum of 2 hours prior to use will pass after workers put the cylinder in an upright position. This requirement is to allow any possible buildup of acetone in the valve assembly to drain back into the cylinder before use.

7.8.4. Pressure hoses will be secured to prevent whipping.

7.8.5. Oxygen cylinders and fittings will be kept free of grease and oil at all times.

7.8.6. Cylinders will be kept away from external sources of heat at all times.

7.8.7. Cylinders will not be dropped or handled roughly. Cylinders or welding sets in excess of 60 pounds total weight will be transported to and from work sites by push cart or motorized vehicle. When cylinders or welding sets are moved by crane or derrick, suitable cradles, boats, or platforms will be used. Slings or electric magnets will not be used to move cylinders or compressed gases or welding sets.

7.8.8. Flashback protection will be provided by an approved device that will prevent the flare from passing into the fuel gas supply system.

7.9. Portable Electric Units:

7.9.1. Circuits will be de-energized before they are tested, repaired, or transported.

7.9.2. Motor-generator sets and other electrical welding equipment will be grounded prior to use.

7.9.3. Rotary and polarity switches will not be operated while the equipment is under an electrical load.

7.9.4. Arc-welding equipment will be inspected periodically (at least annually) and inspected prior to use following relocation. Power cables and electrode holders will be inspected prior to every use.

7.9.5. These units will be repaired by qualified electricians only.

7.10. Arc Welding:

7.10.1. Arc-welding equipment shall conform to the design and installation criteria of OSHA 29 CFR 1910.252, *Welding, Cutting, and Brazing*. The frame or case of the welding machine (except engine-driven machines) shall be grounded under the conditions and according to the methods prescribed in OSHA Standard 1910, Subpart S, *Electrical*, and 1910.252.

7.10.2. Before starting operations, all connections to the arc-welding machine will be checked. The work lead shall be firmly attached to the work. Contact surfaces of the magnetic work clamps will be free of metal splatter particles. Coiled welding cable will be spread out before use to avoid serious overheating and damage to insulation. Work and electrode lead cables will be inspected for damage and wear before use. Cables with damaged insulation or exposed conductors will be replaced. Electrode cables will be joined and insulated according to approved methods.

7.10.3. Grounding of the welding machine frame will be checked. Special attention will be given to the ground connections of portable machines.

7.10.4. Electrode holders, when not in use, shall be placed where they cannot make electrical contact with persons, conducting objects, fuel, or compressed gas cylinders.

7.10.5. When it is necessary to splice cables to extend their length, only certified electricians will make the splices. Cables with splices within 10 feet of the electrode holder will not be used. The welder will not coil or loop welding electrode cables around their body parts.

7.10.6. Welders will not place welding cable and other equipment where it will obstruct passageways, ladders, or stairways.

7.10.7. Machines that have become wet will be thoroughly dried and tested before being used.

7.10.8. When welders are working close to each other on one structure where they may touch the exposed parts of more than one electrode holder simultaneously, the machines will be connected to minimize shock hazard as follows:

7.10.8.1. All direct current (DC) machines will be connected with the same polarity.

7.10.8.2. All alternating current (AC) machines will be connected to the same phase of the supply circuit and with the same instantaneous polarity.

7.11. Resistance Welding:

7.11.1. Thermal Protection. Every pair of ignition tubes used in resistance welding equipment shall be equipped with a thermal protection switch. When used in a series-connected water line, a single switch will be adequate if related to the downstream tube.

7.11.2. Control Safeguards. Controls, such as push buttons, foot switches, retraction, and dual-schedule switches on portable guns, etc., shall be arranged or guarded to prevent inadvertent activation.

7.11.3. Guarding Welding Machines. Multi-gun welding machines will be effectively guarded at the point of operation. Devices such as an electronic eye, latches, blocks, barriers, or two-hand controls will be installed. All chains, gears, operating bus linkage, and belts will be protected by adequate guards.

7.11.4. Electrical Hazards. All external weld-initiating control circuits shall operate on low voltage, not over 120 volts for stationary equipment and not over 36 volts for portable equipment. All electrical equipment will be suitably interlocked and insulated to prevent access by unauthorized persons to live portions of the equipment. Only nonferrous welding clamps should be used to prevent magnetic induction during actuation of the equipment.

7.12. Welding in Confined Spaces. The guidance below has been extracted from OSHA 29 CFR 1910.252.

7.12.1. Confined space means a relatively small or restricted space such as a tank, boiler, pressure vessel, mixing vat, aircraft fuselage, sump, or pit. Ventilation is a prerequisite to work in confined spaces. All welding and cutting operations carried on in confined spaces shall be adequately ventilated to prevent the accumulation of toxic materials, possible oxygen deficiency, or explosive atmosphere. This applies not only to the welder but also to helpers and other personnel in the immediate vicinity. All air replacing that which is withdrawn shall be clear and respirable. Oxygen shall never be used as makeup air.

7.12.2. In circumstances where it is impossible to provide such ventilation, respirators or hose masks approved for this purpose by the US Bureau of Mines or by NIOSH shall be used. In areas immediately hazardous to life, hose masks with blowers or self-contained breathing apparatus shall be used.

7.12.3. Where welding operations are carried on in a confined space and where welders and helpers are provided with hose masks, hose masks with blowers, or self-contained breathing apparatus, a worker shall be stationed on the outside of the confined space to ensure the safety of those working within. (Refer to AFOSH Standard 91-25.)

7.12.4. When welding or cutting is being performed in any confined space, the gas cylinders and welding machines shall be left on the outside. Before operations are started, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

7.12.5. Where a welder must enter a confined space through a manhole or other small opening, a means shall be provided for quick removal of the worker in case of emergency. When safety harnesses and lifelines are used for this purpose, they shall be attached to the welder's body in a way that ensures their body cannot be jammed in a small exit opening. A wrist harness assembly shall be used. An attendant with a preplanned rescue procedure shall be stationed outside to observe the welder at all times and shall be capable of putting rescue operations into effect.

7.12.6. When arc welding is to be stopped for any substantial period of time, such as during lunch hour or overnight, all electrodes shall be removed from the holders and the holders carefully located so accidental contact cannot occur. The machine will be disconnected from the power source.

7.12.7. When gas welding or cutting, the torch valves shall be closed and the fuel-gas and oxygen supply to the torch positively shut off at some point *outside the confined area* whenever the torch is not to be used for a substantial period of time, such as during lunch hour or overnight. Where practicable, the torch and hose shall also be removed from the confined space.

7.12.8. All confined space will be monitored for oxygen content, combustible vapors, and toxic material prior to entry and periodically throughout the operation. Periodic testing will depend on the type of space being entered. The BEE will be consulted for guidance.

7.13. Hazards Associated with Fluxes, Coverings, Filler Metals, and Base Metals. The guidance below has been extracted from OSHA 29 CFR 1910.252.

7.13.1. Fluorine Compounds:

7.13.1.1. General. In confined spaces, welding or cutting involving fluxes, coverings, or other materials that contain fluorine compounds shall be done according to paragraph 7.12. A fluorine compound is one that contains fluorine as an element in chemical combination, not as a free gas.

7.13.1.2. Maximum Allowable Concentration. The need for local exhaust ventilation or airline respirators for welding or cutting in other than confined spaces will depend upon the individual circumstances. However, experience has shown such protection to be desirable for fixed-location production welding and for all production welding on stainless steels. Where air samples taken at the welding location indicate that the fluorides liberated are below the maximum allowable concentration, such protection is not necessary.

7.13.2. Zinc:

7.13.2.1. Confined Spaces. In confined spaces, welding or cutting involving zinc-bearing base or filler metals or metals coated with zinc-bearing materials shall be done according to paragraph [7.12](#).

7.13.2.2. Indoors. Indoors, welding or cutting involving zinc-bearing base or filler metals coated with zinc-bearing materials shall be done using local exhaust ventilation.

7.13.3. Lead:

7.13.3.1. Confined Spaces. In confined spaces, welding involving lead-base metals (erroneously called lead-burning) shall be done according to paragraph 7.2.

7.13.3.2. Indoors. Indoors, welding involving lead-base metals shall be done using local exhaust ventilation.

7.13.3.3. Local Ventilation. In confined spaces or indoors, welding or cutting involving metals containing lead (other than as an impurity) or involving metals coated with lead-bearing materials, including paint, shall be done using local exhaust ventilation or airline respirators. Outdoors such operations shall be done using respiratory protective equipment approved by the US Bureau of Mines for such purposes. In all cases, workers in the immediate vicinity of the cutting operation shall be protected as necessary by local exhaust ventilation or airline respirators.

7.13.4. Beryllium. Welding or cutting indoors, outdoors, or in confined spaces involving beryllium-containing base or filler metals shall be done using local exhaust ventilation and airline respirators, unless atmospheric tests under the most adverse conditions have established that workers' exposure is within the acceptable concentrations. In all cases, workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local exhaust ventilation or airline respirators.

7.13.5. Cadmium:

7.13.5.1. General. Welding or cutting indoors or in confined spaces involving cadmium-bearing or cadmium-coated base metals shall be done using local exhaust ventilation or airline respirators, unless atmospheric tests under the most adverse conditions have established that workers' exposure is within the acceptable concentrations. Outdoors, such operations shall be done using respiratory protective equipment such as fume respirators approved by the US Bureau of Mines for such purposes.

7.13.5.2. Confined Space. Welding (brazing) involving cadmium-bearing filler metals shall be done as prescribed in paragraph 7.12. if the work is to be done in a confined space.

7.13.6. Mercury. Welding or cutting indoors or in a confined space involving metals coated with mercury-bearing materials (including paint) shall be done using local exhaust ventilation or airline respirators, unless atmospheric tests under the most adverse conditions have established that workers' exposure is within the acceptable concentrations. Outdoors, such operations shall be done using respiratory protective equipment approved by the US Bureau of Mines for such purposes.

7.13.7. Additional Guidance. Further guidance may be found in chapter 2 of this standard, AFR 67-12, *Storage and Handling of Compressed Gases Liquids in Cylinders, and of Cylinders*, AFOSH Standards 91-5, 91-31, 48-1, and 161-2, TO 00-25-224, *Welding High-Pressure Gas and Cryogenic Systems*, TO 00-25-235, *Safety Procedures and Equipment for Confined Space Entry-Including Missile Propellant Tanks*, and ANSI Z49.1, *Safety in Welding and Cutting*.

7.14. Sheet Metal:

- 7.14.1. Machines will be guarded using the requirements of AFOSH Standard 91-12 and manufacturer's requirements.
- 7.14.2. Supervisors will ensure sharp metal is stored in an area that will not pose a hazard to machine operators or personnel walking through designated aisles.
- 7.14.3. Work gloves will always be worn when working with metal and metal scraps.
- 7.14.4. Hearing protection shall be worn when working in designated hazardous noise areas with noise sources operating or when using hand tools labeled hazardous noise producers.

Chapter 8

REFRIGERATION AND AIR CONDITIONING MAINTENANCE

8.1. Hazards and Human Factors . Refrigeration and air conditioning maintenance personnel, as with many other civil engineering functions, perform duties in many different locations and environments. Not only must these workers be aware of the hazards of the tasks they are performing, but also tasks being performed around them. Potential hazards include hazardous noise, electrical hazards, exposure to refrigerants (possible asphyxiation if in confined spaces and frostbite), lifting hazards, and compressed gases and cylinders. Potential physical and health hazards can be effectively controlled by following the guidance in this chapter, by proper work procedures and controls, and by using required PPE.

8.2. General Requirements:

8.2.1. Equipment rooms where air conditioning equipment is installed will be kept free and clear of all trash and clutter that could present tripping or fire hazards. Refrigerant piping will be properly insulated, both to improve operating efficiency and to prevent injury to workers who may accidentally come in contact with it. Equipment rooms are not normally designed for, nor intended for, storage of materials by the unit occupying the building.

8.2.2. All belts, pulleys, and rotating shafts will be guarded to prevent accidental contact. Large valve handle stems which can present a bump or trip hazard will be marked (color coded) for easy recognition.

8.2.3. Electrical parts of the equipment and controls will have all covers and plates in place. Wiring will be properly secured to the equipment or structure.

8.3. Storage and Handling . Storage and handling of cylinders of compressed gas refrigerants can be a source of injury to workers. See [Chapter 2](#) for general hazards and guidance on performing safely.

8.3.1. Workers will ensure containers are legibly marked with the type of gas contained and stored with minimum intermingling of types of refrigerant. Cylinders will be stored separately from flammable gases and oxygen.

8.3.2. Where caps have been provided for valve protection, they will be kept in place at all times until the cylinder is actually in use. Valves will be kept closed at all times except when the cylinder is in use.

8.3.3. Cylinders will not be used as rollers or supports. Their only use is to contain the gas.

8.3.4. Non-refillable containers, such as Department of Transportation (DOT) 2P, DOT 2Q, and DOT-39 containers, shall not be refilled with any material after use of the original contents. They shall be disposed of according to the container manufacturer's or filler's instructions.

8.3.5. Cylinders will not be dragged, slid, dropped, or allowed to strike each other or solid objects violently. Whenever possible, a suitable hand truck or roll platform will be used.

8.3.6. Containers will never be lifted by the valve. Cylinders will not be suspended by chains, ropes, or slings unless the manufacturer has provided appropriate attachment points.

8.3.7. Storage areas will be legibly marked with the names of the gases being stored. Full cylinders and empty cylinders will be segregated and the full ones arranged so the oldest stock can be removed

first with a minimum of handling. The storage area will be kept as dry as possible and away from exposure to salt or other corrosive chemicals or materials. Cylinders will be secured by a metal securing device or rack specifically designed to prevent damage.

8.3.8. The rules above apply to all refrigeration and air conditioning maintenance work centers that use and store compressed gases.

8.4. Fluorocarbons . The fluorocarbons are relatively inert, in general are nonflammable (in all concentrations in air under ordinary conditions), and are low in toxicity. Shipped as liquefied compressed gases under their own vapor pressures, they are colorless as liquids and freeze to white solids. The fluorocarbons are odorless in concentrations of less than 20 percent by volume in air but some have a faint and ethereal odor in higher concentrations. The fluorocarbons are unusually stable for organic compounds. Resistance toward thermal decomposition, in general, is high but varies with each product. When decomposition does occur, toxic products are very irritating and usually give adequate warning of their presence in very low concentrations in air. Hot work should never be performed on charged systems.

8.4.1. Large Liquid Leaks. Large liquid leaks in fluorocarbon systems may be detected visually. As the material escapes, moisture in the air surrounding the leak condenses and then freezes around the leak due to the refrigerating effect of the vaporizing fluorocarbons. The frost thus formed is readily apparent. Smaller leaks may be located with the use of:

8.4.1.1. A solution of liquid detergent in water applied directly to the area being tested. The formation of bubbles indicates a leak.

8.4.1.2. A hose through which air is sucked to the flame on a halide torch. The flame will change color when it comes in contact with a leak.

8.4.1.3. Electronic leak detectors, capable of sensitivities far greater than the other methods — often in terms of fractions of an ounce of fluorocarbon per year. When the probe of the instrument is placed near a leak, positive identification of the leak is indicated by a flashing light, meter deflection, or by audible means. **NOTE:** The vapors of these fluorocarbons are all much heavier than air and in the absence of good ventilation will tend to collect in low areas, thus possibly displacing available air. The vapors will undergo decomposition when drawn through a flame or if in contact with very hot surfaces. The products of decomposition include hydrogen fluoride and hydrogen chloride and, perhaps, small quantities of carbonyl compounds such as phosgene. The halogen acids are both toxic and intensely irritating to the nose and throat. The irritating action of these decomposition products is readily noticeable before hazardous levels are reached. If such a situation develops, the affected areas should be vacated, the heat source and leak eliminated, and the area well ventilated before resuming work.

8.4.2. First Aid:

8.4.2.1. Due to their low boiling points, the fluorocarbons evaporate very quickly at ambient temperature, minimizing dermal, eye, and ingestion toxicity. Liquid fluorocarbons in contact with the skin can cause severe freezing or frostbite because of their low temperatures. The worker should warm affected body parts gradually using body heat or warm (tepid) water and seek medical aid. Should liquid splash into the eyes, the worker will wash them thoroughly with water for at least 15 minutes and seek medical aid.

8.4.2.2. The critical mode of entry of fluorocarbons into the body is by inhalation. These products generally show inhalation effects similar to anesthetics, causing central nervous system

(CNS) depression and a decrease in activity, with an initial feeling of intoxication and euphoria (psychological effects). Under conditions of progressively greater exposure, there occurs loss of coordination, loss of consciousness, and eventually death. No adverse effects have been observed during or after long exposures at the Permissible Exposure Limit (PEL). Accidental exposures to concentrations higher than the PEL should be treated by prompt removal to fresh air. Severe exposures requiring medical attention should not be treated with stimulants or adrenaline since high concentrations of these fluorocarbons may result in a sensitization of the heart to adrenaline (a relatively common effect of many volatile organic compounds).

Chapter 9

HEATING SYSTEMS AND CENTRAL HEATING PLANT MAINTENANCE

NOTE: Many locations (boilers, steam pipes, etc.) associated with heating systems and central heating plants have an above average mishap potential where material containing asbestos may be present. For further guidance, consult **Chapter 2** of this standard, AFI 32-1068, Heating Systems Unfired Pressure Vessels, AFI 32-1067, Water Systems, and OSHA 29 CFR 1910.104, Oxygen.

9.1. Boiler Operations:

9.1.1. Written operating procedures and detailed checklists for operator guidance will be posted in all equipment rooms. It is important all functions be included, whether manual or automatic. The basic objectives of safe boiler operations are:

9.1.1.1. Require the minimum number of manual operations.

9.1.1.2. Standardize routine operating procedures for normal start-up and on-line operation. Ensure the use of interlocks to minimize improper operating sequences and to stop sequences when conditions are not proper for continuation. Establish and rigidly enforce purge procedures with necessary interlocks.

9.1.2. Open register light-off and purge rate procedures are the only approved start-up methods. The objective of this procedure is to improve the margin of operational safety, particularly during start-up, by decreasing the number of required equipment manipulations, thereby minimizing the probability of operational errors or equipment malfunction. It provides a means for establishing the desired fuel-rich condition at individual burners during light-off:

9.1.2.1. All or most of the burner air registers are placed in a predetermined open position.

9.1.2.2. The furnace and boiler settings are purged with the burner air registers in the open position. The total air flow for purge will not be less than 25 percent of full load volumetric air flow.

9.2. Boiler Safety:

9.2.1. Water Level. Water in boilers will be checked and kept at proper levels. Water columns will be monitored to ensure connections are clear and water returns to the proper level in the gauge glass when drain valves are closed. When water is not visible in the gauge glass, all stresses on the boiler will be gradually reduced and the following actions shall be taken:

9.2.1.1. In boilers fired by fuels burned in suspension (fuel oil, gas, or pulverized coal), stop the fire immediately, shut off all air flow, close steam outlet valve, and shut off feed water supply. Proceed as in a normal shutdown. Inspect the boiler thoroughly, including a hydrostatic test, before returning it to service.

9.2.1.2. In boilers fired by stoker or hand-fired coal, stop the supply of fuel and air to the boiler and smother the fire with noncombustible materials, taking care to avoid an explosion. Do not use water. Close steam outlet valve, but add feed water to the boiler and maintain a normal water level. Shut off feed water supply as soon as brick work has cooled sufficiently to prevent damage to the boiler by overheating. Proceed as in a normal shutdown, inspect boiler thoroughly, and ensure it is hydrostatically tested before returning it to service.

9.2.2. Lighting Gas- and Oil-Fired Furnaces. Before lighting gas- and oil-fired furnaces, boilers and breaching will be ventilated to remove explosive vapors. Burners will not be lit if there is oil on the floors or combustion chamber, around the burners, or in front of the boilers. If the flame of a gas or oil-fired burner goes out, the fuel will be immediately cut off and the furnace passages ventilated before the furnace is re-lit.

9.3. Cleaning and Maintenance Procedures:

9.3.1. Whenever a boiler is taken out of service for a prolonged period, it should be cleaned promptly and inspected for defects by the plant engineer. Authorized boiler inspectors can also examine the boiler at this time.

9.3.2. Regular prompt cleaning is important. Soot gathers moisture rapidly and thus contributes to deterioration of the metal surfaces. Soot and fly ash should be removed as soon as the boiler has cooled. Ashes may remain hot for days, presenting a hazard to anyone entering the combustion chamber. They should be wetted down with a hose before entry. The operator will wet down from the outside toward the center and stay clear of any steam and dust that arises. A jet of water will not be directed into the center of a hot ash pile as it can literally explode. When removing ashes, the area around the ash gates will be kept clear to prevent injury to personnel from steam or hot water when ash gates are opened.

9.3.3. For boilers in continuous service, planned and scheduled boiler shutdown for preventive maintenance is far safer than risking an extensive shutdown caused by boiler failure. At least once a year the boiler, the flame safeguard supervisory system, and other safety controls will be inspected during a scheduled shutdown by an authorized inspector who is accompanied by the plant supervisor. Defective parts shall be repaired or replaced. For inspection, boilers will be cool, handholes and manholes open, and the boiler shall have been ventilated. Adequate lighting and protective equipment for work in the boiler should be provided. Specific boiler inspection requirements may be found in AFI 32-1068.

9.3.4. Proper and convenient drain connections shall be provided for draining boilers. Unobstructed floor drains, properly located in the boiler room, facilitate proper cleaning. Infrequently used drains should have water poured into the traps, as required based on local conditions, to prevent the entrance of sewer gases and odors into the boiler room. If there is a possibility of freezing, an antifreeze mixture should be used in the drain traps.

9.3.5. When cleaning a boiler, employees will wear protective clothing, hats, goggles, heavy leather-palm gloves, safety shoes, and approved respirators if conditions warrant (high dust, particulates, dirt, etc.).

9.4. Steam Piping and Valve Maintenance:

9.4.1. All 4-inch and larger steam valves or main steam valves to any building will be operated only by qualified heat systems personnel.

9.4.2. High-pressure steam valves located in confined areas will not be turned off until the valve controlling the steam is turned off at the main steam plant. After the valve in the confined area has been closed, the valve in the steam plant may be reopened to distribute steam to other areas.

9.4.3. When a valve in any confined area is to be opened, the operator will close the main valve at the steam plant before opening the steam valve in the confined area. The operator will ensure all pressure

has been bled off prior to opening the steam valve. The operator will open the steam valve and move away from the confined area before the main valve at the steam plant may be reopened.

9.4.4. Routine operations, maintenance, and repair in steam pits and other confined areas may be accomplished on electric circuits, controls, motors, pumps, receivers, condensate lines, and vent fans while steam pressure is in the steam line, providing conditions and temperatures are acceptable. However, no operational changes, repair, or maintenance will be accomplished on steam lines while there is steam pressure on the lines.

9.4.5. Operating personnel will open drain valves and remove water from the steam line prior to opening a high-pressure steam valve. They will familiarize themselves with the location of these drain valves to ensure the water accumulations are drained from the distribution lines.

9.4.6. When bypass lines and valves are installed around a high-pressure steam valve, the bypass valve will be opened first. When the steam line becomes heated or the steam pressure equalized on both sides of main steam valve, the main steam valve may then be opened.

9.4.7. All high-pressure steam valves will be opened very slowly, and everyone will remain at a safe distance while valve positions are being changed.

9.4.8. When dismantling a valve (removing bonnet, etc.) for maintenance, the worker will ensure pressure has been relieved through all possible means. The valve body will be checked for a removable plug to relieve pressure. Bolts will be carefully removed. Personnel will never position their body over the valve or in line with the direction of travel, in case the bonnet blows.

9.5. Vaults, Manholes, and Tanks:

9.5.1. All enclosed areas will be considered hazardous until tested. They will be tested with oxygen deficiency and combustible gas indicators prior to entry.

9.5.2. Atmospheres containing 19.5 percent or less of oxygen by volume should not be entered without the use of an air-supplied respirator.

9.5.3. Only manhole cover hooks or other methods approved for this purpose will be used when removing or replacing manhole covers. When replaced, the covers shall be properly seated. The bearing surfaces will be free from dirt or ice that might prevent proper seating of the cover.

9.5.4. Personnel will enter and leave manholes or vaults only by means of a ladder; they will not step on cables, cable hangers, or pipes.

9.5.5. Personnel will not throw tools or materials into or out of manholes or vaults. They will use canvas buckets, handlines, or other approved methods for lowering and removing tools and equipment.

9.5.6. Working on energized equipment is especially hazardous in subsurface structures and will be performed by an electrician.

9.5.7. When a manhole or vault is open, at least one member of the crew will be stationed at the surface to act as a safety observer and take appropriate actions in case of emergency.

9.5.8. Cool vests or other heat-reducing equipment should be made available to workers who enter vaults or manholes under high heat conditions (e.g., steam leak repair).

9.6. Central Heating Plants:

9.6.1. Boiler Safety:

9.6.1.1. As a minimum, each boiler will be equipped with steam and water gauges, gauge cocks, safety and blowoff valves, and low-water cutoff devices. Safety valves shall be tested for proper operation by the inspector by means of the try lever during boiler inspections. Safety valve inspections shall be as outlined in the National Board Inspection Code published by the National Board of Boiler and Pressure Vessel Inspectors. Boiler feedlines will be equipped with check and cutoff valves placed as close as possible to each boiler. Water gauge glasses, less than 15 feet from the floor or water tender's platform, will be carefully guarded to prevent accidents resulting from breakage or blowouts. High-pressure gauge glasses will be drawn down on each shift. Low-pressure gauge glasses will be checked at least weekly. Pressure gauges will be inspected and tested every 12 months by heating plant personnel. Required testing equipment shall be included in the Table of Allowance (TA) for these facilities. (See AFI 32-1068 for boiler inspections.)

9.6.1.2. No boiler will be operated unless equipped with a safety valve, calibrated to the boiler manufacturer's recommendations unless normal boiler operating pressures are changed. In the latter case, the maximum operating pressure then becomes the controlling factor on safety valve selection. No other valves shall be placed between the safety valve and the boiler or between the safety valve and the end of its discharge pipe. Safety valves will be manually tested on steam or hot water systems at least monthly for proper operation. AFI 32-1068 and manufacturer's boiler operations manuals will be consulted for detailed information on safety valve capacities, settings, disks, and springs. If it is not practical to test safety valves every month for high temperature hot water (HTHW) boilers, the valves should be removed from the boiler, tested, and reset (if required) at a properly equipped safety relief valve testing facility by the valve manufacturer or by a certified ASME shop. Valves should be tested and reset at least once a year for HTHW boilers.

9.6.1.3. When applicable, spark arresters will be installed on boiler stacks to prevent flying sparks.

9.6.1.4. All safety and blowoff valve discharge pipes will be located where the discharge will not create a hazard. Discharge lines from hot water heater relief valves will be arranged with the outlet within 6 inches of the floor. Such an outlet will not be threaded, capped, or plugged. It should be cut off diagonally and not extend outdoors where it may freeze. Discharge lines and outlets will be capable of free flow at all times.

9.6.1.5. No boiler will be operated at pressures higher than determined safe by the most recent boiler inspection. Boilers will not be operated at greater pressures than those specified on the manufacturer's stamped instructions. The lowest of these two pressures will govern boiler operation. The instructions stamped by manufacturers on boilers will not be covered or obliterated.

9.6.1.6. If safety valves do not pop when pressures rise above valve settings, or the valves cannot be opened by hand when tested, the boiler will be taken out of service until the valves have been repaired or replaced.

9.6.1.7. When fires are banked, boiler tenders will make certain that draft is sufficient to prevent accumulations of flammable gases.

9.6.1.8. When a boiler is returned to full operation, all external drains between the boiler and main header will be left open until the boiler is on the line. The stop valve will be kept closed until boiler pressure is equal to that in the steam main. The stop valve will then be gradually opened; if no jars or disturbances occur in the line, the valve may be opened completely. If jarring or rumbling occurs during cutting-in, the stop valve will be closed immediately.

9.6.1.9. Steam will be introduced into cold pipes very slowly until they have warmed enough to preclude damage.

9.6.1.10. Boiler tenders will stand to one side when opening fire doors to protect themselves against flarebacks.

9.6.1.11. Because of the danger of flarebacks, boiler tenders will not throw coal dust sweepings on boiler floors.

9.6.1.12. When not in use, all boiler room tools will be stored in suitable racks. Tool racks will be constructed and located so personnel cannot accidentally touch hot surfaces or knock tools from racks while passing by.

9.6.1.13. Adjustments will not be made to valves or valves removed to increase discharge pressure.

9.6.1.14. Hoistways, driving machinery, conveyors, worm gears, ash sluices, and reciprocating pumps shall be properly guarded. (OSHA 3067, *Concepts and Techniques of Machine Safeguarding*.)

9.6.1.15. Ashes will not be stored against boilers or combustible materials. Ashes contain sulfur compounds which, on contact with water, form highly corrosive acids.

9.6.2. Manning. Only fully automatic plants of less than 7,000,000 BTU per hour will be left unattended. All other boiler furnaces, regardless of the types of fuels or firing methods, operating at 7,000,000 BTU per hour or more will be operated per instructions in AFI 32-1068.

9.6.3. Boiler Water Treatment Tank. Some of the chemicals used to treat boiler water are hazardous and will be handled properly. The following safety precautions shall be observed:

9.6.3.1. Acids. Tests for chemical residuals involve small quantities of acid. The risk is small if spillage is avoided and bottles containing acid are not broken. Greater risks are involved in the handling of sulfuric acid in the hydrogen-zeolite, demineralizing, and direct-acid treatment processes. Observe the following precautions when handling sulfuric acid:

9.6.3.1.1. Do not permit diluted or strong sulfuric acid to come in contact with the eyes, skin, or clothing.

9.6.3.1.2. Always wear full face shields, chemical safety goggles, neoprene gloves, and a neoprene apron.

9.6.3.1.3. Never add water or caustic solutions to concentrated acid since a violent reaction will result.

9.6.3.1.4. Ensure work leader supervises all cleaning and repairing of tanks. Observe instructions about entering and cleaning tanks, including the exact steps to be taken. Ensure emergency equipment is immediately available before workers are allowed to enter tanks to make repairs.

9.6.3.1.5. Wash down spills with plenty of water. Never use combustibles such as cloths, sawdust, or other organic materials to mop up spilled sulfuric acid. Neutralize spills with soda ash before washing down.

9.6.3.1.6. In the event of accidental contact, remove all contaminated clothing immediately and wash affected areas with water for at least 15 minutes. Have medical personnel examine affected areas to determine if further treatment is necessary.

9.6.3.2. Caustic Soda. Never add water to caustic soda (the proper method is to add caustic soda to water) because sufficient heat may be generated to cause the solution to boil and spatter. Personnel may be injured if they come in contact with the spattering, since caustic soda (in either liquid or solid form) has a marked corrosive action on body tissue. Injury to the upper respiratory tract and lung tissue can result if the dust or concentrated mist from caustic soda is inhaled.

9.6.3.2.1. Never store food or eat near caustic soda or in the work area where it is handled.

9.6.3.2.2. Do not depend upon creams or ointments for protection from caustic soda.

9.6.3.2.3. Ensure all workers exposed to caustic soda wear full face shield, close-fitting chemical safety glasses, neoprene gloves, apron, and coveralls that fit snugly at neck and wrist.

9.6.3.3. Application of Chemicals:

9.6.3.3.1. Always drain the feeder before introducing chemicals into it. Before opening the drain valve, close all pressure connections to the feeder to prevent injury to the operator from hot water or chemicals.

9.6.3.3.2. Never place dry chemicals in a chemical feeder or pump. This practice plugs the chemical feed lines in a short time.

9.6.3.3.3. Wherever possible, mix chemicals at floor level to minimize the possibility of injury to eyes and face.

9.6.3.3.4. Check specifications, temperature, pressure, and materials of construction of piping, valves, and pumps, to determine whether they can be used safely with the chemicals.

9.6.3.4. Safety Equipment:

9.6.3.4.1. Have available for eye irrigation an eyewash fountain either permanent or portable (portable must be capable of providing a steady stream of water for at least 15 minutes). If even a minute quantity of sulfuric acid or caustic soda enters the eyes, irrigate immediately and copiously with water for at least 15 minutes. See AFOSH Standard 91-32.

9.6.3.4.2. Have a well-marked, rapid-action safety shower available in the area where sulfuric acid, caustic soda, or other chemicals are being handled and may come in contact with the body. See AFOSH Standard 91-32.

9.6.3.4.3. Inspect all safety equipment regularly to ensure it is in working condition at all times. Post operating instructions at the emergency eyewash fountain and the safety shower. Periodically instruct personnel in the use of these facilities.

9.6.3.5. Chemical Storage and Handling:

9.6.3.5.1. Store all large quantities of chemicals used for boiler or condensate water treatment in locations where accidental spills will be contained and where drainage will not be hazardous to personnel or the environment.

9.6.3.5.2. Conspicuously post warning and handling instructions where use of toxic chemicals is necessary.

9.6.3.5.3. Because chemical storage equipment is subject to corrosion, deterioration, or mechanical hazards, periodically inspect this equipment. (Frequency is determined by supervision, based on local conditions.)

9.6.3.5.4. Train personnel who handle chemicals in safe chemical handling practices.

9.6.3.5.5. Practice neutralization and containment techniques and disposal instructions.

9.6.3.6. Chemical Laboratories:

9.6.3.6.1. Ensure chemical testing laboratories associated with water treatment have operable mechanical ventilation, when required.

9.6.3.6.2. Maintain chemical test kits and test instructions in a current and usable state.

9.6.3.6.3. Conspicuously post appropriate warning instructions.

9.6.3.6.4. Train personnel who conduct chemical tests in use of the chemicals and hazards involved.

9.6.4. Railroad Coal Car Operations:

9.6.4.1. No person will climb on, in, or under a railroad coal car while the railroad crane or switch engine is in operation or coupled to the railroad car.

9.6.4.2. The railroad crane will be moved a minimum of one boom's length away from the railroad coal car while the coal-handling personnel are working in, around, or under the coal car.

9.6.4.3. Signs that read "Do Not Climb on Coal Car When Crane or Switch Engine is in Operation" (or the nearest commercially available equivalent) will be posted on each coal car by coal-handling personnel.

9.6.4.4. Coal-handling personnel will post on the railroad rails, blue flags or blue signals when working in, around, or under coal cars. Flags or signals are to be a minimum of 50 feet from the coal car.

9.6.4.5. There will be a qualified brakeman working with the crane or switch engine. No coal-handling personnel will function as a brakeman.

9.6.5. Coal Storage and Handling:

9.6.5.1. To minimize the probability of fire, free movement of air through all parts of the coal pile is needed to rapidly remove heat generated by oxidation. Air flow depends on preventing segregation (the separation of larger from smaller size lumps), on limiting the coal stored to a relative narrow range of sizes, not storing small sizes, and not compacting the pile.

9.6.5.2. All closed coal storage structures should have, if practical, an access opening at the top with hinged cover and safety rail. Stringent safety precautions shall be followed whenever a storage facility containing coal is entered. An individual shall not enter such a facility without a

safety harness. In addition, a second individual shall stand at the opening and maintain visual contact. An intercom telephone system shall be used when visual contact cannot be maintained. Personnel will never step into coal; they will remain on ladders and catwalks.

9.6.5.3. There will be no surface within the storage structure with a horizontal angle less than 60 degrees, except that catenary bunkers may be used for free-flowing coal (e.g., high-rank, dry, double-screened).

9.6.5.4. A means of loosening coal jams from the outside of the storage structure shall be provided on all structures, except ones used exclusively for free-flowing coal (e.g., high-rank, dry, double-screened).

9.6.5.5. Considerable dust is generated during the filling and emptying of coal storage structures. The BEE will be consulted on evaluation of the health hazards associated with coal dust and for the necessity of wearing respiratory protection. If not confined within the storage structure, such dust settles on machinery and instruments causing rapid wear and (or) improper operation. It also collects on ledges and in crevices, creating a fire hazard and an almost impossible housekeeping situation. Additionally, coal dust in suspension in a storage structure presents an explosion hazard. Although relatively rare, such explosions can cause extensive damage. Such features as damage-limiting construction and (or) explosion-venting panels should be incorporated in the design of coal storage structures. Those structures used exclusively for anthracite coal storage are excluded because the dust from such coal is nonexplosive. Oil treatment of coal should be used if coal dust becomes a problem.

9.6.6. Oil Storage and Handling:

9.6.6.1. Operation of the burner will not be attempted until a satisfactory fuel supply is ensured.

9.6.6.2. Fuel will be continuously delivered to the combustion chamber in a finely atomized form that can be readily ignited and consumed.

9.6.6.3. All equipment associated with pumping, heating, and straining the fuel from storage to the service connection will be designed, sized, and interconnected to the unit to always provide a suitable fuel supply over a full range of conditions. Relief valves will be installed after the pump to prevent overpressure in the system.

9.6.6.4. Fuel will be delivered to the burner at the manufacturer's recommended temperature and pressure. Cold fuel may prevent satisfactory atomization, while excessively heated oil may create vaporlock that can interrupt continuous oil flow.

9.6.6.5. When the oil must be heated, instruments will be calibrated to ensure accurate measurements, particularly in dead-end lines where heavy oil tends to solidify.

9.6.6.6. Sufficient filters will be installed to ensure that oil is free from sludge, water, or other contaminants that may cause fuel interruptions or interfere with proper operation of control and measuring equipment.

Chapter 10

INTERIOR AND EXTERIOR ELECTRIC MAINTENANCE

10.1. Electric Motor Rewind Shops . On most Air Force installations electric motor maintenance consists of a remove and replace-type-operation. However, there are a few electric motor rewind shops in existence in the Air Force. In addition to standard shop safety procedures, the following procedures will apply to electric motor rewind shops:

10.1.1. When the rewind shop is located in the electric shop, it will be located in an area where pedestrian traffic can be avoided.

10.1.2. Continuous air movement is required when working with substances that produce hazardous airborne contaminants, e.g., varnish or cleaning solvents.

10.1.3. Shop machinery located within the rewind shop will comply with the procedures set forth in AFOSH Standard 91-12.

10.1.4. When work must be performed on motors that have capacitors, the capacitors will be considered to have the full voltage of their rating until the terminals have been discharged by an approved method. Circuit terminals will not be shorted until capacitors have been disconnected for at least 5 minutes by an approved method.

10.1.5. Due to their excessive weight, when moving larger sized motors, mechanical lifting and moving devices will be used, e.g., hand trucks, dollies, or portable cranes.

10.2. Storage Batteries:

10.2.1. Compartments for storage batteries that give off gases during charging will be kept well ventilated.

10.2.2. Open flame or spark-producing devices shall not be used in the vicinity of storage battery banks.

10.2.3. Cleaning batteries or terminals with metal brushes or other metal devices that may contact both terminals and short circuit the cells will not be permitted.

10.2.4. A container of neutralizing solution will be available when work is being done on batteries where contact may be made with the electrolyte.

10.2.5. When mixing acid and water, the acid will always be poured slowly into the water. **CAUTION: Water will never be poured into the acid.**

10.2.6. Workers will wear face shields, gloves, aprons, and nonslip shoes or boots when handling electrolyte.

10.3. Work on Energized Circuits:

10.3.1. General Rules. When possible, electrical circuits and equipment will be de-energized before personnel work on them. However, work may be performed on energized circuits and equipment as necessary to support a critical mission, prevent injury to persons, or to protect property. In such instances, at least two workers, fully qualified for hotline work, and all necessary protective equipment and special tools will be available.

10.3.2. Exempted Circumstances. Low voltage control, power, and lighting circuits may be worked on while energized for the purpose of testing, calibrating, troubleshooting, minor repairs, and replacement of fuses and circuit breakers. When working on circuits over 300 volts, a safety observer will be present. **CAUTION:** Connections or contact between energized conductor and ground, or between two energized conductors, are equally hazardous. A grounded apparatus frame, equipment cover, or floor is a potential second point in completing a circuit through the body.

10.3.3. Protective Equipment. When it becomes necessary to work adjacent to energized circuits, rubber blankets or other suitable guards will be used.

10.4. Work Near Energized Equipment:

10.4.1. In passing by or near any switchboard, energized equipment, or a machine in motion, the worker will take precautions to prevent contact between their body (or objects being carried or handled) and the apparatus being passed.

10.4.2. When air-operated equipment (either pressure or vacuum) is used around live parts, it will be equipped with nozzles of nonconductive material. Pressurized air will be moisture free.

10.4.3. Warning tags shall be used as a temporary means of warning employees of an existing hazard. They will not be used in place of, or as a substitute for safety, fire prevention, and occupational health signs. AFOSH Standard 91-45 will be consulted for additional information.

10.4.3.1. AF Form 269, **Electrical Facilities Safe Clearance**. This form will be used to control and record all blocking and tagging actions for work requiring a safe clearance. The electrical superintendent, or in their absence a designated representative, is responsible for issuing an AF Form 269. They will designate the exterior electric supervisor a responsible person to perform switching, blocking, and tagging operations. The electrical superintendent's or a designated representative's signature is required on each AF Form 269 before it is issued. The person receiving the safe clearance is responsible for checking all blocking and tagging and for ensuring all power is removed from the circuit or equipment before any work is begun. The exterior electrical supervisor releases the safe clearance to the electrical superintendent after the work has been completed. "Clearance released by" reflects the signature of the exterior electrical supervisor. AFI 32-1064, *Electrical Safe Practices*, will be referred to for additional information.

10.4.3.2. AF Form 979, **Danger Tag**. This tag is designed for the protection of personnel and will be attached to switches or other control devices that have been deactivated for maintenance purposes. Where practical, control devices will also be locked in the de-energized position while maintenance is being performed on equipment or circuits. The tags may be used by themselves or in conjunction with AF Form 269, **Electrical Facilities Safe Clearance**. An electric equipment disconnect switch will be located near the equipment.

10.4.3.3. AF Form 980, **Caution Tag**. This tag is designed to indicate abnormal operating conditions of circuits or equipment. It will not be used for protection of workers under a safe clearance. AF Forms 979 and 980 applied under each safe clearance will bear the safety clearance number and the name of the person to whom the clearance is issued. Placement of AF Forms 979 and 980 will be coordinated with the host installation ground safety, fire department, or BE staffs (as appropriate).

10.5. Exterior Electric. The vast majority of both interior and exterior electrical work is governed by the AFI 32-series. The following items are addressed for emphasis:

10.5.1. Vaults, Manholes, and Tanks. All enclosed areas will be considered hazardous until tested by the installation BEE or certified for oxygen-deficient or combustible atmospheres.

10.5.1.1. Atmospheres containing 19.5 percent or less of oxygen by volume shall not be entered without the use of an air-supplied respirator.

10.5.1.2. Only manhole cover hooks, or other methods approved for the purpose, will be used when manhole covers are removed or replaced. When replaced, they shall be properly seated. The bearing surfaces will be free of dirt or ice that might prevent proper seating of the cover. Workers will wear leather gloves and steel-toe boots when removing or replacing manhole covers and will employ proper lifting techniques.

10.5.1.3. Manholes or vaults will be entered or left by means of a ladder. Workers will not step on cables or cable hangers.

10.5.1.4. Tools or materials will not be thrown into or out of manholes or vaults. Canvas buckets, handlines, or approved methods for lowering and removing tools and equipment will be used.

10.5.1.5. Working on energized equipment is especially hazardous in subsurface structures because of the presence of moisture.

10.5.1.6. When manhole covers are removed, barriers will be installed to prevent injury to personnel not associated with the hazard.

10.5.1.7. When a manhole or vault is open, at least one member of the crew will be stationed at the surface. This person will remain at the attendant's post and not leave for any reason (except self-preservation) unless replaced by an equally qualified individual. The attendant will order the entrants to exit the space if the attendant must leave and there is no replacement. **UNDER NO CIRCUMSTANCES WILL A PERSON ENTER A SUBSURFACE STRUCTURE FOR ANY REASON WITHOUT A SECOND PERSON TO ACT AS A GUARD AND TO OBTAIN ASSISTANCE IN THE EVENT OF A MISHAP.** In areas where removal of a victim would be difficult, an approved lifeline equipped with a wrist harness will be worn by the person entering the area, to facilitate rapid removal in case of an emergency. (Refer to AFOSH Standard 91-25.)

10.5.2. Work on Energized Circuits. The guidance is the same as previously stated for interior electric and as prescribed in AFI 32-1064.

Chapter 11

ELECTRICAL POWER PRODUCTION

11.1. Plant Operations:

11.1.1. Equipment. The manufacturer's recommendations for operating power generation equipment will be followed in every instance. Personnel will be thoroughly trained and qualified before operating power generation equipment.

11.1.2. Plant Locations:

11.1.2.1. Rooms and spaces in which electric generating equipment is installed shall be arranged to minimize the possibility that unauthorized persons will enter and cause interference with equipment inside. Illumination in the area shall be according to AFI 32-1024, *Standard Facility Requirements*. A separate emergency source of illumination with automatic initiation will be provided. Each room or space shall have a means of exit that shall be kept clear of all obstructions. Exit doors shall be equipped with locks or latches that permit opening by means of simple pressure or torque on the actuating parts under any condition. Entrances not under observation of an authorized attendant shall be kept locked. Warning signs shall be displayed at entrances.

11.1.2.2. Generators may be located outside facilities if they are housed in weatherproof protection and all moving parts and electrical connections are adequately covered. The equipment will be locked when not attended. The area around the power plant will be kept free of debris and unauthorized items; grass will be maintained according to Air Force directives.

11.1.3. Equipment Controls. Electrical control panels, switches, meters, and other hazardous electrical devices will be located where the possibility of accidental contact is minimized. Access routes to electrical controls and meters will be kept free of obstacles. All metal frames will be connected to a low resistance ground (not to exceed 25 ohms). To ensure safe operation during normal and emergency operation, standard operating procedures will be developed and posted. Operators will familiarize themselves with such procedures.

11.1.4. Diagrams. Piping and wiring diagrams of the mechanical and electrical systems will be developed and kept up to date at all times. A detailed singleline diagram of plant and auxiliary piping systems will be developed to ensure safe operations. They will show emergency arrangements with positions of operating valves and other devices positively identified for normal and emergency operation. Alarm and safety systems will also be identified with reset operations included.

11.2. Plant Maintenance:

11.2.1. Safety Precautions. Before major maintenance work is performed, workers will be briefed on the task and hazards involved in the task. All maintenance workers will wear dielectric safety-toe shoes and other protective equipment such as goggles, hard hat, and gloves depending on the specific task involved. All maintenance personnel will remove jewelry before working on machinery. Metal eyeglasses will be secured by a band or cord to prevent them from falling into energized electrical circuits.

11.2.2. Engines. Positive precautions will be taken to guard against accidental or unintentional starting when work is being done on the engine. The throttle will be blocked or locked and an appropriate safety clearance tag will be attached securely to the starting control. As an added precaution, a

flanged or screwed connection may be broken in the air starting line if work of a major nature is being performed. In cases where electric starters are used, the battery supply to the starting system will be disconnected, start switch located in the "OFF" position, and tagged with a tag reading, "Do Not Reconnect—Maintenance in Progress."

11.2.3. Test Equipment:

11.2.3.1. The multimeter is the most common type of equipment used in the shop. Personnel will be thoroughly trained and completely familiar with the specific multimeter to be used prior to using it on equipment. Extreme caution will be taken to ensure the meter is set on the proper scale before connecting it to a power source. The calibration date will be checked prior to each use. If the calibration date is not current, the multimeter will not be used.

11.2.3.2. Generator load banks are used for testing generator sets. Extreme caution will be used because of the high amperage normally encountered when testing a generator set. Also, the noise level of a generator set increases substantially when a heavy load is applied; therefore, hearing protection will be used. Load banks will be maintained according to applicable TOs or manufacturer's manuals. Requirements of AFI 32-series regulations will be observed when troubleshooting with power applied.

11.2.4. Jacking Operations. Improper jacking can cause serious injury or property damage. Unless the equipment is provided with an operable parking brake it will be chocked prior to jacking. Jack stands will be used any time equipment is jacked for maintenance. Equipment will be removed from jacks as soon as possible. Equipment will be jacked to the minimum height required for the particular task. Personnel will not work under a jacked unit, nor will they position themselves under the tire or wheel of jacked equipment. Supervisors are responsible for ensuring that jacks and jack stands of sufficient capacity are available. Care will be exercised to ensure the jack placement will not cause damage to the equipment. Jacks and jack stands will be inspected and maintained according to manufacturer's manuals.

11.2.5. Tires. Tires will not be removed from equipment unless the unit is on jack stands or otherwise blocked to prevent it from falling. Split rim tires will be deflated prior to removal of the tire bolts. High-pressure air will not be used to inflate tires. Tires will be inflated to the pressure specified by the applicable TO. Personnel will be thoroughly trained in the use of equipment used for tire inflation. Tires will be inspected and maintained according to the individual equipment TO and TO 1-1A-15, *General Maintenance Instructions for Support Equipment*.

11.3. Plant Switchgear and Substation:

11.3.1. Energized Circuits. Electrical circuits and equipment will normally be de-energized before they are worked on. However, work may be performed on energized circuits and equipment when certified by the commander or their designated representative, as necessary to support a critical mission, prevent injury to persons, or protect property. In such instances at least two workers who are fully qualified for hot line work and who have all necessary protective equipment and special tools will be available.

11.3.1.1. Whenever possible, an energized circuit should be de-energized regardless of voltage. As an exception to the above, low voltage control circuits (50 volts or less) may be worked on while energized, and low voltage power and control circuits (below 600 volts) may be tested while energized. Voltmeters, ammeters, or other appropriate test equipment for purposes of calibrating

or trouble-shooting electrical circuits or equipment may be used. Such testing or calibrating will be performed only while standing on or in contact with dry surfaces. **CAUTION:** Connections or contact between an energized conductor and ground or between two energized conductors are equally hazardous. A grounded apparatus frame, equipment cover or floor is a potential second point in completing a circuit through a worker's body. Whenever possible, use the one-hand rule or get help from another individual.

11.3.1.2. When working on energized conductors or parts, such conductors within the working area will be covered with approved protective equipment.

11.3.1.3. Routine maintenance should be scheduled so the disruption of power results in the minimum amount of inconvenience to all power users. For critical circuits where power outages may result in loss of an essential mission, possible injuries or fatalities to others, or substantial losses or deterioration of stored products, consideration should be given to provisions for alternate sources, redundancy of equipment, or standby electric services. Electrical circuits and equipment should be arranged so routine maintenance tasks can be accomplished efficiently and with a minimum number of outages of the prime source of power to important facilities. Providing bypass switches around an automatic transfer panel will alleviate maintenance shutdowns.

11.3.2. Safe Clearance Procedures. Paragraph **10.4.3.1.** will be consulted for guidance on these procedures.

11.4. Batteries:

11.4.1. Personnel will be extra cautious when handling and servicing batteries. Acid spills can cause serious injury to personnel and damage equipment.

11.4.2. Personnel will use battery straps for lifting and carrying batteries whenever possible. When straps cannot be used, personnel will exercise extreme caution to prevent strains from improper lifting. Batteries that cannot be carried with straps should be transported on carts or trailers.

11.4.3. Workers will avoid dropping batteries. The weight of some batteries can cause serious injury if dropped on feet or hands. Also, the resulting splattering of the electrolyte may cause serious acid burns.

11.4.4. Nickel-cadmium and unsealed lead-acid batteries will be stored far enough apart to keep the lead-acid gases away from nickel batteries.

11.4.5. Tools or metal parts will not be placed on a battery or stored in such a position that they may fall on a battery.

11.4.6. Workers will not wear rings, watches, bracelets, or other jewelry when working with batteries. Metal eyeglasses will be secured by a band or cord.

11.4.7. When work is being done on batteries where contact is made with the electrolyte, a container with baking soda and water will be provided to use to neutralize electrolyte on hands and tools.

11.4.8. The eyes and skin will be guarded from splashing acid. To prevent acid burns when handling electrolyte, shop personnel will wear protective face shields, gloves, aprons, and nonslip shoes or boots.

11.4.9. Sulfuric acid will not be stored in places where freezing occurs.

11.4.10. Cleaning batteries or tarnish with brushes or other devices, which may short-circuit the cell, will not be permitted.

11.4.11. The electrolyte will be kept at a level above the tops of the plates.

11.4.12. For further information on servicing and maintaining storage batteries, the manufacturer's instructions will be consulted. AFOSH Standard 91-32 will be consulted for proper eyewash equipment requirements.

11.5. Vaults and Manholes . Subsurface structures, such as manholes, transformer vaults, and enclosed pumps are subject to the accumulation of dangerous gases. These gases may be combustible or toxic or the atmosphere might be deficient in oxygen. Generally, subsurface structures are considered hazardous until proven clear by test or until ventilated. **Chapter 10** will be consulted for guidance.

11.6. Air Compressors:

11.6.1. All personnel will be familiar with compressor operating and maintenance instructions.

11.6.2. The drain valve on the air tank should be opened daily to prevent excessive accumulation of liquid. Air receivers shall be stenciled to reflect this requirement. Receivers with automatic drains will be checked periodically (as recommended by the manufacturer) to ensure proper operation.

11.6.3. Air tanks will be protected by adequate safety relief valves. These valves will be tested at regular intervals to ensure they are in good operating condition.

11.6.4. The pressure controller and gauge will be maintained in good operating condition.

11.6.5. There will be no valves between the air tank and the safety valve.

11.6.6. Air compressors will be maintained strictly according to the manufacturer's instructions or an applicable TO.

Chapter 12

WATER AND WASTEWATER TREATMENT

12.1. Hazards and Human Factors . Workers involved in the operations and maintenance of water and wastewater treatment systems are exposed to many potential, but controllable hazards. Through a complete and ongoing training program, specific operating procedures, emergency operating procedures, and being knowledgeable of unsafe chemical reactions most mishaps can be prevented. Mishaps can result from falls, improper lifting, electrical shock, not using protective equipment while handling chemicals, hazardous chemical reactions (NFPA 491M), and asphyxiation from oxygen-deficient atmospheres (containing less than 19.5 percent of oxygen by volume) atmospheres. Other mishaps can be caused by the ignition of flammable or explosive gas, hazards around open excavations, falls into water pits or lagoons, getting caught in moving mechanical parts, striking obstructions, improper use of hand or portable tools, equipment, or vehicles, and exposure to toxic or harmful organisms.

12.1.1. Explosive Gases. The most common sewer gases are methane, carbon monoxide, and hydrogen sulfide. Any or all of these gases, when mixed with air and a spark, can explode with great force. Such explosions are most common and dangerous in confined areas such as a tank, underground lift station, or manhole. Hydrogen sulfide is generally encountered more frequently in the wastewater system than any other hazardous gases. In light concentrations, it has a very foul odor similar to rotten eggs. In heavy concentrations, it is practically odorless. It is heavier than air and usually concentrates in low areas. Both carbon monoxide and methane are lighter than air and will escape with proper ventilation. Closed tanks and tight rooms are the greatest danger areas. They will be tested only with approved meters.

12.1.2. Oxygen Deficiency. Oxygen deficiency is a major hazard in wastewater collection systems and treatment plants. Some of the explosive gasses, and others that are not explosive, are heavier than oxygen. They settle into low spots and displace oxygen physically. Oxygen deficiency will be tested for with approved equipment. Required procedures and methods will be used when entering system components suspected to be oxygen deficient (see [Chapter 2](#) for confined space entry precautions).

12.1.3. Chlorine. Chlorine is used extensively in water and wastewater treatment. Chlorine gas is very poisonous to humans and is also quite corrosive when in contact with water. Extreme care will always be taken when working with chlorine to prevent accidental injury to workers. Even small amounts cause severe coughing and irritation to the nose, throat, and lungs. Every worker should constantly be aware that chlorine is both poisonous and corrosive. Requirements for chlorinating treatment rooms follow:

12.1.3.1. Any chlorinate treatment room containing chlorine gas and injection equipment can pose a potentially hazardous situation for workers from exposure to chlorine gas during handling and maintenance of equipment. This area may become immediately dangerous to life and health (IDLH) because of deficient facility design, location, or equipment malfunction. Each area identified as an IDLH area will have a means of emergency contact available to personnel working in the area. Either a telephone will be located immediately outside the IDLH area or radio contact capabilities will be available while personnel are working in the IDLH area. The IDLH level for chlorine gas is 10 parts per million. The installation BEE will determine the IDLH potential of each chlorinator treatment room based on the design and operational characteristics of the room. The installation BEE will also determine the need for the availability of respiratory protection at each chlorinator treatment facility. As a minimum, each chlorinator treatment room will be

equipped with a mechanical exhaust system that is turned on prior to entering the room (e.g., automated door interlocks). The installation BEE will evaluate each mechanical exhaust ventilation system installed in gaseous chlorinator rooms as outlined in AFOSH Standard 161-2. In addition, a bottle of household ammonia, properly labeled, will be kept available to detect chlorine leaks. Chlorine gas produces a dense white mist (ammonium chloride) in the presence of ammonia. When the bottle is not in use, it will be stored (protected from elements) outside the chlorinator equipment room. As a minimum, the following factors should be considered when evaluating a chlorine treatment room as a potential IDLH area:

12.1.3.1.1. Type of ventilation system, exhaust duct location (should be near floor), size of fan, air changes per hour, automatic fan operation, and availability of make-up air.

12.1.3.1.2. Chlorine use level, quantity stored, location of gas cylinders, condition of equipment, and accessibility of equipment.

12.1.3.1.3. Room location (e.g., above ground or below ground), room size, room layout, and cross-ventilation.

12.1.3.1.4. Mishap history, safety factors, equipment handling problems, and unique conditions.

12.1.3.2. Each chlorinator treatment room should be evaluated by the installation BEE and formally categorized as follows:

12.1.3.2.1. If IDLH conditions exist: (AFOSH Standard 48-1 and 29 CFR 1910.134, *Respiratory Protection*).

12.1.3.2.1.1. Before entry into a gaseous chlorinator room that is potentially IDLH, an additional person will be present with the proper rescue equipment (including self-contained breathing apparatus) to assist the other person in case of emergency.

12.1.3.2.1.2. The self-contained breathing apparatus will be approved by the installation BEE as required by AFOSH Standard 48-1.

12.1.3.2.1.3. The chlorinator room supervisor will develop written OIs covering emergency procedures. Individuals will be thoroughly trained in the use of the equipment. Annual training will be conducted and documented by the chlorinator room supervisor.

12.1.3.2.1.4. The self-contained breathing apparatus shall be inspected monthly. A record shall be kept of inspection dates. Under no circumstances will an air-purifying respirator (e.g., gas mask) be used when entering a chlorine gas-contaminated area.

12.1.3.2.1.5. The functional manager should program and install engineering controls when feasible. When appropriate, each area will be identified under the US Air Force Hazard Abatement Program specified in AFI 91-301 if corrective action is required.

12.1.3.2.2. If IDLH conditions do not exist:

12.1.3.2.2.1. An additional person standing by with a self-contained breathing apparatus is not necessary when entering a chlorinator room not determined to be IDLH by the installation BEE.

12.1.3.2.2.2. Workers should take precautions to ensure the exhaust ventilation is operating when the chlorinator room door is opened. If any chlorine odor is detected, the worker

will not enter the room. The situations should be evaluated and managed the same as an IDLH condition. Entry into the contaminated area will only be conducted by trained and properly protected personnel.

12.1.3.2.2.3. The following will be referred to for further guidance:

OSHA 29 CFR 1910.134. Respiratory Protection.

AFI 32-1067, Water Systems.

AFOSH Standard 48-1, Respiratory Protection Program.

AFOSH Standard 48-14, Swimming Pools, Spas and Hot Tubs, and Bathing Areas.

12.2. Personal Sanitation and Protective Equipment:

12.2.1. Wastewater often contains bacteria of many dangerous diseases. Every employee will practice good personal hygiene to avoid infections. A clean plant is safest, both from physical mishaps and infection. All personnel will maintain current inoculations against common water-borne infections.

12.2.2. Gloves, boots, and coveralls keep wastewater from contacting the skin. Rubber gloves are even more essential if there are scratches or open wounds on the hands. If a worker comes in direct contact with wastewater, they will scrub thoroughly with strong soap and hot water as soon as possible. Both hot and cold water, strong soap, a rich solution of an effective hand disinfectant, and an adequate supply of disposable towels shall be maintained. All employees will scrub well and disinfect hands before eating or smoking. Use of eye and face protection is required when loading, mixing, or adding chemicals. Emergency eyewashes and (or) showers will be provided as required by AFOSH Standard 91-32.

12.2.3. Food or drink preparation, eating, or smoking will be permitted *only* in authorized areas.

12.3. Treatment Plant. Three extremely important items will be accomplished to prevent or lessen the effects of mixing incompatible hazardous chemicals. Plans or OIs will be developed for operations under emergency conditions to include safe venting of toxic gases, neutralization, air sampling, evacuation of non-essential personnel, respiratory protection program, and prompt notification of appropriate officials such as the fire department, the BEE, commanders, ground safety, and others with technical knowledge or skill to help resolve emergencies. The nature of the emergency and chemicals involved will be passed on in notifications. The following precautionary measures will be adhered to for the plant components listed:

12.3.1. Bar Screens and Racks:

12.3.1.1. Be sure all railings are firmly anchored.

12.3.1.2. Place all screening in tight, easily-removed cans.

12.3.1.3. Have and use wash-down hoses to keep all screen deck areas clean.

12.3.2. Shredding (Pulverizing) and Grinding:

12.3.2.1. Keep all walkways clean and free of grease.

12.3.2.2. Turn off and lock out all power before servicing.

12.3.2.3. Maintain all guards and screens firmly in place.

12.3.3. Pumping and Lift Station Maintenance Repair:

- 12.3.3.1. Always switch off and lock out all power before servicing.
- 12.3.3.2. Remember to test for gas and oxygen if below ground level.
- 12.3.3.3. Never open equipment removal hatches except during actual use; then fence off.
- 12.3.3.4. Never start a positive displacement pump against a closed discharge valve.

12.3.4. Wet Pits and Sumps:

- 12.3.4.1. Follow all manhole safety steps.
- 12.3.4.2. Always test for gases and oxygen before entering.
- 12.3.4.3. Turn off all chlorination equipment upstream and allow enough time for ventilation.

12.3.5. Grit Chamber:

- 12.3.5.1. Keep all walking and working surfaces clean and free of grease or oil.
- 12.3.5.2. Never hand-carry tools up or down a ladder; always use a bucket and rope, tool belt, or pouch.

12.3.6. Sedimentation Basin (Clarifier):

- 12.3.6.1. Maintain non-slip surfaces on all ladders, stairs, and catwalks.
- 12.3.6.2. Always have firm rails on inside of all walks.
- 12.3.6.3. Never walk on sludge; hose a path ahead.
- 12.3.6.4. Wear protective overalls and non-skid rubber boots.
- 12.3.6.5. Locate approved life vests with attached lifelines at appropriate points around the clarifier.
- 12.3.6.6. When cleaning effluent weir, wear safety harness, gloves, goggles, and have a helper standing by.
- 12.3.6.7. Provide guards around all moving parts.

12.3.7. Digester Equipment. Digester equipment locations are probably the most dangerous areas in any plant.

- 12.3.7.1. Always test for explosive gas and oxygen.
- 12.3.7.2. Maintain sufficient ventilation.
- 12.3.7.3. Always have a backup helper standing by.
- 12.3.7.4. Be sure all valves on both sides of sludge pumps are completely closed before servicing.
- 12.3.7.5. Wire below-ground pump room blowers so that any time the pump is running, ventilation is provided.
- 12.3.7.6. Avoid spillage and, if it occurs, clean up at once.
- 12.3.7.7. DO NOT attempt to service radioactive element automatic sludge moisture meters. (Automatic sludge moisture meters containing radioactive material may require an Air Force

Radioactive Material Permit according to instructions in AFI 40-201. Contact the BEE to determine if a permit is required.)

12.3.8. Digester Tanks:

12.3.8.1. On start up, completely fill the tank to overflow thereby preventing any air-gas mix in partly filled tank that would be explosive.

12.3.8.2. Draw digested sludge at the same rate you add raw sludge to fixed roof digesters, thus preventing any vacuum or extinguishing of gas boilers.

12.3.8.3. Maintain forced ventilation in all rooms and galleries.

12.3.8.4. Test for gas and oxygen before entering any closed area.

12.3.8.5. Always follow manufacturer's instructions in servicing boilers or heat exchangers.

12.3.8.6. Ensure chamber is cleared before lighting the pilot.

12.3.8.7. Ensure all electrical fixtures are explosion-proof.

12.3.8.8. Always allow heat exchanger to cool before opening.

12.3.8.9. Do NOT allow smoking anywhere around any digestion area of equipment.

12.3.9. Empty or Partially-Filled Digester Tanks. Empty or partially-filled digester tanks are especially dangerous and are to be treated with extreme caution.

12.3.9.1. Always test for explosive atmosphere and oxygen deficiency before entering.

12.3.9.2. Open all manholes and force heavy ventilation during the time anyone is working inside.

12.3.9.3. Always have at least two backup helpers standing by.

12.3.10. Digested Sludge Storage Tanks:

12.3.10.1. Ensure all electrical equipment is explosion-proof.

12.3.10.2. Ensure forced air ventilation is provided before entry and during the period of occupancy by workers.

12.3.10.3. Ensure air relief valves are working during draw-off.

12.3.10.4. Regularly check for flammable gases.

12.3.10.5. Carefully control draw-off rate. Prevent surges.

12.3.10.6. Always clean lines with water, never air.

12.3.11. Sludge Gas Collection and Use Equipment:

12.3.11.1. Protect all gas lines from freezing weather.

12.3.11.2. Use antifreeze in all water traps during freezing weather.

12.3.11.3. Regularly check all points for gas leaks, using a meter or soapy water. **CAUTION:** Never rely on odor to detect the presence of sludge gas.

12.3.11.4. Maintain positive gas pressure in all lines.

12.3.11.5. Use enclosed dry type gas compressors, not water seals.

12.3.11.6. Check gas boiler safety devices often, especially pilot cut off and blow back protection devices (flame arresters).

12.3.11.7. When purging tanks of gas, open all manholes high and low and force ventilate from low ones.

12.3.12. Trickling Filter:

12.3.12.1. Anchor (tie down) the rotary distributor before inspection or servicing.

12.3.12.2. Walk carefully if it is necessary to get on filter media. Never allow equipment on the media.

12.3.12.3. Regularly inspect under drains for solids buildup and collapsed drains. These conditions hinder ventilation and induce septicity causing gas formation.

12.3.12.4. Always provide firm base off media for jack plate, if necessary, to lift distributors for servicing.

12.3.12.5. Prohibit mercury seals on distributors because of hazards to operators and contamination of receiving waters.

12.3.13. Aeration Tanks:

12.3.13.1. Provide firm guardrails for all work areas and walkways.

12.3.13.2. Place approved life vests with attached lifelines at appropriate locations around aerator rails.

12.3.13.3. Always center the test hoists used to service diffusers.

12.3.13.4. Use a dry fixed ladder to enter a dry empty tank and be careful of slick sides and floor. Use a water hose and stiff bristled brush to keep the work area clean and to provide safe footing.

12.3.14. Stabilization Ponds:

12.3.14.1. Maintain roads on top of levees with gravel or asphalt.

12.3.14.2. Never work alone while mowing or clearing vegetation on berms (dikes) because of drowning hazard.

12.3.14.3. Wear a life vest while working, inspecting, or otherwise in a boat or raft on a pond.

12.3.14.4. Always work from a sitting position in a boat, unless it is designed to be stable while working in a standing position.

12.4. Manholes . The following safety precautions and procedures will be observed:

12.4.1. Test for both explosive gases and oxygen deficiency with approved meters before entering.

12.4.2. Remove cover with a special hook, never by hand.

12.4.3. Place the cover flat and at least 3 feet from the manhole lip.

12.4.4. When manhole covers are removed, install barriers to prevent injury to personnel not associated with the hazard.

- 12.4.5. Carefully test the permanent ladder for rust, weakness, or slippery rungs before using.
- 12.4.6. Ensure the portable ladder is firmly seated and cannot slip. Always use the ladder to enter the manhole.
- 12.4.7. Ventilate the lowest working levels with portable blowers for at least 30 minutes before and during the time workers are in the hole.
- 12.4.8. Always wear a safety harness and lifeline and be constantly attended by one helper on the surface.
- 12.4.9. Wear a helmet, gloves, and rubber boots while inside a manhole.
- 12.4.10. Ensure all lighting is explosion-proof.
- 12.4.11. Prohibit open flames, sources of ignition, or smoking in or at the opening of an open manhole.
- 12.4.12. Lower tools in a bucket or pouch; never drop them into the manhole.
- 12.4.13. Continue testing for explosive atmosphere and oxygen deficiency during the entire time a worker is inside a manhole, wet well, etc. DO NOT trust your nose. High concentrations of hydrogen can soon paralyze the sense of smell.

12.5. Laboratories . Laboratories use many dangerous chemicals. Many of the testing procedures can result in mishaps if the technician is not fully alert at all times. Basic rules for laboratory safety are:

12.5.1. Sampling Safety:

- 12.5.1.1. Never take field samples with bare hands; always wear gloves.
- 12.5.1.2. Do not climb over or go inside guardrails. Use poles, ropes, dippers, or other long distance samplers.
- 12.5.1.3. When collecting gas samples, do not open the tank cover completely. Install a sampling port, if needed.
- 12.5.1.4. Use self-contained breathing apparatus (paragraph [12.1.](#)), venting, and a helper when taking gas samples in an IDLH environment.

12.5.2. Lab Housekeeping. General cleanliness and correct storage of chemicals and equipment are important for accuracy as well as safety in the laboratory. Basic rules include:

- 12.5.2.1. Follow a daily general cleanup schedule in the lab. Dirty glassware or clothing can encourage infection.
- 12.5.2.2. Have a special spot for storing each piece of equipment. After each use, clean, disinfect, and return it to its rack (an outline painting, as on a tool board helps keep a place for everything and everything in its place).
- 12.5.2.3. Always clean up and discard any spills at once.
- 12.5.2.4. Keep the lab well lighted, at least 50-foot candles on every work surface.
- 12.5.2.5. Ensure all work benches or tables have slate or special plastic chemical-resistant tops or are painted with chemical-resistant paint frequently.

12.5.2.6. Ensure all work areas have non-drip edges or keep work that could be spilled in containers that would recover the spill.

12.5.2.7. If possible, provide deep sinks of stone or noncrack porcelain lined with disposable rubber or plastic mesh.

12.5.2.8. Do not crowd the lab; have plenty of room. Do not store any other equipment in the lab. Do not permit food or drink preparation, eating, or smoking in the lab.

12.5.2.9. Color code all lab service lines (gas, water, electricity, etc.).

12.5.3. Chemical Safety: (AFOSH Standards 91-68 and 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories*, will be consulted for guidance not included in this standard.)

12.5.3.1. Keep working amounts of chemicals stored in the lab to a minimum, never over 1 gallon (4 liters) of any one kind. Also see AFOSH Standard 91-43 for requirements if chemicals are flammable.

12.5.3.2. Store all bulk chemicals in original containers in a separate fireproof storeroom. If possible, store larger bulk containers on the floor.

12.5.3.3. Have individual bulk siphons to transfer chemicals from bulk storage to working stock bottles. Never siphon by mouth.

12.5.3.4. If possible, place all chemical storage jars on wide shelves with retaining rails to prevent their being accidentally pulled or jarred off.

12.5.3.5. Stand jars (in which strong or highly corrosive acids or bases are stored) in lead, plastic, or ceramic individual trays that are deep enough to contain the solution in the event the jar breaks.

12.5.3.6. Store all chemicals as low as possible, never more than shoulder height. Ensure that chemicals stored together or close to each other are compatible with each other.

12.5.3.7. Clearly label all chemicals with common and chemical names, formula, strength, and date prepared or received. Replace these labels as needed to keep them legible.

12.5.3.8. Add red "Skull and Crossbones" labels to all containers of poisonous chemicals.

12.5.3.9. Ensure used chemicals are carefully disposed of by workers who are familiar with their properties and disposal requirements. Do not flush them down the drain unless this practice is permitted by environmental disposal requirements.

12.5.3.10. Keep highly reactive chemicals stored at safe distances.

12.5.4. Lab Equipment Safety:

12.5.4.1. Only, trained, experienced technicians are permitted to operate lab equipment, especially pressure units.

12.5.4.2. Exact, clear operating procedures for autoclaves, water stills, and any other special pressure equipment will be permanently posted near the same equipment.

12.5.4.3. Valves and switches on such equipment shall be clearly numbered in their order of use.

12.5.4.4. All electrical equipment shall be grounded.

12.5.4.5. All electrical cords will be inspected for wear or cracks in insulation and will be replaced as necessary.

12.5.4.6. Manufacturer's operating and safety instructions shall be kept in a permanent file. Supervisors will ensure workers follow these rules.

12.5.4.7. All equipment shall be set away from gas and electrical service switches or valves.

12.5.4.8. All chemical reactions that produce vapors or gases will be conducted in a ventilated hood with front closed and fan on.

12.5.4.9. Chemicals with high temperature reactions will be heated in a water, oil, or salt bath, not over an open flame. A wired glass shield will be placed between the fan and any high temperature or caustic reaction in case the vial or container breaks.

12.5.4.10. Workers will ensure centrifuges are perfectly balanced before turning them on.

12.5.5. Glass Safety:

12.5.5.1. Always fire polish all ends of glass tubes that are used or stored.

12.5.5.2. Wear gloves any time you are working with glass.

12.5.5.3. Hold rod or tube in contact with stopper and twist to insert.

12.5.5.4. Keep cork borers sharp and use exact size needed.

12.5.5.5. Always insist on Pyrex tubing.

12.5.5.6. Wear full or wrap-around goggles or a face shield when working with glass.

12.5.5.7. Always support glass units with several padded clamps that are firmly anchored.

12.5.5.8. Properly discard all glassware that is chipped or cracked in any way.

12.5.5.9. Pad all glass storage drawers with clean paper towels. Change the towels frequently. Have individual cardboard tubes or dividers for pipette storage drawers.

12.5.6. Lab Safety Procedures. The safest lab can be dangerous unless precautions are observed.

12.5.6.1. Never pipette by mouth; always use a bulk siphon.

12.5.6.2. Always wear rubber gloves to handle wastewater samples and analysis.

12.5.6.3. Always scrub thoroughly and use a hand disinfectant after finishing any waste-water lab work.

12.5.6.4. Know your procedure and follow a checklist.

12.5.6.5. Wear safety glasses or goggles in the lab, when required.

12.5.6.6. Always wear a rubber apron when working with acids or caustics.

12.6. Sanitary Sewer Systems . When maintenance is performed on sewer systems in confined spaces, the buddy system will be used. Before going into a sanitary sewer system, the atmosphere will be tested to determine if dangerous gases are suspected. Sewer gases that may be encountered are: methane, hydrogen sulfide, carbon monoxide, carbon dioxide, and nitrogen. Presence of these gases could cause explosions, asphyxia or death. When these gases are present in a sewer system, the system will be vented to a safe level. Workers will use proper protective clothing, boots, and respirator devices to perform emer-

gency maintenance or rescue operations when these systems cannot be vented to a safe level. Immunizations required (such as tetanus, typhoid, cholera, etc.) will be determined by the Hospital's Aerospace Medicine Council according to requirements in AFI 48-101, *Aerospace Medical Program*.

Chapter 13

AIRCRAFT ARRESTING SYSTEMS (AAS)

13.1. Hazards and Human Factors. Personnel engaged in AAS operations and maintenance are exposed to several potential hazards, including exposure to flammable and combustible liquids and gases and absorption of toxic and hazardous chemicals through the skin and respiratory system. AAS personnel are subject to some physical injuries associated with AAS maintenance, and are also subject to noise, lifting hazards, and in underground facilities, confined space hazards (e.g., oxygen deficiency). Particular attention will be given to protection against noise levels exceeding hazardous noise levels since the effects of over-exposure are not always apparent immediately or in the near future. Potential physical and health hazards can be effectively controlled by following the guidance in this chapter, by proper work procedures and controls, and by using protective equipment and clothing. Refer to AFI 32-1043, *Managing Aircraft Arresting Systems*, TO 35E8-2-4-1, *Operation and Maintenance Instruction Runway Overtake Barrier, MA1*, TO 35E8-2-5-1, *Operation and Maintenance of the BAK-12 System*, and AFOSH Standards 48-19 and 91-31 for detailed guidance.

13.2. Requirements:

13.2.1. Housekeeping. Good housekeeping is essential to safe operations in AAS operations and maintenance areas:

13.2.1.1. Floors and grounds will be kept free of spilled liquids to minimize the possibility of slipping and falling

13.2.1.2. In addition, dry floors are essential to electrical safety.

13.2.1.3. All work and storage areas shall be kept clean. Equipment and materials shall be stored in a proper and orderly manner.

13.2.1.4. Because toxic and hazardous chemicals cling to clothing and body parts, workers should be extremely careful about personal hygiene. They will wash hands thoroughly before eating or smoking and shower and change clothes after completion of work with chemicals.

13.2.2. Personal Protective Equipment (PPE). Engineering and administrative controls are the preferred means of protecting personnel. The use of PPE is supplemental to and not a replacement for such controls. PPE is identified in the text and is also contained in AFOSH Standard 91-31 and in several AFOSH 48-series standards.

13.2.3. Fire Prevention. AFOSH Standard 91-43 will be referred to for guidance on the storage, use, and handling of flammable and combustible liquids. In addition, the installation fire department and AFOSH Standard 91-56 will be consulted for guidance on the selection and placement of fire extinguishers and the required training.

13.2.4. Equipment and Component Cleaning:

13.2.4.1. If compressed air is used, limit the air pressure to the lowest possible level (generally, 5 psi is adequate for equipment cleaning. At no time will air pressure exceed 30 psi when used for cleaning and only when the nozzle is equipped with effective chip guarding and PPE is used). Wear face shields and safety goggles when using compressed air.

13.2.4.2. If solvents are used, use only approved and authorized types and ensure adequate ventilation is maintained throughout the operation. Consult the installation BEE if in doubt about the characteristics of a solvent. AFOSH Standard 161-2 contains additional information on ventilation requirements.

13.2.5. Tools and Equipment:

13.2.5.1. Insulated metal tools will be used while performing work on energized equipment. Taping is not an acceptable means of insulation. Wooden handle tools will not be issued or used.

13.2.5.2. All tools will be kept clean and free of grease, paint, and foreign material and in a serviceable condition.

13.2.5.3. Tools, when not in use, will be kept in suitable containers and not in pockets or left on the floor of the work area.

13.2.5.4. Whenever a tool develops a defect during use, the operation will be stopped and the tool will be returned for repair or replacement.

13.2.6. Illumination. At least 50-foot candles of illumination will be maintained at the operator's position. Where necessary, additional artificial lighting will be supplied.

13.2.7. Occupational Health:

13.2.7.1. When noise level surveys have identified a need for hearing protection, either earplugs or earmuffs will be provided to all personnel and their use will be strictly enforced. Emphasis will also be placed on all personnel who are within the area and may be affected by a designated noise hazard when noise sources are operating.

13.2.7.2. Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes or body shall be provided within the work area for immediate emergency use. If personnel are exposed to materials less harmful than those previously addressed, but considered to be an irritant to the eyes, a portable eyewash that provides 15 minutes continuous flow may be used as an alternative for a plumbed eyewash. A water hose may NOT be used to meet the requirement in this paragraph. Medical attention will be obtained as soon as adequate flushing and drenching of the eyes and (or) body has been accomplished. Supervisors may contact the installation BEE or the ground safety staff for assistance in determining how to meet the requirements of this paragraph (AFOSH Standard 91-32).

13.2.7.3. Where there is a possibility of injury from caustic cleaning materials, flying particles, splatters, or chips, eye and (or) face protection will be worn.

13.2.8. Training:

13.2.8.1. First aid training will be provided at installation level for AAS individuals in need of such training. An initial group of first aid instructors will be trained either by installation medical services or by The American Red Cross. These instructors will be responsible for providing first aid training for AAS personnel. Those individuals requiring this training will be locally identified by the AAS supervisor, ground safety staff, installation BEE, and the fire department personnel.

13.2.8.2. CPR training will be provided for AAS individuals in need of such training. Each unit shall establish an initial group of CPR instructors. They may acquire this training from the installation medical services, The American Red Cross, or The American Heart Association.

13.2.8.2.1. Personnel whose normal daily job exposes them to energized electric circuits will be identified by the AAS supervisor as candidates for this training. MAJCOM, FOA, or DRU headquarters officials will determine voltage and average parameters and levels of exposure.

13.2.8.2.2. CPR training is emergency training and is not a substitute for safe electrical work practices.

13.2.8.2.3. Electrical circuits shall always be de-energized before attempting any work unless the nature of the work itself requires that the circuits remain energized.

13.2.9. Points to Remember:

13.2.9.1. Walking and Working Surfaces. Essential information is included in this standard. Consult AFOSH Standard 91-22 for more detailed information on walking surfaces, openings, and holes.

13.2.9.1.1. The entrance to the BAK-9 and BAK-12 pits is hazardous because of the ladder and hatchway counterweight proximity. In addition, the pits are hazardous because of the presence of the sump pump pit. Use extreme caution in both of these areas.

13.2.9.1.2. Use the two-person policy when working on the BAK-9 and BAK-12 due to pit cover weight and underground location, etc.

13.2.9.1.3. Be observant of liquid spills. Most fluids associated with the AAS are very slippery and can result in serious injury.

13.2.9.2. Active Runway Precautions. Communications are the key to this hazard. Ensure total communication is maintained with the tower and operations during all phases of maintenance and operations.

13.2.9.2.1. Maintain proper runway clearance as prescribed by local regulation and accepted Air Force standards, to include AFI 32-1044, *Visual Air Navigation Systems*.

13.2.9.2.2. Maintain adequate clearances to all types of engagements. **NOTE:** There is a hazard of the pendant or tape breaking, causing a whiplash of the extended tape or pendant.

13.2.9.3. Rotating Machinery Precautions. Rotating machinery is a hazard with all AAS. Use extreme caution during rewind operations and checkouts. Refer to 35E-8-series TOs and AFOSH Standard 91-12 for detailed guidance.

13.2.9.4. High Voltage Precautions. High voltages are present in the BAK-9 system; use caution and two-person policy.

13.3. Runway Barriers:

13.3.1. When engaging aircraft, the facilities (above or below ground) housing the arresting equipment shall be evacuated. Dangers arise from inhaling vapors and (or) brake pad dust (which may contain asbestos particles). In addition, equipment failure can cause debris to fly about. Operators shall remain clear of the tape sweep area. Bailout alarms should be included in barrier buildings to allow notification to evacuate the facilities by the tower.

13.3.2. When engaging an aircraft using the MA-1A system, a minimum safe distance from equipment is 25 feet.

13.3.3. Each operator shall be trained in the use of hand signals according to applicable TO, manual, or manufacturer's guide.

13.3.4. When returning to a facility (above or below ground) after an engagement or to clean the equipment, protective clothing and respiratory protection may be necessary. The type of clothing and respiratory protection will be recommended by the installation BEE for each location. This information shall be posted in each facility.

13.3.5. Safety gloves will be worn when rewinding the tape.

13.3.6. All arresting systems (barriers) require a minimum of three operators. Underground arresting systems require additional operators. Applicable TO 35E8-series will be referred to for requirements.

13.3.7. All operators shall be aware when cable is being rewound.

13.3.8. Sufficient ventilation will be provided during maintenance or rewinding operations.

13.3.9. Operators should be made aware of tripping hazards when using barriers. Hearing and respiratory protection shall be used, as required.

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

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

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

AFI 32-1024, *Standard Facility Requirements*.

AFI 32-1042, *Standards for Marking Airfields*.

AFI 32-1043, *Managing Aircraft Arresting Systems*.

AFI 32-1044, *Visual Air Navigation Systems*.

AFI 32-1045, *Snow and Ice Control*.

AFI 32-1062, *Electrical Power Plants and Generators*.

AFI 32-1063, *Electrical Power System*.

AFI 32-1064, *Electrical Safe Practices*.

AFI 32-1066, *Plumbing Systems*.

AFI 32-1067, *Water Systems*.

AFI 32-1068, *Heating Systems Unfired Pressure Vessels*.

AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program*.

AFI 40-201, *Managing Radioactive Materials in the USAF*.

AFI 48-101, *Aerospace Medical Program*.

AFI 91-202, *The US Air Force Mishap Prevention Program*.

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

Air Force Manual (AFM) 67-1 Vol 4, *Air Force Equipment System Policy and Procedures*.

AFM 85-3, *Paints and Protective Coatings*.

AFM 91-6, *Maintenance and Operation of Gas Systems*.

Air Force Manual (AFMAN) 24-306, *Manual for the Wheeled Vehicle Driver*.

AFMAN 24-309, *Vehicle Operations*.

AFMAN 91-201, *Explosives Safety Standards*.

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

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

AFOSH Standard 48-14, *Swimming Pools, Spas and Hot Tubs, and Bathing Areas*.

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

AFOSH Standard 48-21, *Hazard Communication*.

AFOSH Standard 48-22, *Occupational Exposure to Hazardous Chemicals in Laboratories.*

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

AFOSH Standard 91-5, *Welding, Cutting, and Brazing.*

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

AFOSH Standard 91-17, *Interior Spray Finishing* (formerly designated as AFOSH Standard 127-17).

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

AFOSH Standard 91-25, *Confined Spaces.*

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

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

AFOSH Standard 91-38, *Hydrocarbon Fuels General.*

AFOSH Standard 91-43, *Flammable and Combustible Liquids* (formerly designated as AFOSH Standard 127-43).

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

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

AFOSH Standard 91-56, *Fire Protection and Prevention* (formerly designated as AFOSH Standard 127-56).

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

AFOSH Standard 161-2, *Industrial Ventilation.*

Air Force Regulation (AFR) 67-12, *Storage and Handling of Compressed Gases Liquids in Cylinders, and of Cylinders.*

American National Standards Institute (ANSI) Standard A10.3, *Powder-Actuated Fastening Systems.*

ANSI Standard A10.8, *Scaffolding.*

ANSI Standard A90.1, *Safety Standard for Manlifts.*

ANSI Standard B30.11, *Monorails and Underhung Cranes.*

ANSI Standard B30.16, *Overhead Hoists (Underhung).*

ANSI Standard B71.1, *Lawn Mowers, Lawn and Garden Tractors, and Lawn Tractors.*

ANSI Standard B175.1, *Safety Specifications for Gasoline Powered Chain Saws.*

ANSI Standard B208.1, *Portable Pipe Threading Machines and Portable Power Drives.*

ANSI Standard C2, *National Electrical Safety Code.*

ANSI Standard D6.1, *Manual on Uniform Traffic Control Devices for Streets and Highways*.

ANSI Standard Z49.1, *Safety in Welding and Cutting*.

ANSI Standard Z133.1-1994, *Tree Care Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush—Safety Requirements*.

Department of Defense (DoD) Regulation 4145.19-R-1, *Storage and Materials Handling*.

Military Standard (Mil Std) 101B, *Color Code for Pipeline and for Compressed Gas Cylinders*.

National Fire Protection Association (NFPA) Standard 51, *Standard for the Design and Installation—Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*.

NFPA Standard 70, *National Electrical Code (NEC)*.

NFPA Standard 91, *Standard for Exhaust Systems for Air Conveying of Materials*.

NFPA Standard 101, *Code for Safety to Life from Fire in Buildings and Structures*.

NFPA Standard 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*.

NFPA Standard 491M, *Manual of Hazardous Chemical Reactions*.

National Institute for Occupational Safety and Health (NIOSH) 76-127, *Health and Safety Guide for Plumbing, Heating, and Air Conditioning Contractors*.

National Safety Council (NSC) Data Sheet 236, *Powder-Actuated Hand Tools*.

NSC Data Sheet 445, *Soldering and Brazing*.

NSC Data Sheet 468, *Electrostatic Paint Spraying and Detearing*.

NSC Data Sheet 470, *Blowtorches and Plumber's Furnaces*.

NSC Data Sheet 548, *Airless Spray Painting*.

NSC Data Sheet 550, *Atmospheres in Sub-Surface Structures and Sewers*.

NSC Data Sheet 577, *Sewer Pipe Cleaning*.

NSC Data Sheet 613, *Application of Protective Coatings for Water Pipes, Valves and Fittings*.

NSC Data Sheet 623, *Handling and Storage of Water Transmission Pipes and Fittings*.

Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.22, *Walking-Working Surfaces General Requirements*.

OSHA 29 CFR 1910.23, *Guarding Floor and Wall Openings and Holes*.

OSHA 29 CFR 1910.26, *Portable Metal Ladders*.

OSHA 29 CFR 1910.27, *Fixed Ladders*.

OSHA 29 CFR 1910.37, *Means of Egress, General*.

OSHA 29 CFR 1910.94, *Ventilation*.

OSHA 29 CFR 1910.101, *Compressed Gases, General Requirements*.

OSHA 29 CFR 1910.104, *Oxygen*.

OSHA 29 CFR 1910.106, *Flammable and Combustible Liquids*.

OSHA 29 CFR 1910.132, *Personal Protective Equipment General Requirements.*

OSHA 29 CFR 1910.133, *Eye and Face Protection.*

OSHA 29 CFR 1910.134, *Respiratory Protection.*

OSHA 29 CFR 1910.135, *Head Protection.*

OSHA 29 CFR 1910.141, *Sanitation.*

OSHA 29 CFR 1910.143, *Nonwater Carriage Disposal Systems.*

OSHA 29 CFR 1910.144, *Safety Color Code for Marking Physical Hazards.*

OSHA 29 CFR 1910.169, *Air Receivers.*

OSHA 29 CFR 1910.176, *Handling Materials—General.*

OSHA 29 CFR 1910.179, *Overhead and Gantry Cranes.*

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

OSHA 29 CFR 1910.181, *Derricks.*

OSHA 29 CFR 1910.184, *Slings.*

OSHA 29 CFR 1910.212, *General Requirements for All Machines.*

OSHA 29 CFR 1910.242, *Hand and Portable Powered Tools and Equipment, General.*

OSHA 29 CFR 1910.243, *Guarding of Portable Powered Tools.*

OSHA 29 CFR 1910.244, *Other Portable Tools and Equipment.*

OSHA 29 CFR 1910.252, *Welding, Cutting, and Brazing—General Requirements.*

OSHA 29 CFR 1910.265, *Sawmills.*

OSHA 29 CFR 1910.266, *Logging Operations.*

OSHA 29 CFR 1910, Subpart S—*Electrical.*

OSHA 29 CFR 1910, Subpart Z—*Toxic and Hazardous Substances:*

OSHA 29 CFR 1910.1001, *Asbestos.*

OSHA 29 CFR 1910.1200, *Hazard Communication.*

OSHA 29 CFR 1926.26, *General Safety and Health Provisions, Illumination.*

OSHA 29 CFR 1926, Subpart D—*Occupational and Environmental Controls:*

OSHA 29 CFR 1926.52, *Occupational Noise Exposure.*

OSHA 29 CFR 1926.55, *Gases, Vapors, Fumes, Dusts, and Mists.*

OSHA 29 CFR 1926.56, *Illumination.*

OSHA 29 CFR 1926.57, *Ventilation.*

OSHA 29 CFR 1926, Subpart E—*Personal Protection and Life Saving Equipment:*

OSHA 29 CFR 1926.100, *Head Protection.*

OSHA 29 CFR 1926.102, *Eye and Face Protection.*

OSHA 29 CFR 1926.103, *Respiratory Protection.*

OSHA 29 CFR 1926.104, *Safety Belts, Lifelines, and Lanyards.*

OSHA 29 CFR 1926.105, *Safety Nets.*

OSHA 29 CFR 1926.106, *Working Over or Near Water.*

OSHA 29 CFR 1926, Subpart F—*Fire Protection and Prevention:*

OSHA 29 CFR 1926.150, *Fire Protection.*

OSHA 29 CFR 1926.151, *Fire Prevention.*

OSHA 29 CFR 1926.152, *Flammable and Combustible Liquids.*

OSHA 29 CFR 1926, Subpart H—*Materials Handling, Storage, Use, and Disposal:*

OSHA 29 CFR 1926.250, *General Requirements for Storage.*

OSHA 29 CFR 1926.252, *Disposal of Waste Materials.*

OSHA 29 CFR 1926, Subpart I—*Tools—Hand and Power:*

OSHA 29 CFR 1926.301, *Hand Tools.*

OSHA 29 CFR 1926.302, *Power-Operated Hand Tools.*

OSHA 29 CFR 1926, Subpart L—*Scaffolds:*

OSHA 29 CFR 1926.450, *Ladders.*

OSHA 29 CFR 1926.451, *Scaffolding—General Requirements.*

OSHA 29 CFR 1926.500, *Scope, Application, and Definitions Applicable to Subpart M—Fall Protection.*

OSHA 29 CFR 1926, Subpart N—*Cranes, Derricks, Hoists, Elevators, and Conveyors:*

OSHA 29 CFR 1926.550, *Cranes and Derricks.*

OSHA 29 CFR 1926.552, *Material Hoists.*

OSHA 29 CFR 1926.554, *Overhead Hoists.*

OSHA 29 CFR 1926.556, *Aerial Lifts.*

OSHA 29 CFR 1926, Subpart O—*Motor Vehicles, Mechanized Equipment, and Marine Operations:*

OSHA 29 CFR 1926.600, *Equipment.*

OSHA 29 CFR 1926.601, *Motor Vehicles.*

OSHA 29 CFR 1926.602, *Material Handling Equipment.*

OSHA 29 CFR 1926.603, *Pile Driving Equipment.*

OSHA 29 CFR 1926.604, *Site Clearing.*

OSHA 29 CFR 1926.605, *Marine Operations and Equipment.*

OSHA 29 CFR 1926.606, *Definitions Applicable to Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operation:*

OSHA 29 CFR 1926, Subpart P—*Excavations*:

OSHA 29 CFR 1926.650, *Scope, Application, and Definitions Applicable to Subpart P—Excavations*.

OSHA 29 CFR 1926.651, *Specific Excavation Requirements*.

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

OSHA 29 CFR 1926.253, *Definitions Applicable to Subpart P—Excavations, Trenching, and Shoring*.

OSHA 29 CFR 1926, Subpart W—*Rollover Protective Structures; Overhead Protection*:

OSHA 29 CFR 1926.1002, *Protective Frames (Roll-Over Protective Structures, Known as ROPS) for Wheel-Type Agricultural and Industrial Tractors Used in Construction*.

OSHA 3067, *Concepts and Techniques of Machine Safeguarding*.

Technical Order (TO) 00-25-224, *Welding High-Pressure Gas and Cryogenic Systems*.

TO 00-25-235, *Safety Procedures and Equipment for Confined Space Entry-Including Missile Propellant Tanks*.

TO 1-1A-15, *General Maintenance Instructions for Support Equipment*.

TO 32-1-101, *Use and Care of Hand Tools and Measuring Tools*.

TO 35E8-2-4-1, *Operation and Maintenance Instruction Runway Overrun Barrier, MAI*.

TO 35E8-2-5-1, *Operation and Maintenance of the BAK-12 System*.

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

TO 47C-1-1, *Safety Instructions for Lawn Care Equipment*.

Abbreviations and Acronyms

AAS—Aircraft Arresting System

AC—Alternating Current

AFI—Air Force Instruction (current designation)

AFM—Air Force Manual (outdated designation)

AFMAN—Air Force Manual (current designation)

AFOSH—Air Force Occupational Safety and Health

AFR—Air Force Regulation (outdated designation)

AFTO—Air Force Technical Order

AFVA—Air Force Visual Aid

ANSI—American National Standards Institute

ASME—American Society of Mechanical Engineers

BCE—Base Civil Engineering

BE—Bioenvironmental Engineering

BEE—Bioenvironmental Engineer

BTU—British Thermal Unit

CE—Civil Engineering

cm—Centimeter

CNS—Central Nervous System

CPR—Cardiopulmonary Resuscitation

DC—Direct Current

DoD—Department of Defense

DOT—Department of Transportation

DRU—Direct Reporting Unit

EAID—Equipment Authorized Inventory Data

EOD—Explosive Ordnance Disposal

F—Fahrenheit

FOA—Field Operating Agency

GFCI—Ground Fault Circuit Interrupter

HTHW—High Temperature Hot Water

IDLH—Immediately Dangerous to Life and Health

JSA—Job Safety Analysis

kV—Kilovolt

kW—Kilowatt

LPG—Liquefied Petroleum Gas

MAJCOM—Major Command

Mil Spec—Military Specification

Mil Std—Military Standard

MSDS—Material Safety Data Sheet

MWR—Morale, Welfare, and Recreation

NEC—National Electric Code

NFPA—National Fire Protection Association

NIOSH—National Institute for Occupational Safety and Health

NSC—National Safety Council

OI—Operating Instruction

OJT—On-The-Job Training

ORM—Operational Risk Management
OSHA—Occupational Safety and Health Administration
PATMI—Powder-Actuated Tool Manufacturer's Institute
PDO—Publishing Distribution Office
PEL—Permissible Exposure Limit
PPE—Personal Protective Equipment
psi—Pounds Per Square Inch
psia—Pounds Per Square Inch Absolute
ROPS—Roll-Over Protective Structures
RPIE—Real Property Installed Equipment
sq mm—Square Millimeter
TA—Table of Allowance
TO—Technical Order
UL—Underwriter's Laboratory
US—United States
WWW—World-Wide Web

Terms

Air Atomizing Oil Burner—A burner in which the oil is atomized by compressed air forced into and through one or more streams of oil, breaking the oil into a fine spray.

Air Purge—The removal of undesired matter by replacement with air.

Air Vent—A valve opening in the top of the highest drum of a boiler or pressure vessel for venting air pressure. Also, a device (manual or automatic) which will effect the removal of air from a steam or hot water heating system, usually located at the highest point in the system.

Antikickback Devices—A safety device that is installed on table and rip saws so the dogs (tines) will ride on the stock to keep it from being forced up and back toward the operator.

Approved—Certified by the office of primary responsibility as being the correct product or method. Sanctioned, endorsed, accredited, certified, or accepted as satisfactory by a duly constituted and nationally recognized authority or agency, such as Underwriter's Laboratories, Inc. (UL), the Bureau of Mines, National Institute for Occupational Safety and Health (NIOSH), The National Fire Protection Association (NFPA), American National Standards Institute (ANSI), or other nationally recognized agencies which list, approve, test, or develop specifications for equipment to meet safety, fire prevention, or occupational health requirements.

Atomizer—A device to reduce a liquid to a very fine spray.

Automatic Transfer Panels—Electrical or electronic devices used to transfer an electrical load from a failed power source to an emergency source of electrical power.

Blowdown—Water drained from heating equipment, such as boilers, tanks, pipes, etc., to remove sludge or scale products.

Blowtorches and Plumber's Furnaces—Portable torches and furnaces using liquefied petroleum gas, gasoline, kerosene, or acetylene as a fuel.

Boiler Layup—Any extended period of time during which the boiler is not expected to operate and suitable conditions are made to protect it against corrosion, scaling, pitting, etc., on the water and fire sides.

Brazing—A technique for joining metals that are heated above 800 degrees F.

Breeching—A duct for the transport of the products of combustion between the boiler and the stack.

Caustics—Strong alkaline materials that have a corrosive or irritating effect on living tissue and organic or inorganic materials.

Certification (Boiler)—Verification, provided by an inspection company after semiannual equipment and (or) plant inspections, that the equipment meets or exceeds certain standards.

Certification (Personnel)—Licenses provided to qualified personnel testifying to their ability to maintain and operate plants and equipment (boilers, generators, powder-actuated tools, etc.).

Combustible Liquids—Liquids with flashpoints at or above 100 degrees F. Such liquids are subdivided into three classes: Class II liquids include those with flashpoints at or above 100 degrees F and below 140 degrees F; Class IIIA liquids have flashpoints at or above 140 degrees F and below 200 degrees F; Class IIIB liquids have flashpoints at or above 200 degrees F.

Condensate—Water returned to a heating plant from the distribution system (condensed steam).

Confined Space—An area which by design has limited openings for entry and exit; unfavorable natural ventilation that could contain or produce an actual or potentially hazardous atmosphere or other recognized safety or health hazard; or contains the potential for engulfment by particulate matter or by a liquid; and whose primary function is something other than human occupancy. Typical confined spaces include, but are not limited to, storage tanks, vats, pits, vaults, sumps, sewers, tunnels, manholes, etc.

Convection—The transmission of heat by the circulation of a liquid or a gas such as air. Convection may be natural or forced.

Damper—A device for introducing a variable resistance for regulating the volumetric flow of gas or air.

Design Pressure—The maximum allowable working pressure permitted under the rules of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

Draft—The difference between atmospheric pressure and some lower pressure existing in the furnace or gas passages of a steam generating unit.

Explosion—A rapid increase of pressure in a confined space followed by the sudden release of pressure due to rupture of the container (vessel structure, etc.). The increase in pressure is generally caused by a heat release chemical reaction or over-pressurization of a system.

Eye Hazard Areas—Areas with operations that could result in injuries to the eye. Refer to AFOSH Standard 91-31.

Eye and Face Protectors—Spectacles, goggles, shields, or hoods designed for the protection of the face and (or) eyes.

Feedwater—Treated water entering boilers to replace blowdown water, steam, or other water losses.

Fence—A device installed for the purpose of acting as a stop and guide for sawing the workpiece. Also called rip fence.

Fibrous Materials—Materials such as asbestos or fiberglass that are generated by the installation or modification of insulation around piping, boilers, and ventilation systems.

Flammable Liquid—Flammable liquids have flashpoints below 100 degrees F and vapor pressures not exceeding 40 pounds per square inch absolute (psia) at 100 degrees F. Such liquids are divided into three classes: Class I liquids include those with flashpoints below 100 degrees F and may be subdivided as follows: Class IA includes those with flashpoints below 73 degrees F and with boiling points below 100 degrees F; Class IB includes those with flashpoints below 73 degrees F and with boiling points at or above 100 degrees F; class IC includes those with flashpoints at or above 73 degrees F and below 100 degrees F.

Flashpoint—The lowest temperature at which vapors arising from fuel will ignite (momentarily flash) on application of a flame or spark.

Floor Hole—An opening measuring less than 12 inches but more than 1 inch in its least dimension in any floor, platform, pavement, or yard.

Floor Opening—An opening measuring 12 inches or more in its least dimension in any floor, platform, pavement, or yard.

Forced Draft Fan—A fan supplying air under pressure to the fuel burning equipment.

Ground Fault Circuit Interrupters (GFCI)—A device that is intended for the protection of personnel. The GFCI function is to de-energize a circuit or portion thereof within an established period of time, when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

May—Indicates an acceptable or satisfactory method of accomplishment.

Muriatic Acid—Commercial grade of hydrochloric acid. It is soluble in water and used to etch or clean old or new masonry work.

Oxygen-Deficient Atmosphere—An atmosphere containing less than 19.5 percent of oxygen by volume (OSHA minimum).

Potassium or Sodium Hydroxide—Caustic compounds used in water solution to wash and neutralize masonry work after it's cleaned with a muriatic acid solution.

Powder-Actuated Tools—Tools, such as ramsets, where cartridge-type explosives are the source of power.

Rotating, No-Break Uninterruptable Power System—An electrical device inserted into the electrical system to provide for continuous electrical power when switching from normal to emergency power.

Safety Relief Valve—An automatic pressure relieving device used to ensure safe pressures are not exceeded in pressure vessels.

Shall—Indicates a mandatory requirement.

Should—Indicates a preferred method of accomplishment.

Spreader—A piece of metal thinner than the saw kerf but thicker than the blade, shaped to follow the

approximate curve of a table saw blade, and placed one-half inch in back of the blade resting on the cutting table to prevent stock from kicking back.

TriSodium Phosphate—A strong detergent used in a water solution to clean masonry work.

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

Attachment 2

PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR CIVIL ENGINEERING OPERATIONS

Following is a quick reference guide to the PPE that may be required for selected activities and equipment in civil engineering operations. It is not all inclusive and the omission of an activity or item of equipment is not to be construed to mean that PPE is not required. The supervisor is ultimately responsible for providing and enforcing the wear of PPE that has been determined necessary for the task by the BE or ground safety staffs. Specific PPE for each work area and person is determined through coordination with the supervisor, unit commander, and installation supply, ground safety, and BE officials. The worker is responsible for the care and proper use of the PPE provided. Refer to AFOSH Standard 91-31 for more information on PPE.

OPERATION	PPE WHICH MAY BE REQUIRED
A2.1. Operating Construction Equipment:	
A2.1.1. Dump Truck, Roller, Paver	Safety-toe boots Gloves
A2.1.2. Loader, Grader, Sweeper, Backhoe, Bulldozer	Safety-toe boots Gloves Eye protection (if dusty) Hearing protection Respiratory protection (if dusty)
A2.1.3. Crane	Safety-toe boots Gloves Hearing protection Head protection
A2.2. Pavement Maintenance Equipment	
A2.2.1. Jackhammer, Pneumatic Drill	Respiratory protection Safety-toe boots Eye protection Hearing protection Gloves
A2.2.2. Concrete Saw, Router, Pavement Grinder	Safety-toe boots Grinder Eye protection

	Hearing protection
	Respiratory protection (if dusty)
	Gloves
A2.2.3. Asphalt Kettle	Safety-toe boots
	Eye protection
	Gloves
	Apron
A2.2.4. Concrete Mixer	Safety-toe boots
	Eye protection
	Respiratory protection
	Hearing protection (if noisy)
A2.3. Landscape Maintenance Equipment:	
A2.3.1. Walk-Behind Mower, Powered Edger	Safety-toe boots
	Eye protection
	Hearing protection
	Respiratory protection (if dusty)
A2.3.2. Riding Mower	Safety-toe boots
	Eye protection
	Hearing protection
	Respiratory protection (if dusty)
A2.3.3. Tractor-Towed Mower	Safety-toe boots
	Eye protection
	Hearing protection
	Respiratory protection (if dusty)
	Gloves
	Head protection (if overhead hazard exists)
A2.3.4. Chain Saw	Safety-toe boots
	Eye protection
	Hearing protection
	Respiratory protection (if dusty)
	Gloves
	Head protection
	Leggings (if available)
A2.3.5. Powered Auger Rototiller	Safety-toe boots
	Eye protection
	Hearing protection
	Gloves

A2.3.6. Stump Cutter, Chipper	Safety-toe boots Eye protection Hearing protection Gloves Head protection
A2.3.7. Lawn Roller	Safety-toe boots Gloves
A2.3.8. Fertilizer Handling and Application	Safety-toe boots Eye protection Respiratory protection
A2.4. Stationary Woodworking Machinery	Eye protection Hearing protection Respiratory protection (if dusty)
A2.5. Portable Power Tools	Eye protection Hearing protection Respiratory protection (if dusty)
A2.6. Powder-Actuated Tools	Eye protection Hearing protection
A2.7. General Carpentry, Painting, Plumbing, Sheetmetal, Welding, and Masonry	Safety-toe boots Eye protection Knee pad protection (if extended kneeling) Gloves
A2.8. Roofing	Fall protection Eye and burn protection (if using asphalt, e.g., gloves, long sleeve shirts, aprons, etc.)
A2.9. Soldering, Brazing, Welding	Safety-toe boots Eye protection Gloves Respiratory protection (if poorly ventilated spaces)
A2.10. Spray Painting	Eye protection Respiratory protection (if using dry tints) Gloves Coveralls
A2.11. Paint Mixing	Eye protection Respiratory protection (if using dry tints)

A2.12. Working in Sewers	Gloves Respiratory protection Gloves Rubber boots Head protection
A2.13. Metal-Working Machinery	Safety-toe boots Eye protection Gloves Head protection (if overhead crane system is in use)
A2.14. Mixing Concrete or Mortar	Safety-toe boots Gloves Eye protection Respiratory protection
A2.15. Placing Brick or Block, etc.	Safety-toe boots Gloves Eye protection
A2.16. Cleaning Masonry	Eye protection Acid resistant gloves
A2.17. Working Under Other Workers	Eye protection Head protection
A2.18. General Refrigeration or Heating Work	Safety-toe boots Gloves
A2.19. Exterior Electric Work or Overhead Distribution	Head protection Fall protection (safety harness, lanyard) Electrician gloves Safety-toe boots
A2.20. General Interior Electric and Power Production Work or Barrier Maintenance	Safety-toe boots Gloves Respiratory Protection Eye protection
A2.21. Battery Work (Liquid Electrolyte)	Safety-toe boots Acid resistant gloves and apron Eye and face protection

A2.22. General Water or Waste Work	Safety-toe boots Gloves Life vest
A2.23. Water or Waste Laboratory	Eye protection Respiratory protection Chemical resistant gloves
A2.24. General Materials Handling	Safety-toe boots Gloves Hard hat (overhead hazard)

Attachment 3**EQUIPMENT OPERATIONS, PAVEMENT, AND LANDSCAPE AND GROUNDS MAINTENANCE CHECKLIST**

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

A3.1. Equipment Operations and Pavements: Are training outlines for operator qualifications available and tailored to the particular equipment in possession? (Paragraph 3.1.)

A3.2. Backhoes:

A3.2.1. Are the front bucket (if so equipped) and outriggers in fully-down positions before digs are attempted? (Paragraph 3.1.1.)

A3.2.2. Is the entire area where the digging arm may swing cleared of people and equipment? Is clearance for fixed obstructions assured? (Paragraph 3.1.1.)

A3.2.3. Is operation under energized lines permitted only when absolutely necessary? Are these operations approved by the commander? (Paragraph 3.1.1.)

A3.2.4. During travel to and from worksites, is the backhoe folded, secured, and centered? Is the front bucket raised only high enough to provide adequate ground clearance? (Paragraph 3.1.1.)

A3.3. Mobile Cranes:

A3.3.1. Are mobile cranes operated only by authorized and qualified persons possessing a valid Operator's Identification Card or persons in training under direct supervision of a qualified operator? (Paragraph 3.1.2.)

A3.3.2. Is a list of qualified crane operators available? (Paragraph 3.1.2.)

A3.3.3. Have all potential crane operators passed a written examination containing safety requirements of this chapter and AFOSH Standard 91-46? (Paragraph 3.1.2.)

A3.3.4. During operation, is a person appointed to provide signals to the operator? (Paragraph 3.1.2.)

A3.3.5. Before leaving the crane unattended, are all shutdown procedures performed? (Paragraph 3.1.2.)

A3.3.6. Is a pre-operational inspection performed and annotated on AFTO Form 89 or other appropriate forms? Are discrepancies reported to the supervisor? (Paragraph 3.1.2.)

A3.3.7. Are load weights determined before lifting? (Paragraph 3.1.2.)

A3.3.8. Are outriggers set before lifting, telescoping the boom, or turning a load within the ratings? (Paragraph 3.1.2.)

A3.3.9. Are loads transported on cranes specifically designed for this purpose? (Paragraph 3.1.2.)

A3.3.10. Are personnel restricted from riding on loads or the hook? (Paragraph 3.1.2.)

A3.3.11. Are outriggers used, regardless of the load, when the ground is soft or otherwise unstable? (Paragraph 3.1.2.)

A3.3.12. When two or more cranes are used to lift one load, is one person designated as the responsible individual? (Paragraph 3.1.2.)

A3.3.13. Are normal routes for assigned cranes designated and approved by safety? (Paragraph 3.1.2.)

A3.3.14. Are required safety measures such as securing the empty hook, attaching warning flags (as necessary), etc., taken before the crane is moved to a new job site? (Paragraph 3.1.2.)

A3.3.15. Are all parts of the crane and load restricted within 10 feet of an energized power line? If this is not practical, is the line de-energized? (Paragraph 3.1.2.)

A3.3.16. Are additional clearances assured for work near lines greater than 50 kV and are they listed on AF Form 103? (Paragraph 3.1.2.)

A3.3.17. Is a permanent sign posted within the crane cab warning of electrical power line dangers and restrictions? (Paragraph 3.1.2.)

Are operators aware of necessary precautions in the event of contact with power lines? (Paragraph 3.1.2.)

A3.3.18. Is an approved fire extinguisher kept in the crane cab? (Paragraph 3.1.2.)

A3.4. Dump Trucks:

A3.4.1. Are dump trucks operated within the load capabilities established by the manufacturer and consideration given to the specified weights of the material being carried? (Paragraph 3.1.3.)

A3.4.2. Are personnel restricted from the bed while it is being raised? (Paragraph 3.1.3.)

A3.5. Motor Graders:

A3.5.1. Are operators familiar with manufacturer's operating instructions; in particular, required clearances? (Paragraph 3.1.4.)

A3.5.2. Is required PPE designated and used? (Paragraph 3.1.4.)

A3.6. Wheeled Loaders:

A3.6.1. Are operators familiar with manufacturer's operating instructions and weight limitations? (Paragraph 3.1.5.)

A3.6.2. Is required PPE designated and used? (Paragraph 3.1.5.)

A3.7. Bulldozers and Tracked Loaders:

A3.7.1. Are operators familiar with manufacturer's operating instructions? (Paragraph 3.1.6.)

A3.7.2. Is required PPE designated and used? (Paragraph 3.1.6.)

A3.8. Sweepers:

A3.8.1. Are sweepers operated on airfields equipped with headset radios in direct contact with control tower or escorted by a vehicle that is? (Paragraph 3.1.7.)

A3.8.2. Is hearing protection worn when required? (Paragraph 3.1.7.)

A3.9. Concrete Saw:

A3.9.1. Is a water supply maintained during operation? (Paragraph 3.1.9.)

A3.9.2. Is required PPE designated and used by personnel operating or within the hazard zone of the saw? (Paragraph 3.1.9.)

A3.10. Pavement Breaker (Jackhammer):

A3.10.1. Are proper lifting techniques used during equipment operation and transport? (Paragraph 3.1.10.)

A3.10.2. Is required PPE designated and used by operators and personnel within the hazard zone? (Paragraph 3.1.10.)

A3.11. Router. Is required PPE designated and worn by the operators and all personnel exposed to the hazards? (Paragraph 3.1.11.)

A3.12. Concrete Mixer:

A3.12.1. Are mixers supported in stable positions prior to operation? (Paragraph 3.1.12.)

A3.12.2. Is required PPE designated and used by all exposed personnel? (Paragraph 3.1.12.)

A3.13. Joint Seal Kettle-Melter:

A3.13.1. Are kettles operated in the vicinity of buildings only if fire department approval has been obtained? (Paragraph 3.1.14.)

A3.13.2. Is appropriate clothing, i.e., long sleeve shirts, long pants, etc., worn during operation? (Paragraph 3.1.14.)

A3.13.3. Are safety shoes and face shields worn by personnel handling the heated kettle product? (Paragraph 3.1.14.)

A3.13.4. Is an approved fire extinguisher available near the kettle? (Paragraph 3.1.14.)

A3.13.5. Is the safe heating temperature specified by the manufacturer maintained during heating? (Paragraph 3.1.14.)

A3.13.6. Is material eased into the kettle to prevent splashing? (Paragraph 3.1.14.)

A3.13.7. Are open flames or other sources of ignition not permitted near material heated to its flash-point? (Paragraph 3.1.14.)

A3.14. Pavement Grinders. Is required PPE designated and in use by personnel exposed to the hazards generated? (Paragraph 3.1.15.)

A3.15. Tampers. Are safety shoes and hearing protection used during operation? (Paragraph 3.1.16.)

A3.16. Compressed Air and Pneumatic Tools:

A3.16.1. Is compressed air never used to blow debris from personnel? (Paragraph 3.1.17.)

A3.16.2. Is the downstream pressure of compressed air used for cleaning purposes maintained below 30 psi and only used when effective chip guarding and eye protection are used? (Paragraph 3.1.17.)

A3.16.3. Are air supply lines marked or tagged to identify the maximum psi on the lines? (Paragraph 3.1.17.)

A3.16.4. Is eye and hearing protection (if required) worn when working around an operating air compressor and pneumatic tools? (Paragraph 3.1.17.)

A3.17. Portable Powered Equipment:

A3.17.1. Is required PPE designated and used during gasoline powered auger operations? (Paragraph 3.2.1.)

A3.17.2. Is a grounded power cord used when electric hedge clippers are not double insulated? (Paragraph 3.2.1.)

A3.17.3. Are electric power tools never operated in rain, sprinklers, or any kind of precipitation? (Paragraph 3.2.1.)

A3.18. Tire Removal and Mounting. Are multi-piece or split-rim tires gauged prior to installation and is the "80-percent rule" followed for inflation purposes? (Paragraph 3.2.2.)

A3.19. Mowing:

A3.19.1. Is required PPE designated and in use during the operation of lawnmowers? (Paragraph 3.2.3.)

A3.19.2. Are extension cords used for electric mowers or trimmers grounded, unless the equipment is listed or labeled as being double insulated? (Paragraph 3.2.3.)

A3.19.3. Are all mower discharge chutes guarded with shields or approved grass catchers and appropriate safety messages placed near the discharge opening? (Paragraph 3.2.3.)

A3.19.4. Are operators aware of special precautions to be used when mowing hills or slopes? (Paragraph 3.2.3.)

A3.20. Batteries:

A3.20.1. Is required PPE designated and used during battery servicing? (Paragraph 3.2.4.)

A3.20.2. Are nickel-cadmium and unsealed lead-acid batteries stored and serviced in separate areas? (Paragraph 3.2.4.)

A3.20.3. Are personnel prohibited from wearing rings, watches, bracelets or other metallic jewelry when working with batteries? (Paragraph 3.2.4.)

A3.20.4. Is battery charging done in specifically designated areas that are equipped with adequate ventilation, water supply, and (where necessary) emergency eyewash and shower? (Paragraph 3.2.4.)

A3.21. Tractor Operations:

A3.21.1. Are all tractors used for landscape maintenance equipped with rollover protection and seat belts? (Paragraph 3.2.5.)

A3.21.2. Are tractor operators prohibited from mowing grass on slopes of greater than 4-inch rise or drop per foot of travel? (Paragraph 3.2.5.)

A3.21.3. When using sickle-bar blades, do personnel always position them up hill? (Paragraph 3.2.5.)

A3.21.4. Are riders prohibited on tractors, the draw bar, or towed equipment except when specifically designed for such use? (Paragraph 3.2.5.)

A3.21.5. Are fenders in place on tractors? (Paragraph 3.2.5.)

A3.21.6. Are tractors left on inclines braked and blocked? (Paragraph 3.2.5.)

A3.21.7. Is the power take-off guard in place? (Paragraph 3.2.5.)

A3.21.8. Is required PPE designated and used by operators? (Paragraph 3.2.5.)

A3.22. Maintenance of Irrigation Systems:

A3.22.1. Are oxygen and combustible gas levels tested prior to entry to an irrigation pit? (Paragraph 3.2.6.)

A3.22.2. Are transformers and other electrical equipment located in waterproof boxes? (Paragraph 3.2.6.)

A3.22.3. Is required PPE designated and used? (Paragraph 3.2.6.)

A3.22.4. Are orange reflective vests worn when working within 15 feet of a roadway or parking lot? (Paragraph 3.2.6.)

A3.23. Tree Maintenance:

A3.23.1. Are a minimum of two workers and an on-site supervisor assigned during tree maintenance involving climbing, working from high reach lift, and cutting down trees other than small, low trees? (Paragraph 3.2.7.)

A3.23.2. Are all safety related climbing devices inspected prior to use? (Paragraph 3.2.7.)

A3.23.3. Does each climber have at least one lifeline and one handline? (Paragraph 3.2.7.)

A3.23.4. Is required PPE designated and in use by all workers involved in tree maintenance? (Paragraph 3.2.7.)

A3.23.5. Have supervisors performed a job safety analysis and developed local operating procedures for tree maintenance operations? (Paragraph 3.2.7.)

A3.24. Flower Bed and Shrub Maintenance:

A3.24.1. Are flowers and shrubs maintained at a height that does not interfere with the vision of vehicle operators? (Paragraph 3.2.8.)

A3.24.2. Are personnel restricted from working on flower or shrub beds within 24 hours of herbicide applications? (Paragraph 3.2.8.)

A3.25. Edging:

A3.25.1. Is required PPE designated and used? (Paragraph 3.2.9.)

A3.25.2. Is a grounded cord used when edgers are not double insulated? (Paragraph 3.2.9.)

A3.26. Herbicides:

A3.26.1. Are herbicides applied per manufacturer's instructions and used only by certified personnel? (Paragraph 3.2.13.)

A3.26.2. Is required PPE designated and used by personnel applying herbicides? (Paragraph 3.2.13.)

Attachment 4**CARPENTRY AND STRUCTURAL MAINTENANCE CHECKLIST**

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

A4.1. General:

- A4.1.1. Are all woodworking machines turned off when left unattended? (Paragraph 4.2.1.)
- A4.1.2. Are workers restricted from clearing or repairing equipment while it is operating? (Paragraph 4.2.1.)
- A4.1.3. Are machines shut down, locked out, and tagged during maintenance? (Paragraph 4.2.1.)
- A4.1.4. Are all machine guards in place and, if not, is the machine locked out and tagged? (Paragraph 4.2.1.)
- A4.1.5. Is required PPE designated and used by all exposed personnel? (Paragraph 4.2.2.)

A4.2. Ventilation Systems:

- A4.2.1. Are industrial ventilation systems installed, as required, and are they operational? (Paragraph 4.3.2.)
- A4.2.2. Do industrial ventilation systems exhaust to an enclosed collection container? (Paragraph 4.3.3.)

A4.3. Storage and Handling of Lumber:

- A4.3.1. When lumber is stored in tiers, is it stored properly? (Paragraph 4.4.1.)
- A4.3.2. Is smoking prohibited in lumber storage areas? (Paragraph 4.4.1.)
- A4.3.3. When stock cannot be safely handled by hand, is suitable material handling equipment available and used? (Paragraph 4.4.2.)
- A4.3.4. Are gloves worn by workers when handling lumber? (Paragraph 4.4.3.)

A4.4. Installed Equipment. Have the contents of AFOSH Standard 91-12 been complied with for installed equipment? (Paragraph 4.5.)

A4.5. Powder-Actuated Fastening Tools:

- A4.5.1. Are only specific size powder charges used as required by manufacturer's instructions? (Paragraph 4.6.1.)
- A4.5.2. Are powder-actuated tools prohibited from use for attaching material to soft construction materials? (Paragraph 4.6.1.)
- A4.5.3. Are operators trained and issued a qualified operator's card by the manufacturer or PATMI? (Paragraph 4.6.3.)

- A4.5.4. Is required PPE designated and in use by all exposed personnel? (Paragraph 4.6.4.)
- A4.5.5. Is the tool loaded only when ready to make the required fasten? (Paragraph 4.6.5.)
- A4.5.6. Are tools unloaded during transfer? (Paragraph 4.6.5.)
- A4.5.7. Are tools cleaned, maintained, and checked prior to use according to manufacturer's instructions? (Paragraph 4.6.5.)
- A4.5.8. Are tools stored unloaded and in a locked container? (Paragraph 4.6.5.)
- A4.5.9. Are tools equipped with proper shields? (Paragraph 4.6.5.)
- A4.5.10. Is use restricted in explosive or flammable atmospheres? (Paragraph 4.6.5.)
- A4.5.11. Are operators familiar with procedures in the event of a misfire? (Paragraph 4.6.5.)
- A4.5.12. Are unfired powder loads disposed of properly? (Paragraph 4.6.5.)
- A4.5.13. Are tool powder loads transported properly? (Paragraph 4.6.5.)
- A4.5.14. Are tool powder loads stored according to instructions in AFMAN 91-201? (Paragraph 4.6.5.)
- A4.5.15. Are warning signs posted in areas of tool use? (Paragraph 4.6.5.)
- A4.5.16. Does the operator ensure no personnel are present on the opposite side of the wall, structure, or material prior to firing a fastener into it? (Paragraph 4.6.7.)

A4.6. Roofing Operations:

- A4.6.1. Are roofing materials segregated and stored in stable conditions? (Paragraph 4.7.2.)
- A4.6.2. Are scaffolds provided or safety harnesses used as required? (Paragraph 4.7.4.)
- A4.6.3. Is required PPE designated and used for all exposed workers? (Paragraph 4.7.8.)
- A4.6.4. Are tar kettles and pots located so they will not pose a fire hazard? (Paragraph 4.7.9.)

A4.7. Masonry:

A4.7.1. Mixing Concrete and Mortar:

- A4.7.1.1. Are workers aware of potential hazards associated with the use of Portland Cement? (Paragraph 4.8.1.)
- A4.7.1.2. Is required PPE designated and used by exposed personnel? (Paragraph 4.8.1.)

A4.7.2. Cleaning and Etching Old and New Brick and Concrete Work. Are personnel aware of the hazards and is required PPE used when cleaning and etching brick and concrete work? (Paragraph 4.8.3.)

A4.7.3. Care and Use of Power Mixers and Trowels:

- A4.7.3.1. Are gears, pulleys, chains, or belts adequately guarded? (Paragraph 4.8.6.)
- A4.7.3.2. Is the power source for electrically operated mixers grounded? (Paragraph 4.8.6.)

A4.7.4. Preparation of Footings: Are locations of underground utilities identified prior to any excavations? (Paragraph 4.8.7.)

Attachment 5**PROTECTIVE COATING MAINTENANCE CHECKLIST**

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

A5.1. General:

A5.1.1. Is required PPE designated and used by all workers exposed to hazards addressed in this chapter? (Paragraph 5.1.1.)

A5.1.2. Are flammable and combustible liquids used and stored according to instructions in AFOSH Standard 91-43? (Paragraph 5.1.2.)

A5.2. Occupational Health and Toxic Materials:

A5.2.1. Are required control measures for exposures to pigments, extenders, and fillers instituted and enforced? (Paragraph 5.2.1.)

A5.2.2. Are required control measures for exposure to solvents instituted and enforced? (Paragraph 5.2.2.)

Attachment 6**PLUMBING MAINTENANCE CHECKLIST**

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

A6.1. Personal Protective Equipment: Is required PPE for all operations designated and in use by exposed personnel? (Paragraph 6.2.)

A6.2. Torches and Furnaces:

A6.2.1. Are operators trained and familiar with operating instructions of torches and furnaces before being permitted to use them? (Paragraph 6.4.1.)

A6.2.2. Are torches and furnaces restricted from use where flammable or explosive environments may be present? (Paragraph 6.4.1.)

A6.2.3. Is the use of gasoline torches and furnace prohibited in small, unventilated spaces? (Paragraph 6.4.1.)

A6.2.4. Are appropriate fire extinguishers available as required? (Paragraph 6.4.1.)

A6.3. Soldering and Brazing:

A6.3.1. Are electric soldering irons grounded unless double insulated? (Paragraph 6.4.2.)

A6.3.2. Are soldering irons placed in suitable non-combustible receptacles when not in use? (Paragraph 6.4.2.)

A6.3.3. Do personnel wear required safety eyewear during soldering and brazing operations? (Paragraph 6.4.2.)

A6.4. Industrial Waste Drains:

A6.4.1. Are industrial waste manholes treated as confined spaces and appropriate safety measures taken prior to entry? (Paragraph 6.5.)

A6.4.2. Is required PPE designated and used by personnel entering industrial waste manholes? (Paragraph 6.5.)

A6.5. Open Storm Drains:

A6.5.1. Are proper pry bar tools, special lifting tools, and additional help used when lifting manhole covers as necessary? (Paragraph 6.6.1.)

A6.5.2. Is required PPE designated and worn by personnel entering manholes? (Paragraph 6.6.3.)

A6.6. Gas Systems:

A6.6.1. Where a gas leak is suspected, is the area properly vented and purged and do personnel entering the area utilize required PPE? (Paragraph 6.7.)

A6.6.2. Are tools used to repair leaks or perform maintenance on gas lines spark-free and is clothing static-free? (Paragraph 6.7.)

A6.7. Tunnels, Pits, and Sumps:

A6.7.1. Are atmospheric conditions tested prior to entry into tunnels, pits, and sumps? (Paragraph 6.8.1.)

A6.7.2. Is required PPE designated, available, and used as necessary? (Paragraph 6.8.1.)

A6.7.3. Are tunnels, pits, and sumps (which are known to be contaminated) tagged or identified for information of work crews? (Paragraph 6.8.1.)

A6.7.4. Is a second person available to provide emergency assistance for persons entering a subsurface? (Paragraph 6.8.3.)

A6.8. Compressed Air:

A6.8.1. Are lines completely drained of existing air prior to opening compressed air lines? Are new lines completely secured prior to air entry into the system? (Paragraph 6.9.)

A6.8.2. Is required PPE designated and used while working on compressed air lines? (Paragraph 6.9.)

A6.8.3. Is air used for cleaning restricted to 30 psi and below? (Paragraph 6.9.)

Attachment 7**METAL FABRICATION AND WELDING MAINTENANCE CHECKLIST**

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

A7.1. Inert Gas Brazing and Welding:

A7.1.1. Are workers instructed on the hazards of inert gas asphyxiation in confined spaces? (Paragraph 7.1.)

A7.1.2. Are chambers completely ventilated and cooled prior to entry? (Paragraph 7.1.)

A7.1.3. Is adequate ventilation or, as necessary, air-supplied respiratory protection available? (Paragraph 7.1.)

A7.2. Electron Beam Welding. Are operating instructions for electron beam welding established and adhered to? (Paragraph 7.2.)

A7.3. Plasma Arc Cutting:

A7.3.1. Is required shielding in place and do walls, floors, ceilings, etc., have nonreflective surfaces? (Paragraph 7.3.1.)

A7.3.2. Are adequate controls (e.g., exhaust ventilation or approved respiratory protective devices) provided? (Paragraph 7.3.2.)

A7.4. Air Carbon-Arc Cutting. Do personnel, who are exposed to air carbon-arc cutting, use PPE that is designated and provided? (Paragraph 7.4.)

A7.5. Induction (Spot) Welding and Brazing. Do welders replace filter materials within induction coils and not attempt to adjust placement while the welding or brazing equipment is activated? (Paragraph 7.5.)

A7.6. Magnesium-Thorium Welding, Cutting, and Grinding. Prior to welding, cutting, or grinding operations on magnesium-thorium, is the installation Radiation Protection Officer consulted? (Paragraph 7.6.)

A7.7. Welding and Cutting Tanks, Cylinders, or Containers:

A7.7.1. Are all tanks, cylinders, or containers to be welded or cut, purged or made inert prior to the operation being conducted? (Paragraph 7.7.1.)

A7.7.2. Are pipelines to these containers disconnected prior to welding or cutting? (Paragraph 7.7.1.)

A7.8. Portable Gas Units:

A7.8.1. Are compressed gas cylinders equipped with pressure reducing regulators? (Paragraph 7.8.1.)

A7.8.2. Are cylinders stored in upright position with caps installed and secured with materials other than rope or other readily combustible material? (Paragraph 7.8.2.)

A7.8.3. Are gaseous systems and containers color-coded? (Paragraph 7.8.3.)

A7.8.4. Are pressure hoses secured to prevent whipping? (Paragraph 7.8.4.)

A7.8.5. Are oxygen cylinders and fittings free of grease and oil? (Paragraph 7.8.5.)

A7.8.6. Are cylinders kept separate from external sources of heat? (Paragraph 7.8.6.)

A7.8.7. Are approved devices provided for flashback protection? (Paragraph 7.8.8.)

A7.9. Portable Electric Units:

A7.9.1. Are units de-energized before they are tested, repaired, or transported? (Paragraph 7.9.1.)

A7.9.2. Are motor generators and other electrical equipment grounded prior to use? (Paragraph 7.9.2.)

A7.10. Arc Welding:

A7.10.1. Are necessary cable splices performed only by qualified electricians and are splices prohibited within 10 feet of the electrode holder? (Paragraph 7.10.5.)

A7.10.2. Do welders working close together on one structure follow requirements of paragraph 7.10.8.?

A7.11. Resistance Welding:

A7.11.1. Are thermal protection switches in use on ignition tubes? (Paragraph 7.11.1.)

A7.11.2. Are controls safeguarded from inadvertent activation? (Paragraph 7.11.2.)

A7.11.3. Are multi-gun welding machines guarded at the point of operation? (Paragraph 7.11.3.)

A7.11.4. Are all external weld-initiating control circuits operated on required voltage and are interlocks available to prevent access by unauthorized individuals? (Paragraph 7.11.4.)

A7.12. Welding in Confined Spaces:

A7.12.1. Are confined spaces where welding or cutting is performed adequately ventilated? (Paragraph 7.12.1.)

A7.12.2. Is a worker positioned on the outside of a confined space entry point to ensure the safety of those in the confined space? (Paragraph 7.12.3.)

A7.12.3. Are gas cylinders and welding machines left outside confined spaces? (Paragraph 7.12.4.)

A7.12.4. Are confined spaces tested for oxygen content and combustible vapors prior to entry? (Paragraph 7.12.8.)

A7.13. Hazards Associated With Fluxes, Coverings, Filler Metals, and Base Metals. Are precautions identified and requirements met when welding materials addressed in paragraph 7.13. and subsequent subparagraphs? (Paragraph 7.13.)

Attachment 8**REFRIGERATION AND AIR CONDITIONING MAINTENANCE CHECKLIST**

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

A8.1. General. Are all belts, pulleys, and rotating shafts adequately guarded? (Paragraph 8.2.2.)

A8.2. Storage and Handling. Are compressed gas cylinders adequately stored and handled? (Paragraph 8.3.)

Attachment 9**HEATING SYSTEMS AND CENTRAL HEATING PLANT MAINTENANCE CHECKLIST**

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

A9.1. Boiler Operations:

A9.1.1. Are written operating procedures and detailed checklists for operator guidance posted in all equipment rooms? (Paragraph 9.1.1.)

A9.1.2. Are purge procedures with necessary interlocks developed for normal start-up and on-line operations? (Paragraph 9.1.1.)

A9.2. Boiler Safety:

A9.2.1. Is water in boilers maintained at proper levels and checked? (Paragraph 9.2.1.)

A9.2.2. Are water columns monitored to ensure connections are clear and water returns to proper levels when drain valves are closed? (Paragraph 9.2.1.)

A9.2.3. Are appropriate actions taken when water is not visible in the gauge glass? (Paragraph 9.2.1.)

A9.2.4. Are furnace boilers and breaching ventilated prior to lighting? (Paragraph 9.2.2.)

A9.3. Cleaning and Maintenance Procedures:

A9.3.1. Are boilers, flames safeguard supervisory systems, and other safety controls inspected during scheduled shutdowns (at least annually) by authorized inspectors? (Paragraph 9.3.3.)

A9.3.2. Is required PPE designated and used during boiler cleaning? (Paragraph 9.3.5.)

A9.4. Steam Piping and Valve Maintenance:

A9.4.1. Are all 4-inch and larger steam valves or main steam valves operated only by authorized personnel? (Paragraph 9.4.1.)

A9.4.2. Are high-pressure steam valves in confined areas turned off only after steam is turned off at the main plant? (Paragraph 9.4.2.)

A9.4.3. When valves in a confined area are to be opened, is the main steam plant valve closed first? (Paragraph 9.4.3.)

A9.4.4. Are drain valves opened and water removed from steam lines prior to opening high-pressure steam valves? (Paragraph 9.4.5.)

A9.4.5. Is pressure relieved through all possible means prior to dismantling a valve? (Paragraph 9.4.8.)

A9.5. Vaults, Manholes, and Tanks. Are all vaults, manholes, and tanks considered confined spaces and proper precautions taken, e.g., atmospheric testing, use of respirators, etc., prior to entry or otherwise proven not hazardous? (Paragraph 9.5.)

A9.6. Central Heating Plants:

A9.6.1. Are all boilers equipped with steam and water gauges, gauge cocks, safety and blowoff valves, and low water cutoff devices? (Paragraph 9.6.1.)

A9.6.2. Are boiler feedlines equipped with check and cutoff valves? (Paragraph 9.6.1.)

A9.6.3. Are water gauge glasses located less than 15 feet from the floor or tender's platform carefully guarded? (Paragraph 9.6.1.)

A9.6.4. Are pressure gauges inspected and tested every 12 months? (Paragraph 9.6.1.)

A9.6.5. Are safety valves manually tested monthly or as required for high temperature water boilers? (Paragraph 9.6.1.)

A9.6.6. Are safety and blowoff valve discharge pipes located where discharge will not create a hazard? (Paragraph 9.6.1.)

A9.6.7. Are discharge lines from hot water heater relief valves arranged with the outlet within 6 inches of the floor, and not threaded, capped, or plugged? (Paragraph 9.6.1.)

A9.6.8. Are boilers operated at pressures within manufacturer's stamped instructions? (Paragraph 9.6.1.)

A9.6.9. Are hoistways, machinery, conveyors, gears, ash sluices, and reciprocating pumps properly guarded? (Paragraph 9.6.1.)

A9.6.10. Are all boiler furnaces operating at 7,000,000 BTU per hour or more staffed at all times? (Paragraph 9.6.2.)

A9.6.11. Is required PPE designated and used when working with acid or caustics? (Paragraph 9.6.3.)

A9.6.12. Are emergency eyewashes and showers installed if required? (Paragraph 9.6.3.)

A9.6.13. Is emergency equipment operable and inspected? (Paragraph 9.6.3.)

A9.6.14. Are all chemicals stored properly? (Paragraph 9.6.3.)

A9.6.15. Are railroad coal cars posted as required? (Paragraph 9.6.4.)

A9.6.16. Is there a qualified brakeman, other than coal-handling personnel, when working with the crane or switch engine? (Paragraph 9.6.4.)

A9.6.17. Are safety precautions established and followed whenever coal storage facilities are entered? (Paragraph 9.6.5.)

A9.6.18. Are relief valves installed after pumps on fuel pumping lines? (Paragraph 9.6.6.)

Attachment 10**INTERIOR AND EXTERIOR ELECTRIC MAINTENANCE CHECKLIST**

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

A10.1. Electric Motor Rewind Shops. Are capacitors disconnected for at least 5 minutes before circuit terminals are shorted by an approved method? (Paragraph 10.1.4.)

A10.2. Storage Batteries:

A10.2.1. Are open flames or spark-producing devices restricted in the vicinity of storage battery banks? (Paragraph 10.2.2.)

A10.2.2. Is a neutralizing solution available when work involves contact with electrolyte? (Paragraph 10.2.4.)

A10.2.3. When mixing acid and water, is the acid poured into the water and not vice-versa? (Paragraph 10.2.5.)

A10.2.4. When working with electrolyte, is required PPE available and used? (Paragraph 10.2.6.)

A10.3. Work on Energized Circuits:

A10.3.1. Is work on energized circuits performed only when absolutely necessary? (Paragraph 10.3.1.)

A10.3.2. Is approved protective equipment used when work on energized conductors or parts is performed? (Paragraph 10.3.3.)

A10.4. Work Near Energized Circuits:

A10.4.1. When air operated equipment is used around live parts, are the nozzles made of nonconducting material? (Paragraph 10.4.2.)

A10.4.2. Are appropriate warning tags used as a temporary means of warning employees of existing electrical hazards? (Paragraph 10.4.3.)

A10.5. Exterior Electric:

A10.5.1. Are leather gloves and safety-toed shoes worn when removing or replacing manhole covers? (Paragraph 10.5.1.)

A10.5.2. Are confined space entry precautions used when entering manholes and vaults? (Paragraph 10.5.1.)

Attachment 11**ELECTRICAL POWER PRODUCTION CHECKLIST**

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

A11.1. Plant Operations:

A11.1.1. Are generators located in outside facilities housed in weatherproof protection and all moving parts and electrical connections adequately guarded or covered? (Paragraph 11.1.2.)

A11.1.2. Are all metal frames for electrical control panels, switches, meters, and other hazardous electrical devices grounded not to exceed 25 ohms? (Paragraph 11.1.3.)

A11.1.3. Are standard operating procedures developed and posted for normal and emergency operations for equipment controls? (Paragraph 11.1.3.)

A11.2. Plant Maintenance:

A11.2.1. Is required PPE designated and used by personnel? (Paragraph 11.2.1.)

A11.2.2. Is jewelry removed prior to working on machinery? (Paragraph 11.2.1.)

A11.2.3. Are appropriate safety clearance tags and interlocks used to prevent accidental or unintentional start up of equipment that is being worked on? (Paragraph 11.2.2.)

A11.2.4. Does all test equipment have current calibration? (Paragraph 11.2.3.)

A11.2.5. Are proper jacking procedures used? (Paragraph 11.2.4.)

A11.3. Plant Switchgear and Substation:

A11.3.1. When work is performed on energized circuits, is it approved by the Civil Engineering Commander or designated representative? (Paragraph 11.3.1.)

A11.3.2. When performing approved work on energized circuits, are at least two fully qualified workers and necessary protective equipment available? (Paragraph 11.3.1.)

A11.3.3. When working adjacent to energized circuits exceeding 600 volts, are rubber blankets or other guards provided? (Paragraph 11.3.1.)

A11.4. Batteries:

A11.4.1. Are nickel-cadmium and unsealed lead-acid batteries stored separately? (Paragraph 11.4.4.)

A11.4.2. Is required PPE designated and used? (Paragraph 11.4.8.)

A11.4.3. If required, are emergency eyewashes and showers provided? (Paragraph 11.4.12.)

A11.5. Vaults and Manholes. Are vaults and manholes considered confined space hazards until proven otherwise and if so, are confined space requirements followed? (Paragraph 11.5.)

A11.6. Air Compressors:

A11.6.1. Are adequate safety relief valves installed on air tanks? (Paragraph 11.6.3.)

A11.6.2. Are valves prohibited between air tanks and safety valves? (Paragraph 11.6.5.)

Attachment 12**WATER AND WASTEWATER TREATMENT CHECKLIST**

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

A12.1. Nature of Hazards:

A12.1.1. Are required procedures and methods used in all areas addressed in this chapter when entering system components that can be classified as confined spaces? (Paragraph 12.1.2.)

A12.1.2. Are chlorinator treatment rooms that are identified as potential IDLH areas equipped with a telephone or are other means of communication used? (Paragraph 12.1.3.)

A12.1.3. Are chlorinator treatment rooms equipped with mechanical exhaust systems that are turned on prior to entry? (Paragraph 12.1.3.)

A12.1.4. Are written procedures developed for emergency conditions for chlorinator treatment rooms? (Paragraph 12.1.3.)

A12.2. Personal Sanitation and Protective Equipment:

A12.2.1. Is required PPE designated and used for all water and wastewater operations? (Paragraph 12.2.2.)

A12.2.2. Are emergency eyewashes and showers provided when necessary? (Paragraph 12.2.2.)

A12.3. Treatment Plant:

A12.3.1. Are emergency OIs developed? (Paragraph 12.3.)

A12.3.2. At shredding and grinding stations, is power turned off, tagged, and locked out before servicing? (Paragraph 12.3.2.)

A12.3.3. Are guards and screens in place at shredding and grinding stations? (Paragraph 12.3.2.)

Sedimentation Basin (Clarifier):

A12.3.3.1. Are approved life vests and lifelines located around the clarifier? (Paragraph 12.3.6.)

A12.3.3.2. Are guards provided around moving parts? (Paragraph 12.3.6.)

A12.3.4. Is the rotary distributor of the trickling filter anchored prior to inspection or servicing? (Paragraph 12.3.12.)

A12.4. Aeration Tanks:

A12.4.1. Are firm guardrails in place for work areas and walkways? (Paragraph 12.3.13.)

A12.4.2. Are approved life vests with lifelines located at appropriate points around aerator rails? (Paragraph 12.3.13.)

A12.5. Stabilization Ponds. Are life vests available and worn when working on a boat or raft? (Paragraph 12.3.14.)

A12.6. Laboratories:

A12.6.1. Are laboratories clean and designed safely and are chemicals stored properly? (Paragraph 12.5.2.)

A12.6.2. Is all electrical equipment properly grounded in laboratories? (Paragraph 12.5.4.)

A12.6.3. Is pipetting of chemicals by mouth restricted? (Paragraph 12.5.6.)

Attachment 13**AIRCRAFT ARRESTING SYSTEMS (AAS) CHECKLIST**

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

A13.1. Requirements:

A13.1.1. Is good housekeeping maintained in all AAS operations and maintenance areas? (Paragraph 13.2.1.)

A13.1.2. Are flammable and combustible liquids stored, used, and handled according to instructions in AFOSH Standard 91-43? (Paragraph 13.2.3.)

A13.1.3. When using compressed air for cleaning is air pressure less than 30 psi and is required PPE used? (Paragraph 13.2.4.)

A13.1.4. Is proper hearing protection provided and used as required? (Paragraph 13.2.7.)

A13.1.5. Where necessary, are emergency eyewashes and showers provided? (Paragraph 13.2.7.)

A13.1.6. Where required, is eye protection designated and used? (Paragraph 13.2.7.)

A13.1.7. When working on active runways, is total communication maintained with the tower and operations? (Paragraph 13.2.9.)

A13.2. Runway Barriers:

A13.2.1. Are facilities housing the AAS evacuated to proper distances? (Paragraph 13.3.1.)

A13.2.2. After engagement and upon returning to the AAS housing facility is required PPE designated and used? (Paragraph 13.3.4.)

A13.2.3. Are the minimum number of operators, according to applicable TOs available? (Paragraph 13.3.6.)