DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY MATERIEL COMMAND
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AMC REGULATION
No. 385-100

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Safety

SAFETY MANUAL

Local supplementation of this regulation is prohibited unless prior approval is obtained from the proponent.

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*This regulation supersedes AMC-R 385-100, 1 August 1985, and Change 1, 16 March 1990

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CHAPTER 1

INTRODUCTION

1-1. Purpose. This regulation prescribes the general safety rules of the U.S. Army Materiel Command (AMC).

1-2. Scope. This regulation applies to Headquarters (HQ), AMC; AMC major subordinate commands (including subordinate installations and activities); AMC project/product managers; and separate installations and activities reporting directly to Headquarters, AMC. It prescribes safe methods and practices for safeguarding personnel, ensuring continuity of production, and preventing property damage. Occupational safety and health standards promulgated under the Occupational Safety and Health Act (OSHA) are minimum requirements of AMC. AR 385-64, U.S. Army Explosives Safety Program and DA PAM 385-64, Ammunition and Explosives Safety Standards (AR/DA PAM 385-64) implement Department of Defense (DOD) ammunition and explosives safety standards. AMC-R 385-100 prescribes additional industrial and explosives safety standards for AMC operations and facilities. In cases where there is a conflict between OSHA and AMC standards, the more restrictive standard will apply and will be specifically incorporated as a requirement in construction and maintenance contracts and purchase requests. See AR 385-10, The Army Safety Program for additional guidance regarding conflicts in standards. Guides, codes, and safety standards of the National Safety Council, American National Standard Institute, National Fire Protection Association, and other nationally recognized organizations, not already mandated for implementation by this or other applicable regulations, may be used in conjunction with these regulations to develop appropriate local standards for safe practices and procedures, personal protective equipment, machine guards, etc. However, when these guides, codes, or standards are in conflict with OSHA standards or AMC regulations, the OSHA standards or AMC regulations whichever are more restrictive, shall apply. Nothing in this regulation shall be construed as obviating the need for compliance with other applicable regulations, standards, and laws.

1-3. Application. a. The mandatory requirements and advisory provisions set forth in this regulation apply to each activity and facility where the Commander, AMC is charged with the responsibility for safety.

b. Mandatory requirements are those in which the term "shall," "will," or "must" is used, and no deviation is permitted without specific written authority in the form of a waiver or exemption. The advisory provisions are those in which "may" or "should" are used, and no

deviations are permitted unless authorized in writing by the local commander. Advisory standards shall be interpreted as mandatory for new construction.

1-4. Responsibilities for Enforcement and Compliance. a. The Commander of an AMC command, installation, or activity is responsible for the safety of personnel and property under his control. At installations with tenant activities, the installation commander has overall responsibility for safety within the geographical confines of the installation. It is the responsibility of the commander to ensure that all activities are conducted per the safety rules and regulations set forth herein. The lack of existing regulations or standards does not relieve the commander of responsibility for developing local countermeasures for control of recognized hazards.

b. It is also the responsibility of the commander to require personnel of other agencies, while on an AMC establishment, to comply with the general safety regulations of his establishment and assure that operations and activities of tenant agencies do not endanger personnel and facilities for which he is responsible.

c. The commander shall enforce the mandatory requirements of this regulation and be guided by the advisory provisions. He shall institute those inspections necessary to effect compliance with the rules and regulations prescribed herein.

1-5. Authority for Stopping Unsafe Operations where Imminent Danger is Involved. a. The following personnel have authority to stop operations or practices which, if allowed to continue, could reasonably be expected to result in death or serious physical harm to personnel, major system damage, or endanger the installation's ability to accomplish its mission, immediately or before the imminence of such danger can be eliminated through regular channels:

(1) The safety/health/fire inspector.

(2) Radiation protection officer.

(3) Any operational supervisor.

(4) Operator or team member responding to specific Standing Operating Procedure (SOP) instructions regarding identification and reaction to a hazardous, potentially hazardous condition, or defined quality defect.

(5) Ammunition Surveillance/Quality Assurance Specialist (Ammunition Surveillance) GS-1910 Series and wage grade Ammunition Inspectors WG-6501 Series.

(6) Personnel within the installation's command chain who exercise supervisory authority over the preceding personnel.

b. Any action taken by any of the individuals, as authorized in paragraph a above, to stop an unsafe operation where imminent danger is involved, will be followed immediately by direct verbal, telephonic, or radio communication and notification to the installation commander or his designated alternate.

c. Personnel whose presence is necessary to avoid, correct or remove such imminent danger or to maintain the capacity of a continuous process operation to resume normal operations without a complete cessation of operations, or where a cessation of operations is necessary, to permit such to be accomplished in a safe and orderly manner may remain in the operation area.

1-6. Procedure Concerning Waivers or Exemptions of Safety Regulations. a. The policy of AMC is to comply with DOD, DA, and AMC explosives safety requirements. When a compelling reason makes a deviation from a mandatory requirement necessary, a commander or management official may request a waiver (temporary authority to deviate for a specified period, not to exceed 5 years) or an exemption (long term authority to deviate). The level of final approval authority depends upon the level of risk identified and the type of deviation (waiver or exemption).

b. Four risk levels are established as depicted in table 1-1. A risk assessment must be documented for each deviation. The risk assessment will include--

(1) A detailed description (including maps and drawings where applicable) of the deviation.

(2) The safety regulation(s) violated (cited by paragraph or subparagraph, as applicable).

(3) A statement of the compelling reasons necessitating the deviation, and corrective action plan and schedule.

(4) The interim control measures applied to minimize the risk.

(5) A statement of the residual risk level, with an explanation of its derivation from the matrix in table 1-1. (For deviations from Quantity-Distance (QD) requirements, the residual risk is the added risk attributable to the difference between the actual distance and the

			HAZARD PROBABILITY				
			Frequent	Likely	Occasional	Seldom	Unlikely
			A	B	C	D	E
HAZARD SEVERITY	Catastrophic	I	HIGH	HIGH	MEDIUM	LOW	
	Critical	II					
	Moderate	III					
	Negligible	IV					
			LEVELS OF RISK				

Table 1-1. Waiver and Exemption Level of Risk Matrix

	ACCEPTANCE AUTHORITIES	
RISK LEVEL	Residual Risks & Waivers	EXEMPTIONS
Extremely High	Commanding General, AMC	ASA(IL&E)
High	Commander, MSC	Chief of Staff, AMC
Medium	* Commander, MSC	Commander, MSC
Low	* Commander, MSC	* Commander, MSC

* Authority may be delegated in writing to the Installation/Activity Commander level.

Table 1-2. Waiver and Exemption Risk Acceptance Authorities

required distance. That risk is based solely on effect, and may not be reduced due to a low event probability. In other words, for QD deviations, use only the left column of Table 1-1. Estimate and record the increase in potential monetary loss, the number of exposed people, and the increase in the potential for injuries due to the deviation.)

c. Originating organizations must summarize each waiver or exemption in the mandatory Department of Army (DA) format prescribed in AR 385-64. Instructions are in appendix B, Draft AR 385-64. Submit requests through command channels to the appropriate final approval authority (see subparagraph 1-6e). The summary will be used to record signatures of the prescribed approval authorities at each successive organizational level.

d. Do not assign an identification number on the summary. Forward three copies of each signed waiver/exemption summary and one copy of the supporting documentation (listed in subparagraph 1-6b) approved at the MSC or lower level to HQ AMC, ATTN: AMCSF-X. HQ AMC will assign the identification number and forward one copy of the completed summary to the U.S. Army Technical Center for Explosives Safety (USATCES), ATTN: SMCAC-EST, and one copy to the originator.

e. Table 1-2 prescribes the approval authorities for waivers and exemptions, based on the level of risk. Those authorities will not be subdelegated below the officials indicated by the table.

f. A copy of each approved waiver and exemption will be maintained on file in the safety office of the installation where the deviation exists for as long as the deviation exists.

g. Originating organizations will implement procedures to review active waivers and exemptions not less than annually to determine continuing need. Whenever feasible, action will be taken to eliminate the need for waivers and exemptions, and to reduce the risk associated with those that cannot be canceled. When a waiver or exemption can be canceled, notify the final decision authority, the HQ AMC Safety Office, and USATCES, in writing.

h. Copies of supplemental waiver/exemption policies, procedures, or delegations of authority must be forwarded to the HQ AMC Safety Office, ATTN: AMCSF-X.

1-7. Safety Director. The commander of each AMC major subordinate command and installation and activity shall designate an individual who is occupationally qualified, according to Office of Personnel Management Standards, as either a Safety Engineer, GS-803, or Safety and Occupational Health Manager or Specialist, GS-018 to serve as safety

director. This individual shall be a member of the commander's staff, and, per AR 385-10, shall function as the principal staff advisor to the commander and staff in planning, organizing, directing, and evaluating all safety and occupational health efforts, including ammunition and explosives safety. This staff official will report directly to the commander on all safety program matters and should rely on technical expertise available and data generated from such sources as Quality Assurance Specialist (Ammunition Surveillance)(QASAS), Medical Personnel, Radiological Protection Personnel, Aviation Safety Officer, the Provost Marshal, and Fire Protection Personnel. In explosives and chemical agent and munitions operations, the duties of the Safety Director include responsibility for--

a. Reviewing all SOPs involving ammunition operations and assure incorporation of safety requirements from Depot Maintenance Work Request (DMWR)/Letter of Instruction (LOI).

b. Reviewing quantity distance consideration of sites selected for construction of facilities.

c. Reviewing design criteria for structures to resist the effects of accidental explosions.

d. Conducting periodic inspections of explosives workplaces for safety deficiencies.

e. Monitoring the actions required to correct explosives safety deficiencies identified by periodic internal as well as external inspection, accident investigations, and requirements resulting from the site plan/safety submission approval process.

f. Reviewing justification for waivers that may be necessary in the course of explosives and ammunition operations.

g. Assuring that all new equipment and operating lines are analyzed for hazards using system safety concepts and techniques before operations commence.

h. Providing information regarding correct hazard classification of ammunition and explosives, including those energetic materials in various process formulations.

i. Establishing local explosives safety policy in addition to that contained in this regulation.

1-8. Directors or Production Chiefs. Each director or production chief shall be responsible to the commander for the safety of his area. In addition, each shall aggressively promote the safety of activities within his area, shall comply with the requirements of this regulation and take an active part in the overall safety program.

1-9. Foremen or Supervisors. Each foreman or supervisor shall consider the identification and elimination of hazards and prevention of injuries to employees under his jurisdiction to be a major responsibility of his job, equivalent to his responsibility for quantity and quality of production. To accomplish this, he shall ensure his employees are trained in all safety requirements and hazards of the workplace, supervise them closely, enforce safety regulations, identify hazards of the workplace, take action to abate or eliminate identified hazards, investigate and report accidents, and take other action necessary to ensure the safety of the employee. The success of a safety program depends upon the ability of the operations foreman or supervisor and his enthusiastic participation in the organized safety effort.

1-10. Ammunition Surveillance. The ammunition surveillance organization and QASAS have unique qualifications and serve an essential role in the explosive safety program. The explosives safety functions of the QASAS are described in detail in AR 702-6.

1-11. Employees. Each employee, as a condition of employment, shall adhere to all instructions and use the personal protective equipment and protective devices provided. Failure to do so may result in disciplinary action. Employees should contribute any suggestions which may assist in the effort to prevent accidents and otherwise take an active part in the safety program.

1-12. Safety and Occupational Health Advisory Council Committee. See AR 385-10 and AMC Supplement 1 thereto for requirements and membership. Installations will comply with the requirements defined in AR 15-1, appendix A, Committee Management, and any supplements thereto.

1-13. Safety Program. There shall be only one safety program within any AMC subordinate command, installation, or activity (see para 1-4 for host-tenant safety responsibilities). The safety program shall be specific to the installation or activity and be all encompassing. The safety program will include functions prescribed in AR 385-10 and AMC Supplement 1 thereto. The safety program shall include a section on explosives safety if ammunition and explosives are handled or stored on the installation or activity.

1-14. Hazard Control. a. Hazard analysis is a practical, structured approach to identifying and eliminating or mitigating hazards before they result in accidents. Hazard analysis is essentially a before-the-fact accident investigation.

b. All operations, planned, regular, seasonal, or special shall be analyzed for identification and correction of hazardous conditions by the responsible supervisor. Hazard analyses shall support the development of SOPs for hazardous operations. The cognizant safety office will assist the supervisor in development of the hazard analysis when required, and will participate in evaluation of all residual hazards after control measures have been identified.

c. If all identified risks cannot be eliminated, the residual risk will require acceptance by the appropriate authority as identified in table 1-2, prior to conducting the operation.

d. To maintain benefit from hazard analyses performed, a continuous program of implementation and follow-up will be established. Specific assignments will be made for implementation of findings and recommendations and assuring the analyses are updated as changes in conditions occur.

e. Additional requirements for hazard analysis and control may be found in 29 CFR 1910.132, Personal Protective Equipment - General requirements, and 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals.

1-15. Educational Program. An educational program shall be instituted in each establishment to develop and maintain employees' interest in the safety program, and to train employees in safe practices and safe procedures. The safety director shall determine the need and arrange for the procurement and selective distribution of safety promotional and educational materials. Available media for employee education include posters, bulletin boards, scoreboards, special exhibits, "No accident" campaigns, safety or cleanup contests, articles in establishment publications, safety rules handout cards, pamphlets, warning signs for specific hazards, suggested systems, essay contests, and slides/films for groups of employees. Appropriate "off-the-job" accident prevention features shall be included in the program, and the safety organization should stimulate the interest of and cooperate with outside agencies concerned with this phase of the accident prevention program.

1-16. Employee Training. a. The employee's supervisor is responsible for preparing a written employee training program to ensure that the employee is trained in all safety requirements and hazards of the job. It is the responsibility of the training

department to assist all departments in determining training needs, and to provide courses to meet these needs. The personnel organization should collaborate with the safety office to ensure employee training meets applicable OSHA and Federal Agency Program training requirements.

b. All new employees must be made aware of installation general safety rules and regulations before being placed on the job. Each employee shall be trained in all the hazards and safety requirements for the specific job to which he/she is assigned. This training will be accomplished by the supervisor. Additional safety training may be accomplished by special instructors or by experienced workers through the apprenticeship method. The employee shall be thoroughly instructed in the efficient safe method of performing his/her assigned work before being permitted to work "on his/her own." The personal benefits accruing to the employee by conformity with these rules should be explained.

c. The supervisor should use a written job procedure (job breakdown) based on complete analysis of the job. Such analysis should include an outline of the necessary steps in the performance of each operation, a listing of the hazards preset in each step, and definite, positive instructions regarding each hazard which will enable the worker to avoid accidents or injury.

d. To ensure receiving the maximum benefits from any training, supervision shall maintain a continuous program of follow-up, reinstruction, and enforcement of regulations and procedures with each employee.

1-17. First-Aid Training. a. In the absence of an infirmary, clinic, or hospital within a 3- to 4-minute response time of hazardous workplace which can be used for the treatment of all injured personnel, a sufficient number of personnel as determined by the safety office in coordination with the medical officer and the training officer shall be adequately trained to render first aid. Designated first-aid responders will be enrolled in a bloodborne pathogen program and trained in the requirements of 29 CFR 1910.1030. First-aid supplies approved by the installation medical officer shall be readily available. Merely training personnel in first aid/CPR does not automatically make a person a first aid responder, invoking coverage of personnel by the Bloodborne Pathogens Standard. Coverage will be dictated by exposure potential and designated response responsibilities.

b. Cardiopulmonary Resuscitation (CPR) training is recommended for all employees. Periodic refresher training should be programmed.

1-18. Accident Prevention Records. A complete and accurate system of accident records is essential to a successful safety program. Accident records must be used, and used effectively, to obtain the best results in any accident prevention program. In order that effective accident cause analyses can be made, accident records will include data which will--

a. Indicate the accident trend.

b. Identify departments with the poorer records as well as those with superior records.

c. Reveal hazardous agencies, conditions, practices, and processes requiring correction or protection.

d. Point to predominant types of accidents.

e. Indicate employees who require special attention and/or training.

f. Reveal the lack of enforcement of established regulations.

g. Indicate the need for additional safety standards.

1-19. Accident Prevention Inspections. a. Supervisors shall inspect their workplaces daily to identify hazards.

b. All facilities shall be inspected at least annually using the Standard Army Safety and Occupational Health Inspection Procedures as outlined in AR 385-10 and AMC Supplement 1 to AR 385-10. All facilities involving hazardous operations, as designated by the Safety office, should be inspected at least quarterly with the exception of ammunition and explosives sites (see para 15-25). The safety official shall arrange for prompt inspections of any seasonal or unusual work of a hazardous nature.

c. Accident prevention inspections shall be systematic and thorough so that no location will be overlooked. Contractor performed safety inspections need not meet all format requirements of AR 385-10 provided that the essential elements of identification, recording, communicating, and correcting hazards are active elements of the contractor inspection program. At installations where QASAS provide magazine and demilitarization facility inspections on a 100 percent basis, the safety office will perform as a minimum a semiannual inspection of the demilitarization areas and annually inspect 5 percent of the magazines on a random sampling basis.

d. The manager, supervisor, or operations foreman should accompany the safety inspector. The safety inspector will provide the responsible supervisor or manager with inspection findings before leaving the area or as soon as possible thereafter in order that hazards may be promptly corrected or abatement plans developed.

CHAPTER 2

GENERAL DEFINITIONS

The terms defined, with the meanings indicated, are used in this regulation for this purpose only and should not be considered as being in conflict with other Department of the Army regulations or usage.

2-1. Administration Area. The area in which administrative offices are located which function for the establishment as a whole in contrast to field offices (para 2-34).

2-2. Alternate Standard. A standard designed to take the place of an OSHA standard when the pertinent OSHA standard does not meet the needs of the installation or command. An alternate standard must provide equivalent or greater protection for affected employees and must be approved by HQ AMC, ATTN: AMCSF; Headquarters, Department of the Army (HQDA), ATTN: DACS-SF and Department of Labor (DOL).

2-3. Ammunition. Type of munitions normally containing explosives, propellant, pyrotechnics, initiating composition, nuclear, or chemical material which are designed to inflict damage upon structures, personnel, materiel or military objectives. Ammunition includes cartridges, projectiles, grenades, bombs, pyrotechnics, and mines together with projectiles such as bullets, shot, and their necessary primers, propellants, fuzes, and detonators.

2-4. Approved. Complying with the provisions of this regulation and with instructions and details issued by the Commander, AMC, or with those of other approving agencies specifically referred to herein.

2-5. Azimuth. In gunnery, the angle of horizonal deviation, measured clockwise of a bearing from a standard direction, as from North or South (synonymous with line of fire).

2-6. Barricade. An intervening approved barrier, natural or artificial, of such type, size and construction as to limit in a prescribed manner, the effect of an explosion on nearby buildings or exposures.

2-7. Barricaded. To be protected by a barricade.

2-8. Blast. The brief and rapid movement of air or fluid away from a center of outward pressure, as in an explosion; the pressure accompanying this movement.

2-9. Bombproof (Shelter). An approved structure emplaced to provide protection to personnel and equipment.

2-10. Change House. A building provided with facilities for employees to change to and from work clothes. Such buildings may be provided with sanitary facilities, drinking fountains, lockers, and eating facilities.

2-11. Chemical Agent. A chemical compound used in military operations to kill, seriously injure, or incapacitate persons through its chemical properties. Excluded are research, development, test and evaluation (RDTE) dilute solutions, riot control agents, chemical defoliants and herbicides, smoke, flame and incendiaries, and industrial chemicals.

2-12. Chemical Ammunition. Ammunition, the filler of which has the basic function of producing a toxic or irritant effect on the body, a screening or signaling smoke, or an incendiary action.

2-13. Classification Yard. A group of railroad tracks or paved area used for receiving, shipping, and switching railway cars or motor vehicles.

2-14. Clearance (Range). Obtained from appropriate range control/ range safety officer or person having jurisdiction.

a. Testing/Firing/Demolition Clearance. Permission to conduct a materiel test or demolition operation.

b. Entrance/Exit Clearance. Permission to enter or exit a danger area.

2-15. Craft. Any ship, vessel, or floating object used for transportation over water. The term "small craft" includes rowboats, lifeboats, dinghies, rubber rafts, and similar non-power craft.

2-16. Component. Any part of a complete item whether loaded with explosives (commonly called "live"), inert (not containing explosives), or empty.

2-17. Danger area. Those areas of the establishment in which operations/tests are conducted and into which no one is permitted to enter, to be within, or conduct tests within until clearance has been obtained from a range control/range safety person or person having jurisdiction over danger area being entered.

2-18. Danger zone. A zone within a danger area, such as impact fields and recovery fields, the size of which varies with the class of firing, which is hazardous to life and property because of the dangers incident to the use of material or ammunition.

2-19. Deflagration. A rapid chemical reaction in which the output of heat is sufficient to enable the reaction to proceed and be accelerated without input of heat from another source. Deflagration is a surface phenomenon with the reaction proceeding towards the nonreacted material along the surface at subsonic velocity. The effect of a true deflagration under confinement is an explosion. Confinement of the reaction increases pressure, rate of reaction and temperature, and may cause transition into a detonation.

2-20. Deflection. Deviation from the horizontal.

2-21. Demilitarize. To mutilate, disarm, neutralize, and to accomplish any other action required to render ammunition, explosives, and chemical agents innocuous or ineffectual for military use.

2-22. Detonation. A violent chemical reaction within a chemical compound or mechanical mixture evolving heat and pressure. A detonation is a reaction which proceeds through the reacted material toward the unreacted material at a supersonic velocity. The result of the chemical reaction is exertion of extremely high pressure on the surrounding medium forming a propagating shockwave which is originally of supersonic velocity. A detonation, when the material is located on or near the surface of the ground, is normally characterized by a crater.

2-23. Dud. Explosive munition which has not armed as intended or which has failed to function after being armed.

2-24. Elevation (quadrant). The angle that the axis of the weapon makes with the horizontal.

2-25. Employees and Personnel. Any and all persons employed within the confines of the installation and all authorized transients.

2-26. Environmental Conditioning Units (ECU). Equipment used for environmental conditioning of items.

2-27. Establishment. Any plant, works, arsenal, depot, proving ground, or any other activity under control of the Commanding General, AMC.

2-28. Exemption. A relatively long term exception (greater than 5 years) to an otherwise mandatory requirement of the regulation. Exemptions will not be granted for a period in excess of that estimated to be required for correction.

2-29. Explosive Anchorage. An area upon navigable waters within which a vessel may anchor or moor to handle, stow, store, load, or discharge explosives as cargo.

2-30. Explosives. The term "explosive" or "explosives" include any chemical compound or mechanical mixture which, when subjected to heat, impact, friction, detonation or other suitable initiation, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases which exert pressures in the surrounding medium. The term applies to materials that either detonate or deflagrate.

2-31. Explosives Area. A restricted area specifically designated and set aside from other portions of an installation for the manufacturing, processing, storing, and handling of explosives and ammunition.

2-32. Field Office. An office required by operational supervision (e.g., foremen and line supervisors) in direct support of ammunition and explosives operations.

2-33. Firebrand. A projected burning or hot fragment whose thermal energy is transferred to receptor.

2-34. Fire hazard Area. A location in which the primary but not necessarily the only hazard is that of fire including "explosions" of gas or vapor and air mixtures.

2-35. Fire-Resistive. A term used to indicate the property of structures or materials to resist a fire to which they might be subjected without themselves becoming weakened to the point of failure.

2-36. Fire-Retardant. A term used to designate generally combustible materials or structures which have been treated or have surface coverings designed to retard ignition or fire spread.

2-37. Firing Point or Position. The location from which a projectile, bomb, grenade, flare, ground troop signal, rocket, guided missile, or other device is to be ignited, propelled, or released.

2-38. Fire Wall. A wall of fire-resistive construction designed to prevent the spread of fire from one side to the other. A fire wall may also be termed a "fire division wall."

2-39. Fixed Ammunition. Ammunition, except small arms and rocket ammunition, consisting of a cartridge case loaded with propellant and a projectile which are loaded in one operation into the weapon, the cartridge case being firmly attached to the projectile.

2-40. Flame Resistant. A term applied to combustible materials, such as clothing, which have been treated, coated, or designed to decrease their burning characteristics (e.g., fabrics which meet the requirements of MIL-C-43122).

2-41. Flammable. A flammable material is one which is easily ignited and burns readily.

2-42. Fragmentation. The breaking up of the confining material of a chemical compound or mechanical mixture when an explosion takes place. Fragments may be complete items, subassemblies, pieces thereof, or pieces of equipment or buildings containing the items.

2-43. Hazardous Fragment. A hazardous fragment is one having an impact energy of 58 ft-lb or greater.

2-44. Hazardous Fragment Density. A density of hazardous fragments exceeding 1 per 600 square feet.

2-45. Hangfire. Temporary failure or delay in the action of a primer, igniter, or propelling charge.

2-46. Hazard. Any condition which may result in the occurrence, or contribute to the severity of an accident.

2-47. Hazard Analysis. The logical, systematic examination of an item, process, condition, facility, or system to identify and analyze the probability, causes, and consequences of potential or real hazards.

2-48. Hazardous Material. Any compound, mixture, element or assemblage of material which, because of its inherent characteristics, is dangerous to manufacture, process, store, or handle.

2-49. Holding Yard. An area containing groups of railcars, trucks or trailers used to hold ammunition, explosives, and other dangerous materials for interim periods prior to storage or shipment.

2-50. Hypergolic. Self igniting upon contact of fuel and oxidizer, without a spark or external aid.

2-51. Impact area. An area designated for the impacts of a projectile, bomb, rocket, guided missile or other items.

2-52. Inert (As Applicable to Ammunition). Containing no explosives or chemical agents.

2-53. Inert Area. Any area other than an explosives or ammunition area within an establishment.

2-54. Inert Components. The parts of ammunition which do not contain explosives or chemical agents.

2-55. Inhabited Building. A building or structure other than operating buildings, magazines and auxiliary buildings occupied in whole or in part as a habitation for human beings, or when people are accustomed to assemble, both within and outside of Government establishments. Land outside the boundaries of AMC establishments shall be considered as possible sites for inhabited buildings.

2-56. Interchange yard. A location set aside for the exchange of rail cars or trailers between a common carrier and the Government.

2-57. Intraline Operations. Those processes accomplished within one operating line.

2-58. Loading Docks. Loading docks are facilities at ground level or elevated structures designed and installed for transferring explosives, ammunition, and components parts thereof to or from automotive vehicles or railway cars.

2-59. Magazine. A structure designed or specifically designated for the storage of explosives or ammunition.

2-60. Magazine Area. A restricted area, specifically designated and set aside from other portions of the establishment of the primary purpose of ammunition and explosives storage.

2-61. Mass Detonation. The virtually instantaneous explosion of a mass of explosives when only a small portion is subjected to fire, severe concussion or impact, the impulse of an initiating agent, or to the effect of a considerable discharge of energy from without.

2-62. Materiel Test. Any research, experimental, development, surveillance, or acceptance test of materiel or ammunition.

2-63. Maximum Credible Event (MCE). In hazards evaluation, the maximum credible event from a hypothesized accidental explosion, fire, or agent release is the worst single event that is likely to occur from a given quantity and disposition of ammunition, explosives, chemical agent, or reactive material. Event must be realistic with a reasonable probability (see MIL-STD-882) of occurrence considering the

explosion propagation, burning rate characteristics, and physical protection given to the items involved. The MCE evaluation on this basis may then be used as a basis for effects calculations and casualty predictions.

2-64. Military Pyrotechnic. Ammunition manufactured specifically for use as signals, illuminants, and like items.

2-65. Military Unique Equipment. The term "uniquely military equipment, systems, and operations" is interpreted as the design of Department of Defense equipment and systems that are unique to the national defense mission, such as military aircraft, ships, submarines, missiles and missile sites, early warning systems, military space systems, artillery, tanks, and tactical vehicles; and operations that are uniquely military such as field maneuvers, naval operations, military flight operations, associated research test and development activities and actions required under emergency conditions. It does not include Department of Defense workplaces and operations comparable to those of industry in the private sector such as: vessel, aircraft, and vehicle repair, overhaul, and modification (except for equipment trials); construction; supply services; civil engineering or public works; medical services; and office work.

2-66. Misfire. Failure of a component to fire or explode following an intentional attempt to cause an item to do so.

2-67. Navigable Streams. Those parts of streams, channels, or canals capable of being used in their ordinary or maintained condition as highway of commerce over which trade and travel are or may be conducted in the customary modes, not including streams which are not capable of navigation by barges, tugboats, and other large vessels unless they are extensively and regularly used for operation of pleasure boats.

2-68. Noncombustible. Not combustible, not burnable in the ordinary sense of the word.

2-69. Normal Maintenance. Work performed on ammunition to prevent deterioration and to correct minor defects not requiring renovation or major modification operations.

2-70. Operating Building. Any structure, except a magazine, in which operations pertaining to manufacturing, processing, or handling explosives or ammunition are performed.

2-71. Operating Line. The group of buildings used to perform the consecutive steps in the manufacture, loading, assembling, modification, normal maintenance, renovation, demilitarization, testing, or salvaging of an item of ammunition or explosive.

2-72. Operational Shield. A barrier constructed per MIL STD 398 to protect personnel, materiel, or equipment from the effects of a possible fire or explosion occurring at a particular operation.

2-73. Operator. A person assigned to perform a specific function defined in an SOP.

2-74. Operator Workstation. A specific area where an operator is assigned to perform operations described in the relevant SOP.

2-75. Outdoor Storage Sites. Locations selected within the magazine area for the storage of ammunition and, in exception cases, inert items. These locations can be any of the following types:

a. Earth revetted four sides (except entrance) located between earth-covered magazines.

b. Earth revetted four sides (except entrance) not located between earth-covered magazines.

c. Nonrevetted with roof cover only (not located between earth-covered magazines).

d. Nonrevetted without cover (not located between earth-covered magazines).

2-76. Patrol craft. A powered craft for patrolling restricted waters.

2-77. Public Highway. Any street, road, or highway not under DOD custody used by the general public for any type of vehicular travel.

2-78. Public Traffic Route. Any public street, road, highway, navigable stream, or passenger railroad (includes roads on a military reservation which are open to the public for thoroughfare).

2-79. Passenger Railroad. Any steam, diesel, electric, or other railroad which carries passengers for hire.

2-80. Propellant, Solid. Explosives compositions used for propelling projectiles and rockets and to generate gases for powering auxiliary devices.

2-81. Pyrotechnic Material. The explosive or chemical ingredients, including powdered metals, used in the manufacture of military pyrotechnics.

2-82. Quality Assurance Specialist (Ammunition Surveillance)(QASAS). Department of the Army Civilians that function in the ammunition surveillance program at DOD installations, activities, and commands that receive, store, maintain, issue, use, and dispose of ammunition.

2-83. Quantity-Distance (QD). The quantity of explosives material and distance separation relationships which provide defined types of protection. These relationships are based on levels of risk considered acceptable for the stipulated exposures and are tabulated in the appropriate quantity-distance tables in DA PAM 385-64.

2-84. Range. Horizontal distance only.

2-85. Range Control. The organization where a range controller works.

2-86. Range Controller/Safety Person. A qualified individual having detailed responsibilities over safety in a danger area.

2-87. Range Safety Officer. Person responsible for the Range Safety Program.

2-88. Range Work Crew. Individual(s) required to perform tasks within a range area. Work may be required to be performed where significant hazards from munitions, terrain, equipment, etc., may exist.

2-89. Recovery Field. An area used for observing burst or impact of bombs or projectiles for subsequent recovery.

2-90. Renovation. That work performed on ammunition, missiles, or rockets to restore them to a completely serviceable condition; usually involves the replacement of unserviceable or outmoded parts.

2-91. Restricted Area. Any area, usually fenced, at an establishment where the entrance and egress of personnel and vehicular traffic are controlled for reasons of safety.

2-92. Rocket. A complete missile which derives its thrust from ejection of hot gases generated from propellants carried in the missiles.

2-93. Rocket Motor. That portion of the complete rocket which is loaded with propellant.

2-94. Roentgen. The unit of measure of the total quantity of X or gamma radiation, absorbed in air. This is technically defined as the

amount of X or gamma radiation which as a result of ionization will produce in cubic centimeter of dry air, at standard conditions of temperature and pressure, ions carrying one electrostatic unit of electricity of either sign.

2-95. Safety Director. The individual (occupationally qualified according to civil service requirements) responsible for managing all aspects of the safety program.

2-96. Semi-fixed Ammunition. Ammunition loaded into a weapon in one operation and whose cartridge case is not firmly attached to the projectile so that the propelling charge may be adjusted for zone firing.

2-97. Separate-Loading Ammunition. Ammunition whose propelling charge and projectile are loaded separately into the weapon.

2-98. Separated-Loading Ammunition. Ammunition consisting of a projectile and a primed cartridge case containing propellant. Unlike separate loading ammunition, the propelling charge is not adjustable for zone firing.

2-99. Service Magazine. An auxiliary building used for the intermediate storage of explosives materials not exceeding the minimum amount necessary for the safe efficient production.

2-100. Simultaneous Detonation. Detonation of separated quantities of explosives of ammunition occurring so nearly at the same time that the affect the surroundings is the same as if the several quantities were not separated and were detonated enmasse.

2-101. Small Arms Ammunition. Ammunition used in firearms of caliber up to and including caliber .60 and shotguns.

2-102. Storage Compatibility. A relationship between different items of ammunition, explosives, and other dangerous materials whose characteristics are such that a quantity of two or more of the items stored or transported together is not more hazardous than a comparable quantity of any one of the items stored alone.

2-103. Static Detonation Site. The location from which an explosives item, either on the ground or secured in a fixture, is initiated.

2-104. Substantial Dividing Wall. An interior wall designed to prevent detonation of quantities of explosives on opposite sides of the wall.

2-105. Supplementary Standard. A standard designed to supplement safety standards issued by OSHA when no appropriate OSHA standard currently exists covering the particular situation. The subject matter of such a standard must be forwarded through channels to DOL.

2-106. Surface Danger Zones (SDZ). That segment of the range area which is endangered by a particular type of testing.

2-107. Suspect Car Track. A railway spur track where a car suspected of being in a hazardous condition can be examined prior to unloading of the explosive contents.

2-108. Surveillance. The observation, inspection, test, study, investigation, and classification of ammunition, ammunition components, and explosives in movement, storage, and use, with respect to degree of serviceability and rate of deterioration.

2-109. Surveillance Workshop. A special building equipped to permit all normal ammunition surveillance inspections.

2-110. Test Sites. Locations where materiel testing is conducted.

2-111. Test Director/Officer. A trained, certified individual responsible for conduct of a materiel test.

2-112. Transient. A person with official business on a production line or operation but who is not routinely assigned to a specific limited location. Typically, transients are roving supervisors, quality assurance, or maintenance personnel.
Official visitors are considered transients.

2-113. Utilities. Those services such as water, air, steam, sewage, telephone, electricity necessary to the operation of an establishment.

2-114. Waiver. Written authority from the risk acceptance authority (see table 1-2) permitting deviation from a mandatory requirement of these regulations for a limited period of time not to exceed 5 years. Local waivers are written authority from an installation commander permitting deviation from an advisory provision of this regulation. Local waivers are also granted for specific periods of time.

2-115. Warhead. That portion of a rocket or guided missile containing the high explosives charge or other destructive agent.

2-116. Weapon. A gun, howitzer, mortar, launcher, or projector of any type.

CHAPTER 3

NUCLEAR WEAPONS SAFETY

3-1. Scope. This chapter contains specialized safety requirements for storage, handling, and maintenance of nuclear weapons and related equipment. It supplements the TM 9-1100/1115 and TM 39-series manuals. In general, other chapters of this manual do not apply to nuclear weapon operations; however, some specific paragraphs are related. In those cases, the responsible commander shall apply them as required. Conflicts in interpretation shall be directed to the Commander, AMC, ATTN: AMCSF, for resolution.

3-2. Definitions. a. Abnormal operations. Any operation that requires application of force greater than normal (primarily when explosives or explosive components are involved), the establishment of extra precautions, special protection of personnel, or specialized tools and/or equipment (para 3-4 and 3-8). Examples are--

(1) Removal of "frozen" components, including screws, nuts, and other fasteners within the warhead section or warhead (when associated with explosives, explosive components, or limited life components).

(2) Disassembly of a warhead section (WHS) or warhead after being involved in a fire, accident, or incident.

(3) Any operation involving a "suspect" weapon.

b. Ancillary electrical equipment. Portable and permanently installed electrical equipment used in support of nuclear weapon operations.

c. Compatible and incompatible operations. Certain operations that may or may not be performed concurrently, depending on the circumstances (table 3-1).

d. Explosive components. Components that contain encased explosive or propellants, designed to accomplish a specific function in a weapon.

e. Inert operations. Nuclear weapon-related storage and maintenance functions that do not involve explosives or nuclear material.

f. Limited life components. Components used in nuclear weapon that decay with age and must be replaced on a periodic basis.

g. Locally fabricated equipment. Any tool, device, or item of handling equipment not available through normal supply channels and which is designed and approved for a specialized task that cannot be accomplished by equipment authorized in existing, approved, technical publications (para 3-4).

h. Normal operations. Any routine procedures specified in approved technical publications that do not require the use of tools and/or equipment not prescribed therein. Examples are--

(1) Unpackaging, packaging, inspection, and maintenance.

(2) Assembly or disassembly of WHS.

(3) Installation or removal of components.

(4) Processing of adaption kits (AK), test and handling (T&H) equipment, and general supply items.

i. Suspect weapon. Any weapon that, when suspected of having been tampered with or when subjected to authorized test procedures, fails to respond to the criteria in the appropriate technical manual and which also indicates a condition that is potentially unsafe for further testing or handling without increased safety precautions, including reduction of personnel exposed to the operation.

j. Unpackaging. Removal of warheads, WHS, AK, and related components from shipping containers and the use of specialized materials handling equipment (MHE) in conjunction therewith.

3-3. Operations with Electrical and Electronic Equipment. a. General. Refer to TB 385-4 and TM 39-35-51 for guidance on operations with this equipment.

b. Portable power supplies. As a general rule, use of portable power supplies is covered in approved system publications that specify proper shop practices for their application. If there is a requirement for equipment not authorized therein, paragraph 3-4 applies.

c. Thermal batteries. These batteries, and components containing them, shall be kept away from high heat sources and circuits containing exposed potentials where inadvertent contact would

actuate them. An inadvertently activated battery should be cooled until it can be handled by the bare hands, otherwise use of approved gloves is recommended.

d. Radio-frequency energy. Although electroexplosive devices (EED), such as squibs and detonators, can be fired by radio-frequency (RF) energy from radio or radar transmitters under certain conditions, the design of components containing them will normally preclude their inadvertent functioning. Prerequisites for firing are--

(1) A sufficiently strong electromagnetic field and;

(2) A suitable receiving antenna.

e. WHS or lead wires may act as antenna. Under certain conditions, the WHS in which an EED is located or the lead wires of the EED itself can act as an antenna. They are relatively safe even in strong RF fields when enclosed in metal containers. A perfect enclosure can eliminate the hazard of firing due to entry of RF energy; however, functioning may occur in strong fields due to induction heating. Breaks or ports in the surface of hollow metal enclosures also make possible entry of RF energy. Protection against hazards can be enhanced by--

(1) Twisting lead wires together after they are removed from a circuit.

(2) Avoiding unnecessary exposure to RF fields, in particular the main beam of radar transmitters.

(3) Turning off an RF transmitter during installation and removal of an EED from a weapon.

(4) Performing operations involving exposed EED in structures that, due to design and construction, attenuate the RF energy.

(5) Minimize exposure by ample separation of the devices from RF energy sources. Refer to chapter 7, AR 50-5 for further guidance.

f. Heat sealing equipment. Electric heat sealing equipment may be used in rooms, bays, or cubicles containing inert materials without any restrictions. If such areas contain sealed explosives, separation of the equipment from the components shall be determined by the hazard presented, the objective being to prevent any adverse interaction between the equipment and the component(s).

3-4. Locally Fabricated Equipment. a. The basic policy on use of equipment and procedures for nuclear weapon operations is contained in the Safety Rules for each weapons system as follows:

> "Only authorized equipment and procedures, as described in applicable publications or directives approved by military department of higher level for a system, will be employed for all operations involving the system. All military department approved technical and operational procedures involving the weapon system throughout the stockpile to target sequence will be consistent with these specific rules and the nuclear safety standards."

b. It is recognized that locally fabricated items are sometimes required because of specialized application and feasibility of including them as stock listed components. Approval for their design and use is the responsibility of the system design agency. To obtain this approval--

(1) Review the function for the proposed equipment to determine whether existing equipment is adequate, requires modification, or can be eliminated by changing the procedures.

(2) Submit an Equipment Improvement Recommendation report (TB 9-1100-803-15) including detailed drawings to accompany the proposal, if applicable. This procedure ensures that review and approval is obtained under the "approved by military department or higher level" concept, required by the weapon system safety rules.

3-5. Materials Handling and Industrial Equipment. a. Criteria for installation and use.

(1) Structures to which MHE is to be attached shall be capable of supporting the weight of equipment and its maximum load.

(2) Sufficient overhead and side clearances shall be provided.

(3) Floors, roadways, and ramps must be capable of supporting the MHE and its load without damage and be free of imperfections that would make operations hazardous.

(4) MHE shall be free of unauthorized enclosures and attachments that interfere with driver vision, and shall not be equipped with nonessential accessories.

(5) Hydraulic systems shall be maintained according to instructions covering specific items.

b. Inspections, testing, and maintenance. For application of the OSHA standards, refer to TB 43-0142. This publication provides minimum inspection and testing requirements for all installed and portable lifting devices. For additional information on load testing, refer to TB 9-1100-804-15 and/or system technical manuals.

3-6. Substantial Dividing Walls. As defined in chapter 5 and DA PAM 385-64, such walls shall be used within an assembly structure to separate operations and to prevent explosive propagation. The following rules apply for conducting operations in multibay structures:

a. Dividing walls separating one bay from another shall not contain any openings.

b. The number of nuclear weapons and total weight of high explosives in a single bay shall conform to the requirements of TM 39-20-7, but in no case shall the quantity exceed that for which the wall(s) was designed.

c. Weapons shall be located no less than 1 meter (3 feet) from the dividing walls. In multibay structures, they shall be oriented so that the maximum amount of nonexplosive components and materials face the nearest dividing wall separating it from a bay containing other weapons.

3-7. Operational Shields. These shields are not required for normal weapon assembly or disassembly and operations involving inert components.

3-8. Removal of Frozen or Damaged Explosive Components. Contact the appropriate weapon commodity manager for technical assistance before attempting to remove such components in the event that guidance has not been previously provided for identical cases.

3-9. Authorized Storage Operations. If adequate work space is available and special handling equipment is not required, these functions may be performed in a magazine--

a. Removal of container covers.

b. Removal of access ports to accomplish monitoring.

c. Replacement of desiccant in containers having an external port accessible to the compartment.

d. The use of continuity loop testers not requiring an external power supply.

e. Testing of systems having a built-in, self-test capability.

f. Performance of pressure checks.

g. Pressurizing, monitoring, and coding/recording of Permissive Action Links (PAL), and the removal of container hardware necessary for performing these operations. The use of compressed gas cylinders, according to TM 39-3551, is authorized. Large, bulky cylinders that weigh over 11.5 kg (25 lbs)shall be moved on a hand-operated vehicle. Hoses shall be of sufficient length to enable pressurization of items when the cylinder is located either in the center aisle of, or outside, the magazine.

h. Loading, unloading, or rewarehousing of weapons and their components by use of types E, ES, EE, and EX electronically-powered forklifts and lowlifts.

i. Minor repair to weapon containers that does not require cutting, drilling, soldering, welding, or other operations producing heat and flame.

j. Unpackaging, as required for verification inspections.

k. The removal of fungus contamination from warheads, AKs, WHS, and containers.

l. The following guidance of a nonfunctional nature is also provided:

(1) Rail cars, vans, and other transporters will remain at the entrance or apron of a storage site only during loading and unloading.

(2) Weapons or high-cost inert materials shall not be stored outside; between magazines or other structures. Existing facilities, formerly termed Y-sites, may be used for storage of inert items such as transfer dollies, shipping crates, and handling gear if adequate inside storage space is not available.

(3) Ventilators in heated storage structures or in low humidity areas may be closed when they contain weapons in normal shipping and storage containers.

(4) Only authorized containers shall be stored in magazines that are equipped with high density polystyrene protective barricades. Because of the flammability characteristics of polystyrene, any flammable material or flame-producing devices are prohibited therein (TM 39-20-7).

(5) Limited life components, in their authorized containers, may be stored in any convenient location in the nuclear weapon storage area with weapons or related components.

3-10. Exceptions and Related Guidance. a. Fire fighting. Refer to TB 385-2 and TM 39-20-11.

b. Fire symbols. Fire symbols shall not be used in connection with storage, maintenance, or transportation of nuclear weapons. Local instructions to ensure that the fire department personnel are made aware of structure, vehicle, and loading/unloading area contents shall be contained in appropriate station documentation.

c. Placards. EXPLOSIVE or RADIOACTIVE placards shall not be used on vehicles or aircraft containing nuclear weapons while on AMC installations. This is not intended to mean vehicles or aircraft cannot be placarded in the exclusion area prior to their departure from the installation. Posting of loading and unloading areas is not required; control thereof while they contain nuclear weapons shall be provided by security forces according to AR 50-5.

3-11. Compatible/Incompatible Operations. Table 3-1 identifies compatible and incompatible operations. Compatibility is determined by separating the operations to be performed concurrently, enter table 3-1 at the row for one of the operations to be performed and follow that row to the intersection with the column for the other operation. If the block at this intersection is blank the operations are compatible and may be performed concurrently. If the block contains a number referring to a footnote, the footnote requirements must be met to make the operations compatible, thus allowing them to be performed concurrently. If the block contains an "x" the operations are incompatible and shall not be performed concurrently unless written approval is granted from the Commander, AMC (ATTN: AMCSF) per paragraph 1-6.

3-12. Inspection. The installation's surveillance organization may monitor the operating segments for compliance with safety provisions of this chapter. This does not relieve the installation's safety office from its responsibilities as outlined in paragraphs 1-8 and 1-17.

No.	OPERATION	SAME NUMBERED OPERATIONS AS IN LEFT COLUMN									
		1	2	3	4	5	6	7	8	9	10
1	Inspection of Projectile						X	X		1, 2	X
2	Insp, Test, Rep, of T & H Equip							X		2	X
3	Maintenance Calibration						X	X		2	X
4	Insp, Test, Assy, Disassy, Tng Item							X		2	X
5	Soldering							X		2	X
6	Welding	X		X				X		2	X
7	Abnormal Operations (See para 3-2(a))	X	X	X	X	X	X		X	X	X
8	Demilitarization (Non-explosive, non-nuclear)							X		2	X
9	Operations Involving Inert Items	1, 2	2	2	2	2	2	X	2		2
10	Operations Involving Explosive Components	X	X	X	X	X	X	X	X	2	
	FOOTNOTES: (1) Operation shall be incompatible if explosive components are involved. (2) Permitted provided operations are mission-related. See paragraphs 5-6 and 16-1.										

Table 3-1. Operational Compatibility Chart

CHAPTER 4

LABORATORY SAFETY

4-1. General. a. Local safety standards covering all laboratory practices and procedures shall be formulated, approved, and adopted. Laboratory work involving explosives, chemical agents, biological, radiological, and other hazardous materials shall be performed only per the provisions of approved SOPs. SOPs should include emergency procedures, formal functions, and unexpected or uncontrolled reactions that might occur. The emergency procedures should be practiced periodically.

b. Laboratory safety standards shall take into account the requirements of 29 CFR 1450, including appendix A - National Research Council Recommendations Concerning Chemical Hygiene in Laboratories.

c. Chemical Agent Laboratory operations. Refer to AR 385-61 and DA PAM 385-61 for safety requirements pertaining to toxic chemical agent laboratory operations.

d. Biological Defense Program Laboratory. Refer to AR 385-69 and DA PAM 385-69 for safety requirements pertaining to biological laboratory operations.

4-2. Storage. a. Each laboratory building should have storage room(s) for bulk chemicals and one for laboratory equipment and apparatus. The chemical storage room(s) shall be well ventilated and lighted, provided with adequate means for emergency exit, and shall be separated from other parts of laboratory buildings by adequate fire walls. Openings in the fire walls shall be protected by approved automatically closing doors. The room shall be protected by permanently installed automatic class B fire extinguishers or sprinklers. Personnel deluge showers and emergency eye lavages shall be installed in or accessible to all chemical storage rooms. An inventory of chemical supplies shall be maintained for all rooms. Carboys, containers of chemicals and bulky items should be stored as near the floor as practicable. Chemicals which might react to produce dangerous fumes or explosions must be stored so that they will not come together in the event of a leak or spill. Radioactive materials must be isolated, and properly shielded and identified per established safety standards. Volatile liquids must be stored away from heat sources and out of the direct rays of sunlight. Flammable liquids shall be stored in approved-type flammable storage cabinets per 29 CFR 1910.106. All electrical equipment must be of the approved type. Each container must be legibly marked or labeled for identification of contents and should be tightly closed when not in use.

b. Explosives and other highly reactive material must be stored separately from other materials with which they may react or are incompatible. The separation must be such to preclude mixing of the reactive or incompatible materials. All explosives and other particularly hazardous materials must be stored outside the laboratory building, in separate facilities that meet the construction and quantity-distance requirements set forth in DA PAM 385-64.

c. Experimental explosive compositions made in the laboratory shall be disposed of promptly after the purpose for which they were prepared has been fulfilled. Sample materials shall not be allowed to accumulate. All samples placed in storage must be identified with a permanent label.

d. Control logs shall be maintained of all radioactive material in stock, particularly tracer material. Radioactive materials shall be kept in a secure location and issued only to properly trained personnel, authorized by license to use them.

e. Where refrigeration is required for any flammable or explosive chemical, an ice chest of approved design or an explosion-proof refrigerator meeting the requirements of NFPA 45 shall be used. Refrigerators for laboratory storage shall not be used to store personal food or drink items.

4-3. Handling. a. Mechanical devices should be used to transfer, lift, and pour chemicals from large containers or carboys. Safety siphons, approved type pumps or inclinators shall be used when dispensing acids from carboys. Drums of chemical should be mounted horizontally, securely braced, with drip pans placed on the floor under the taps of faucets to absorb any drippings. Class I flammable liquids should not be drawn from or dispensed into vessels or containers within a building except by means of a device drawing from the top of the tank or container. Within a building, gravity discharge of class I flammable liquids from other than a safety container is prohibited unless essential to the operation and specifically approved by the installation Commander. The quantity of class I liquids in these containers must not exceed that required for one day of operation. Faucets, when used, should have spring closing action and a locking pin, (see fig 11, National Safety Council Safe Practice Pamphlet No. 60). Necessary protective clothing and equipment shall be readily available and used as required. Hazardous materials and materials of unknown characteristics should be handled remotely during processing, testing, and experimenting.

b. Laboratory equipment or apparatus should be installed in a manner that will ensure stability as well as prevent inadvertent

movement of equipment that would affect equipment alignment or the operation. Pieces of apparatus or equipment containing heated chemicals, acids, flammable materials, or other hazardous chemical should also be carefully assembled, positioned, and secured to prevent them from falling or being knocked over.

4-4. Laboratory Techniques. a. Before starting a research project, investigators should identify the health and safety hazards of chemicals to be used and produced and the hazards of the reactions which may occur. In addition to SOPs, emergency procedures for malfunctions and unexpected or uncontrolled reactions that might occur should be established and practiced. When in doubt about any operation and before working with material whose properties are in doubt, the supervisor must be consulted.

b. Simultaneous chemical investigation of incompatible materials such as fuels and oxidizers, or acids and cyanides shall not be conducted by one person, nor in adjacent work areas that are not separated in a manner to prevent mixing.

c. Good housekeeping must be practiced at all times. Each laboratory/room must be kept neat, orderly, and free of hazardous amounts of explosives and chemical contamination. Corridors must be kept clean; floors, shelves, and work areas shall be kept free from all unnecessary apparatus and chemicals. Spills shall be cleaned up immediately and broken glassware shall be placed in separate, specially marked receptacles.

d. Every scientist/lab operator, upon vacating a laboratory on completion of a project, must decontaminate that laboratory to ensure that the next occupant will not encounter any unforeseen hazard created by unused or spilled explosives/chemicals, incompatible mixtures in sink and water trap, and the like, accomplishing same to the satisfaction of his supervisor/lab chief. At the end of each day, decontamination must be accomplished to the maximum extent which will not interfere with essential work.

e. Working alone outside of normal duty hours, on weekends, or on holidays in an explosives laboratory must have local safety office approval on a timely basis.

f. All laboratory clothing which may become contaminated with substances unsafe for removal at the installation or commercial laundries shall be washed on a scheduled basis in a separate facility designated for that purpose.

g. Carrying or use of smoking, eating, or cosmetic materials is prohibited in laboratories where toxic materials are or may be present.

4-5. Protective Clothing and Equipment. a. Each operation must be evaluated for the potential hazards and proper protective clothing and equipment per 29 CFR 1910 Subpart I. Safety goggles constitute a very important item of personal protective equipment for laboratory work, and they must be worn during all operations presenting eye hazards. Eye protection conforming to ANSI Z 87-1 and Army Environmental Hygiene Agency (AEHA) Occupational Vision Guide shall be worn by all personnel where operations presenting eye hazards are being conducted (including aisles and hallways). Heat resistant mittens or tongs must be used to handle hot or cryogenic objects. Respirators approved by National Institute of Occupational Safety and Health (NIOSH), Mine Safety and Health Administration (MSHA), or by the Surgeon General's Office and the USA Chemical Research and Development Center must be worn or adequate ventilation provided when personnel are working with materials that may produce harmful air contamination.

b. Safety showers of the deluge type and eye wash fountains shall be provided at locations where personnel are exposed to hazardous chemicals.

c. Protective shields (approved for quantities being used) and indirect handling devices must be used for operations involving hazardous materials which may react violently, and which could result in a fire or explosion. Safeguards must also be used when handling and storing radiological and biological materials.

4-6. Ventilation. a. Laboratory ventilation systems must be adequate to maintain a comfortable temperature level. They must have sufficient capacities to properly condition make-up air required for exhaust hoods. The principle means for removal of toxic contaminants shall be exhaust systems, with intakes (normally in the form of hoods) at points where contaminants are generated. Exhaust systems for toxic chemicals must conform with guidelines established by the U.S. Army Center for Health Promotion and Preventive Medicine. Operators shall physically verify local ventilation hood flow rates and direction daily prior to use by measuring flow at least three places across the hood face and ensuring the average is within the certified hood limits.

b. Proper maintenance is essential to a safe laboratory operation.

(1) Laboratory hoods and exhaust system components should receive preventive maintenance semiannually. The checklist should include: replacing of worn belts; greasing of bearings; checking corrosion of ducts, fans, blowers, and discharge stack; checking tightness of duct connections; cleaning of ducts and equipment; adjustment of volume dampers and hood baffles; and cleaning or replacing filters.

(2) Laboratory hoods should be performance-evaluated at least every 3 months, immediately after installation, and immediately before and after ventilation modification. Uniform air distribution should be provided. Because adjustable baffles and dampers are subject to tampering, they should be checked with each inspection. The proper air distribution is determined by the face velocity test, contaminant leakage test, and static pressure test. Before performing the tests, verify that the make-up air system and other laboratory hoods or exhaust devices are operating and windows and doors are in their normal positions.

(3) A filter maintenance program will ensure that the filter materials are performing as required.

(4) When maintenance personnel are required to work on potentially contaminated systems they will receive prior concurrences from safety and operating personnel and will be trained on potential exposures.

4-7. Pressure Processes. a. Autoclaves, bombs with inside diameter greater than 6 inches used in services at 15 psig or more, and other pressure equipment containing explosives or other hazardous chemicals shall be placed in separate cubicles that are designed to confine and direct the force of possible explosions away from personnel and other facilities. Walls separating these cubicles from other parts of laboratories shall meet requirements of TM 5-1300 for new construction. At least one side of the cubicle shall be open to wall(s) designed to vent internal explosions with the formation of a minimum of large fragments. Glass pressure vessels shall be so enclosed that breakage would not endanger personnel. Pressurizing containers of explosives or other hazardous materials shall be done by remote control regardless of container size.

b. Pressure vessels shall be constructed, inspected, and tested per American Society of Mechanical Engineers (ASME) codes and Army regulations. Materials of construction must be compatible with chemicals to which they are to be exposed. Means shall be provided for safe release of positive pressure of vacuum from a pressure vessel prior to opening.

c. SOPs should be developed covering use of pressure vessels.

4-8. Flammable Liquids. The quantity of flammable liquids stored in laboratories shall be kept to the minimum required for safe and efficient operation. Except where prohibited by technical considerations, flammable liquids shall be stored in and dispensed from approved type safety containers. Operations involving volatile flammable liquids should be carried out behind protective shields, under hoods, within trays or other suitable containers that will make control easier if a fire should start. Flammable liquids should be kept away from ignition sources such as exposed electric heating elements, open flame, and electrical wiring and equipment that is not of the type approved for use in class I hazardous locations. When flammable liquids must be heated in the laboratory, it is preferable that water, steam, or electrical heat be used.

4-9. Electrical Equipment and Wiring. Electrical wiring and equipment and their installation shall be per the National Electric Code and chapter 6 of this regulation. A certification of electrical safety by a qualified Government safety engineer based on a hazard analysis will be accepted in lieu of approval by a recognized testing agency if equipment approved by such an agency is unavailable, and if the certification and analysis are maintained at the responsible major subordinate command until the equipment is withdrawn from service.

4-10. Disposal of Waste Materials. a. Proper containers shall be provided for disposal of various waste materials. A sufficient number of containers shall be available to preclude mixing of materials which may result in a chemical reaction, fire, or explosion. Innocuous materials should not be mixed with hazardous materials. All containers must be distinctly marked to identify the contents. Volatile flammable liquids shall never be poured down a sink, basin, or any drain.

b. Materials such as cyanides, which are capable of evolving poisonous gases either alone or as a result of a reaction with other materials, shall not be emptied into drains or sewers. A chemist or other qualified person should supervise their disposal.

c. Disposal and storage for disposal are also dictated by established installation waste management procedures to ensure compliance with environmental regulations. Coordinate with the Installation Environmental Coordinator.

4-11. Radiation Safety. Laboratory operations involving sources of ionizing radiation shall comply with provisions of AR 385-11, Radiation Protection, and applicable regulations of the Nuclear Regulatory Commission.

4-12. Explosives Safety. a. The quantity of explosives used in any laboratory operation must be approved by the local safety office. Repetitive testing will require only initial approval of quantities involved. Where operations involve explosives, severe fire hazards, or toxic materials, exposure must be limited to the minimum number of personnel, for the minimum time, consistent with safe and efficient operation.

b. Laboratory operations involving explosives should be separated from each other and from those involving nonexplosives by operational shields (DA PAM 385-64, para 18-3). Particularly hazardous laboratory operations involving explosives should be performed by remote control with the operator protected by an operational shield.

c. The quantity-distances set forth in table 4-1 are applicable between laboratories and adjacent exposures if analysis verifies the absence of fragment hazards.

d. Ovens used to dry samples of explosives should be designed to vent an internal explosion safely.

e. Collection and disposal of explosives waste shall comply with requirements of chapter 21. Explosives waste shall be removed from the laboratory at regular and frequent intervals.

Quantity of Explosives		Unbarricaded Distance in Feet *		
Pounds (Over)	Pounds (Not Over)	Inhabited Building	Public Traffic Route	Intraline
0	5	10	10	10
5	10	15	15	15
10	20	20	20	20
20	30	25	25	25
30	50	30	30	30
50	80	35	35	35
80	100	40	40	40
100	150	45	45	45
150	200	50	50	50

* When a fragment hazard to adjacent exposures is created by the casing, the container, or the structural elements of the buildings or process equipment surrounding the high explosives, or the quantity of high explosives exceeds 50 pounds, distances shall be obtained from tables in DA PAM 385-64.

Table 4-1. Class 1.3 - Quantity Distance (Laboratories)

CHAPTER 5

CONSTRUCTION AND UTILITIES

5-1. Introduction. New construction. Each new operating and auxiliary building, and each new utility pertaining thereto, at any AMC establishment, shall comply with the mandatory and advisory provisions of this regulation.

5-2. Building Exteriors. Exterior wall and roof coverings of buildings containing explosives or explosives operations should be noncombustible. While it is recognized that wood may be the material of choice in a few applications, in general it is considered a combustible material, whether treated or untreated for fire resistance, and should not be used in construction of explosives facilities. Justification of the selection of wood as a construction material for explosives facilities shall be contained in the safety review submissions. If combustible built-up roofing is used, roof decks should be noncombustible. The buildings should be without basements and not more than one story high, except where necessitated by process requirements.

5-3. Floors and Work Surfaces. Floors and work surfaces in explosives facilities shall be constructed to facilitate cleaning and to preclude, insofar as possible, cracks or crevices in which explosives may lodge. Subfloors, finished flooring, and work surfaces must not wrinkle or buckle under operating conditions. In chemical munitions facilities, surfaces must be sealed or treated to prevent agent absorption during spills so that complete decontamination can be obtained. No porous material should be used for flooring where there is danger of agent contamination. Coating or sealing materials must not react with agent. In explosives facilities and locations where the atmosphere may contain combustible dusts, or flammable vapors or gases, ferrous metal surfaces shall not be coated with aluminum paint due to the potential sparking hazard. Cove bases at the junction of walls and floor are recommended. Exposed nails, screws or bolts in work surfaces must be avoided. Floors, floor coverings, and floor treatments should be noncombustible except that vinyl, ethylene vinyl acetate, and similar floor coverings are acceptable where special characteristics such as conductivity are required.

5-4. Interior Walls, Roofs, and Ceiling. a. In chemical munitions manufacturing facilities, walls and ceilings must be constructed of nonporous material. Walls and ceilings must not absorb agent, must decontaminate easily and resist action by liquid and gaseous agent.

b. Suspended ceilings shall not be used in explosives operating buildings where explosive dust may be present. Recommended practice is to install insulation and covering directly on the underside of the roof deck.

c. When explosives buildings are used to store explosive material, appropriate structural features should be included in the design to deter access by unauthorized personnel. The wall should appear to present an obstacle to intrusion into the building yet be lightly constructed to provide maximum venting for an internal explosion. Construction materials used should clearly show any break-in to operational or security personnel checking the building.

5-5. Fire Walls. Fire walls and openings in fire walls must comply with requirements of MIL-HDBK 1008, Fire Prevention Handbook. Fire walls in munitions buildings should be constructed of approved nonporous materials and sealed with coating materials that will prevent absorption of explosives and chemical agents, resist action by the chemical agents, and be easy to clean.

5-6. Substantial Dividing Walls. a. Substantial dividing walls will be designed per TM 5-1300, Structures to Resist the Effects of Accidental Explosions, to prevent propagation of detonation by blast and by ammunition or wall fragments.

b. Existing Reinforced Concrete Walls (RCW) not less than 12 inches thick, are considered effective in preventing propagation between bays when the donor quantity does not exceed 425 pounds of class 1, division 1 explosives. In existing building having such walls, operations must be planned so that the minimum quantity of explosives or ammunition required for safe and efficient operations will be in each bay. For operations, located in an existing building with 12-inch RCW, the following siting criteria apply:

(1) If each bay in the existing building will have an explosive limit equal to or less than 425 pounds of class 1, division 1 explosives the quantity associated with the building for quantity distance purposes is equal to the largest quantity in a single bay.

(2) If any bay in the existing building will have an explosive limit in excess of 425 pounds of class 1, division 1 explosives the total quantity of explosives in the building will be used for quantity distance purposes. If it can be shown that a lesser quantity is appropriate by virtue of test results or other convincing rationale, it must be documented by submission of site and general construction plans.

c. Openings in substantial dividing walls for the installation of conveyors are not recommended. Where such openings are deemed necessary, the size shall not be larger than the minimum which will permit safe passage of the item being transferred. When the conveyors are not being used, the openings shall be provided with closures designed to the level of protection afforded by the wall.

5-7. Building Exits. a. Each operating room or building containing explosives and other materials which constitute a serious hazard to operating personnel shall be provided with at least two exits unless the room or building is small and occupied by not more than two persons. In the latter instance, a single properly located exit is acceptable. Exits shall be at least 30 inches wide and located at opposite ends or sides of the area involved. The explosives hazard should not be located between the operator and the exit. The path of travel from the work place shall be unobstructed. Rooms in which more than eight persons are employed shall be provided with one additional exit for each five additional employees or portion thereof. In determining the total number of exits required where exit widths exceed 30 inches, each 30 inches of width may be considered one exit. Exits should be equally spaced about the perimeter of large explosives operating buildings. No operator work station should be located more than 25 feet from the nearest exit. Travel to exits in buildings containing explosives shall not exceed 75 feet from any point to reach the nearest exit. Exit should be to the outside of the building rather than into a hallway or another room.

b. Refer to NFPA 101, Life Safety Code and/or consult your local fire department for additional guidance.

5-8. Doors. a. Exit doors in explosives operating buildings shall open outward and during operating hours shall not be fastened with locks other than antipanic catches or other quick-releasing devices. Exit doors shall not be obstructed. Exit doors in buildings containing explosives, except storage magazines, shall be casement type and glazed with nonshatter plastic materials. In no case shall the opening be less than 30 inches wide by 80 inches high. All interior doors should open in the direction of flow of material through the building and shall open upon unobstructed passageways. Explosives buildings exit doors which are more than 4 feet above the ground shall open on platforms that are provided with safety chutes, ramps, or stairways with handrails. Doors opening onto ramps or passageways shall be designed for rapid exit.

b. Refer to NFPA 101, Life Safety Code and/or consult your local fire department for additional guidance.

5-9. Safety Chutes. a. Safety chutes shall be provided for elevated explosives locations from which rapid egress may be vital and cannot be otherwise obtained. Safety chutes should be located on opposite sides of the explosives operating where practicable to reduce the likelihood of personnel being trapped by fire between them and a single chute. Exit to safety chutes must open on a platform that is not less than 3 feet square and equipped with guardrails. The chutes shall begin at the outside edge of the platform and not at the edge of the buildings. Landings from safety chutes shall be located at selected places that lead directly to escape routes that are free from tripping hazards, low guy lines, drains, ditches, or other obstructions. Manually or automatically controlled trips shall be installed at or near the entrances to chutes to give an alarm in the operating building and in nearby structures; this device may also activate deluge valves and water curtains in the building or room affected.

b. Recommended safety chute specifications are: Angle 40 degrees-50 degrees with the horizontal; depth of chute, 24 inches; radius at bottom of chute, 12 inches. The lower end of the chute must not be over 24 inches above the ground. The end of the chute must have a horizontal run sufficient to prevent an injury to the employee because of speed of exit, without the use of landing cushions which are unsatisfactory in cold weather. One foot of horizontal run at the bottom of the chute is required for each 15 feet of angled run. The juncture of the two sections must be well rounded. The finish of the chute must be durable and smooth. Each chute will have only one entrance and will not merge with other chutes. Chutes will run in a straight line perpendicular to the building. Supporting members for safety chutes may be of wood.

5-10. Emergency Exits and Fire Escapes. Windows or doors in proximity to the fire escape, and from which flames may reach escaping personnel, shall be glazed with wire glass except in explosives operating buildings where the glazing should consist of relatively nonshatterable plastic materials.

5-11. Windows and Skylights. Ordinary glass offers little resistance to blast effects from an explosion. Window breakage can be expected beyond inhabited building distances. The extent of hazard resulting is largely dependent on the velocity of flying glass from breaking windows. Vulnerability to breakage depends on such factors as orientation of the window with respect to the site of the explosion, the surface area and thickness of the pane or sheet of glass involved, and the construction of frame and hardware. For increased safety the number of windows facing a potential explosion site should be kept to the minimum. The overall size of windows, and individual panes of glass therein also should be kept to the minimum. Shatter-resistant plastic glazing is recommended and will be used in all new

construction. Where glazing with conventional glass is in use, the danger of falling and projected glass is present and should be anticipated. The hazard may be reduced by covering such glass with wire mesh screening properly fixed in position on the inside.

5-12. Drains and Sumps. a. All drain lines handling explosive wastes shall be provided with sumps or basins of adequate design and capacity for the removal of explosives by settling. The drains shall be of adequate capacity, free of pockets and shall have sufficient slope (at least ¨ inch per foot) to prevent settling out of explosives in the drain line until it reaches the sump or settling basin where the explosives are to be collected. Sumps must be designed so that suspended and settleable solid explosive material cannot be carried in the wash waters beyond the sumps. The design shall allow sufficient settling time based upon the settling rate of the material and the usual rate of flow. The sump shall be constructed so that the overflow will not disturb any floating solids. The design must also permit easy removal of collected explosives, and retention of those explosives which float on water until they can be skimmed off. If settling basins are used to supplement sumps, the settling basins will be cleaned periodically and a log maintained. Explosive collection trays for sumps will not be made of ferrous metal. Hoisting equipment used for lifting the trays will be designed to prevent the trays from binding on the sides of the sump. Bolted sump tanks or other types of construction that permit the explosives to settle in obscure or hidden spaces are prohibited. Drain gutters within buildings may be constructed with a slope of inch per foot. However, a satisfactory program of cleaning must be developed to assure that all hazardous material is removed from drain gutters.

b. Care must be taken to avoid the possibility of deposition of explosives from sump effluent due to drying, temperature changes, or interaction with other industrial contaminants. When explosives which are appreciably soluble in water are handled, sweeping and other dry collecting measures shall be used to keep them out of the drainage system.

c. Drains between the source of explosives and the sump shall be troughs with rounded bottoms and with removable ventilated covers to facilitate inspection for accumulations of explosives. Waste liquids shall not be run into closed piping systems except where necessary to transport the liquid to a waste treatment facility. Drains shall be inspected periodically and necessary steps taken to prevent the buildup of explosives deposits in them. Drains and sewers containing explosive waste materials must not be connected in a manner to empty such wastes into the normal sewage systems carrying inert or sanitary wastes or into open ditches.

d. Connections between sumps or buildings and waste treatment facilities should meet the same design goals as for drains and sumps. Connections will be constructed of materials compatible with the effluent, easily inspected and cleaned. Connections should be of flanged and bolted construction, not threaded. It is preferred that such connections not be buried.

5-13. Laundries. Plants operating laundries should have facilities for washing and flameproofing uniforms where such clothing is in use. Where uniforms and rags which are contaminated with explosives are to be laundered, the facilities shall include a safe storage place for contaminated clothing prior to washing, and also sumps for the removal of explosives from waste water. Drains to the sumps may be closed providing the water has an adequate scouring velocity to prevent deposition of explosive material. Testing facilities shall be provided to check the complete removal of the contaminants from the clothing, particularly when insoluble toxic substances are involved. Commercial concerns laundering such articles shall be informed of the nature of the explosives contamination and dangerous chemical reactions therewith. These commercial concerns should have the facilities listed above. Uniforms contaminated with explosives or explosives ingredients shall be stored in containers approved by the installation safety office, at pickup points pending removal to laundries. Compatibility of contaminants will be assured before mixing uniforms.

5-14. Steam for Processing and Heating. a. Steam used for heating operating buildings containing explosives shall have a maximum pressure of 5 psi (228 degrees Fahrenheit), except for facilities where freeze protection is required. Steam pressures in lines or vessels that may inadvertently come in contact with propellants or explosives shall not exceed 15 psi (250 degrees Fahrenheit).

b. Where necessary, process steam may exceed 5 psi but shall not exceed 15 psi for routine operations. When the operation demands that the process steam pressure be greater than 15 psi, the following will be required:

(1) A hazard analysis to establish pressure limits.

(2) Verification that adequate safety factors are maintained.

(3) Limits specifically noted in the appropriate SOPs with approval of the cognizant installation safety office. Process steam is that which is in direct contact with explosives, used directly in the manufacture of explosives, or that which in case of

equipment failure would exhaust directly into contact with explosives or explosives fumes.

c. The exterior of steam or hot water pipes in contact with wood, paper, or other combustible materials shall not exceed 160 degrees Fahrenheit (71 degrees Celsius). Piping containing hot water or steam in excess of 140 degrees Fahrenheit should be insulated in areas where personnel may contact them.

d. Where steam temperatures must exceed 228 degrees Fahrenheit, in hazardous locations, steam lines shall be covered and painted with an impervious material or otherwise protected against contact with explosives. Where a reducing valve is used, a relief valve should be installed on the low pressure piping. Pressure reducing valves must not be bypassed in a manner that will permit circumvention of pressure reduction requirements. The production of super-heated steam which results from the throttling action of reducing valves must be prevented by positive means. The use of a "water leg" or water column for control of steam pressure of 5 pounds or less is recommended. Where close control of steam temperature is necessary, indicating and recording pressure or temperature gages should be installed. Such devices shall be periodically tested and the test results recorded.

5-15. Ventilation. The following general information and specifications apply to fusible links for doors and rear-stack ventilators on magazines:

a. The melting point will be between 155 degrees and 165 degrees Fahrenheit. The minimum rated breaking strength will be 20 pounds for the door ventilator link and 8 pounds for the rear-stack ventilator link. The fusible link used will be on the current approved list published by the Underwriters Laboratories, Inc., or other recognized testing laboratories.

b. Fusible links will not be painted.

5-16. Fuels for Heating and Power Boilers. a. Fuel, oil, coal, biomass, natural or manufactured gases, and liquefied petroleum gases may be used in both explosives and inert areas in AMC installations.

b. DA PAM 385-64 specifies the siting requirements for detached boiler houses in explosives areas. Low pressure heating boilers may be located in an explosives operating building provided that--

(1) The boiler is separated from the rest of the building by a 2-hour rated fire wall or a wall offering equivalent protection.

(2) Entry/exit to the boiler room is through exterior walls only and there are no wall openings between the boiler room and the remainder of the building.

(3) The fuel tank is located underground at least 10 feet from the building and is not adjacent to the open end of an explosives bay.

(4) The fill spout for the fuel tank is located at least 50 feet from the building.

(5) If a day tank is located adjacent to the boiler, it should not contain more than an 8-hour supply of fuel.

5-17. Radiological Facilities/Operations. a. Proper facility design/operational planning is the most effective approach in reducing unnecessary occupational exposures and in minimizing operational difficulties resulting from unexpected radiation exposures or safety problems. Participation by a qualified expert in the early planning stages of a radiation operation or facility to house such an operation will present the proposing installation with various methods by which adequate protection for both operational and nonoperational personnel may be accomplished.

b. Construction of a new facility/operation or modification of an existing one to house equipment which can produce a significant whole body radiation dose will include the participation of a person having the necessary knowledge and training to advise regarding the radiation protection needs of the facility/operation. A whole body radiation dose in excess of the public exposure limit as defined in 20 CFR will be considered significant for purposes of this requirement.

c. Radiological operations/equipment which could produce radiation in significant quantity to require the participation of a qualified expert in radiation safety would include--

(1) Particle accelerators, including large X-ray units.

(2) Subcritical uses of fissionable material.

(3) Neutron generator or source assemblies.

(4) Radiographic or calibration operations.

(5) Irradiation facilities.

d. Qualified experts in health physics, radiological physics, or radiation shielding are ones who have been certified by nationally accepted testing boards or who have equivalent competence. Further information on the availability of qualified radiological safety consultants may be obtained from your local university or hospitals. Names of individuals having relevant certification may be obtained from the American Board of Health Physics, the American Board of Radiology, or the American Board of Industrial Hygiene.

e. The coordination between the radiological safety consultant and the installation must be affected sufficiently far in advance to assure adequate time for review and approval of the facility/operation by HQ AMC. Proposals for review and approval should be forwarded to HQ AMC, ATTN: AMCSF-P.

f. The type of information required for review and approval of radiological operations which could produce radiation in excess of 1000 millirem per hour will include--

(1) Manufacturer's brochures and drawings which describe the specifications and characteristics of the device: maximum output, inherent shielding, geometry of the source, etc.

(2) Expected workload of the device, especially if the operation time will be limited by other operations, e.g., input time of material to be processed, necessary recharging or servicing time, etc. Future operational workload should be considered for shielding purposes.

(3) A line diagram of the room in which the equipment will be used, relationship of this room or operational area to other portions of the building, and activities above and below the operational area must be included. Include a plot plan which describes operations outside the primary building to a minimum distance of 1000 feet.

(4) Expected radiation levels both in the operational area, and nonoccupational areas of the room/building as well as radiation levels which may be released outside the building and calculations by which these radiation levels were obtained, should be included.

(5) Recommendations submitted by the qualified expert in radiological safety (which will facilitate review and approval), e.g., use of fail-safe interlocks system, area monitoring system, warning lights and signals, shielding of room penetrations.

g. The review and approval by HQ AMC, must be obtained prior to the 60 percent design review. Draft architectural drawings will be submitted for approval.

h. The above review and approval process for radiological operations/facilities will require an entirely separate submission than the one required by paragraph 5-27 for explosive safety site plan approval.

i. Ensure radiological facilities/operations have provided for proper environmental disposal of hazardous/toxic materials per AR 200-1.

j. Ensure that new facility/operation or modification of existing operations has been assessed for environmental consequences per AR 200-2.

CHAPTER 6

ELECTRICAL EQUIPMENT AND WIRING

6-1. National Electrical Code (NEC). a. In certain cases, such as those occupancies involving explosives, it may be necessary to exceed the requirements of the NEC. Electrical installations shall also comply with the requirements of this regulation.

b. The National Electrical Safety Code, ANSI C2, may be used to supplement the NEC and this regulation.

6-2. Approval Authority. Approval of HQ AMC, AMCSF, shall be secured prior to placing in service any electrical equipment not specifically labeled for the purpose or for the conditions of operation intended by a recognized testing agency, or manufactured or installed to meet the electrical classification of the area in which the equipment is to be operated when the area classification is determined per this chapter. A certification of electrical safety by a qualified Government safety engineer based on a hazard analysis will be accepted in lieu of approval by a recognized testing agency if equipment approved by such an agency is unavailable, and if the certification and analysis are maintained at the responsible major subordinate command until the equipment is withdrawn from service.

6-3. Definitions of Hazardous (Classified) Locations. a. Hazardous (classified) locations are defined in article 500 of the NEC. However, some explosives and propellants are not covered. In the past, area classifications were based on analogies to the common industrial substances referenced on the NEC classifications. The classification assigned to explosive operating areas was often class I, group C and/or D; class II, groups E, F, and G, division 1. In many instances, this is a conservative rating; in others, it is insufficient to provide the desired degree of safety.

b. For AMC installations, the following subparagraphs define the minimum requirements to be applied in the classification of areas in which explosives, pyrotechnics or propellants are, or are expected to be, present. These requirements will be followed unless less stringent classifications are justified and approved as a part of the site plan/safety submission process.

(1) Where flammable/combustible gases will be present, locations will be classified as class I locations if either a division 1 or division 2 situation can exist. Most commonly utilized gases and vapor-emitting solvents have been classified according to

the NEC. See references c and d of paragraph 6-17. Recognize that a division 2 hazardous location normally exists in the vicinity of a division 1 hazardous location.

(2) Where explosives, propellant, or pyrotechnic dusts will be present, locations will be classified as class II locations if a division 1 or division 2 condition can exist. Few explosives, pyrotechnics, or propellants have been classified per the NEC, therefore, either of two means of classification must be used--

(a) The more desirable approach is to use the methods and equipment of reference h together with more general guidance from reference c.

(b) Area classification by analogy with previously classified materials is less desirable but can be accomplished with a degree of accuracy if care is exercised, as increasing numbers of substances have been classified. With the publication of the 1981 Edition of the NEC, classification of groups within class II is based on the resistivity of the dusts involved. Reference f provides the basis for this change to the NEC, as well as recommended NEC classifications of many dusts.

(3) Some applications may represent dual hazards and will, therefore, require dual classification.

(4) In locations where exposed explosives, pyrotechnics or propellants will be present, the permanent facility wiring (i.e., lighting and power) will, as a minimum, meet the NEC requirements for class I and II, as appropriate, division 2 and the appropriate group(s). Wiring from the permanent facility wiring to process equipment itself should be rated for the actual environment, including ordinary (nonhazard rated) when it can be demonstrated that a class I or II hazardous location does not exist. In design of process equipment, it must be remembered that a micro-environment can exist within the equipment that would dictate hazard-rated wiring or the exclusion of electrical power. The rationale for these requirements is--

(a) To maintain maximum, long-term flexibility of use for facilities, wiring should be installed consistent with the most hazardous environment likely to be encountered in multiple uses over the lifetime of the facility.

(b) Wiring and equipment used for ordinary locations shall not be used for locations where exposed energetic materials are present, even if a hazardous location per NEC definitions does not exist, due to the possibility of ignition sources arising from physical damage (i.e., crushing by a forklift truck) or electrical overload or short circuit.

c. Table 6-1 contains a listing of typical hazardous (classified) locations and their corresponding NEC classifications. The entries in this listing are examples only, and are not to be used in lieu of analysis of the specific hazards of individual situations.

Location Description	NEC Classification
Pressed HE billet inspection-no measurable* dusting of vapors.	Ordinary hazard (permanent wiring and lighting - class II, division 2, group G)
Magnesium or aluminum powder weighing, mixing, blending, with or without other ingredients present.	Class II, division 1, group E
Cooling of melt-poured projectiles or mines - no measurable vapors.	Ordinary hazard (permanent wiring and lighting - class I, division 2, group G)
Screening or blending of dry, solid HE.	Class II, division 1, group G
Cloth Bagged propellant handling - no measurable dusts.	Ordinary hazard (permanent wiring and lighting - class II, division 2, group G)
Machining HE - shavings, but no measurable dust or vapor.	Ordinary hazard (permanent wiring and lighting - class II, division 1, group G)
Component assembly area - no measurable dust or vapor.**	Ordinary hazard (permanent wiring and lighting - class II, division 2, group G)
Storage of ammunition or explosives in approved DOT packages.	Ordinary hazard (permanent wiring and lighting -

* Measurable means measurement at the source of vapor or dust using standard equipment. "No measurable" means 50 percent below the lower explosive limit for the substance

**In determining area classifications, it is necessary to consider abnormal modes of operation as well as normal. Some situations may require the use of large volumes of flammable solvents during rework (for example) that are not needed during production. Rework in this instance may create a class I Hazardous location that does not exist during production.

Table 6-1. Typical Hazardous (classified) Locations and Their Corresponding NEC Classifications

6-4. Location of Electrical Equipment. Through careful planning, it is frequently possible to locate much of an electrical installation in a less-hazardous or nonhazardous location, thus reducing the amount and cost of special equipment. In some cases hazards may be reduced or eliminated by enclosing them and providing adequate positive pressure ventilation from a source of clean air, with effective safeguards against ventilation failure (NFPA 496). Also, intrinsically safe equipment and wiring (NFPA 493) may be permitted in any location for which it is approved. The above shall be considered as primary requirements. Electrical equipment will be located in potentially hazardous locations only when it can be demonstrated that location outside the area is impracticable.

6-5. Temperature Limitations. When exposed explosives, pyrotechnics, or propellants are present, (regardless of area classification) lights, motors, and other electrical devices that produce heat under normal modes of operation or failure must not have any surface exposed to the explosives, pyrotechnics, or propellants, which is capable of reaching the lowest of the following temperatures:

a. Twenty five degrees Celsius (45 degrees Fahrenheit) less than the dust layer or cloud ignition temperatures of the material involved, whichever is less. (Values to be determined through the use of ref a-e, para 6-17.)

b. Twenty five degrees Celsius (45 degrees Fahrenheit) less than the auto ignition temperature of the material as determined by differential thermal analysis.

c. Fifty degrees Celsius (90 degrees Fahrenheit) less than the 5-second explosion temperature of the material involved, reference AMC-P 706-177.

6-6. Maintenance. a. The National Electrical Code requirements for the construction of equipment and for installation in hazardous locations are based on safe performance under conditions of proper use and maintenance. AMC establishments shall, therefore, exercise more than ordinary care with regard to maintenance of electrical installations in hazardous locations.

b. Electrical equipment and installations in hazardous locations shall be inspected and maintained periodically by qualified personnel. A written record of the inspections and of the maintenance work performed shall be kept.

c. Insofar as electrical safety is concerned, AMC installations and activities will comply with requirements of this regulation and be

guided by provisions of TM 5-682, Facilities Engineering: Electrical Facilities Safety.

6-7. Working "Live" or "Hot" Circuits. a. In some cases of commercial practice, energized electrical lines and equipment are worked due to inconvenience to the consumer as a result of shutdowns. In general, the inconveniences must not be considered causes for working on energized electrical lines or equipment at AMC installations. In cases of critical processes and operations where alternate power sources are not available, it may become necessary to perform emergency work on energized circuits (para 6-7b). When emergencies do not exist, electrical lines and equipment must be disconnected from the power source, properly grounded and proven to be deenergized, as outlined below, before work is performed. Where deenergized circuits are in close proximity to energized circuits, rubber blankets or other suitable equipment shall be used for protection from the hot circuits.

b. Following is a list of "hot" circuit operations and conditions under which they may be performed:

(1) Whenever necessary, circuits at a potential of 30 volts or less may be worked while energized.

(2) Electrical equipment or devices may be tested or worked on while energized, provided the desired results cannot be accomplished with them deenergized. In such cases, requirements of paragraph 90, TM 5-682 and the following are applicable:

(a) Two persons must be present at all times while work is being performed on energized circuits. The second person (CPR certified) will stand clear, ready to render assistance in case of accident.

(b) Work on electrical equipment or devices at a potential of greater than 30 volts may be accomplished when deenergizing the circuits would result in serious interruptions of work. The commanding officer or duly appointed representative such as the post engineer must approve all "hot" work. Prior to the commencement of any work involving energized lines or equipment, an SOP shall be developed and approved. The SOP shall contain a detailed sequence of operations, specific tools, and protective clothing and equipment required.

c. Current rather than voltage is the most important variable in establishing the criterion for shock intensity. Three factors that determine the severity of electrical shock are: (1) Quantity of current flowing through the body; (2) path of current through the

body; and (3) duration of time that the current flows through the body. The voltage necessary to produce the fatal current is dependent upon the resistance of the body, contact conditions, and the path through the body, (see table 6-2).

CURRENT VALUES (milliamperes)		EFFECTS
AC 60 Hz	DC	
0-1	0-4	Perception
1-4	4-15	Surprise
4-21	15-80	Reflex action
21-40	80-160	Muscular inhibition
40-100	160-300	Respiratory block
Over 100	Over 300	Usually fatal

Table 6-2. Probable Effects of Shock

d. Sufficient current passing through any part of the body will cause severe burns and hemorrhages. However, relatively small currents can be lethal if the path includes a vital part of the body, such as the heart or lungs. Thus, the most dangerous path for the body to receive a shock is with current flow between the left hand and the right hand, or between the left hand and either foot.

6-8. Repairs. Unauthorized employees shall not make changes in, or tamper with electrical equipment. Repairs and changes shall be made only by qualified persons (TB 385-4). Where the equipment may have been exposed to contamination from explosives, the explosives must be removed or neutralized (by the user) and certified per paragraph 16-14 before repairs are started.

6-9. Safety Switches. Electrical services to locations where explosives are present should be so configured as to permit controlled interruption of power to prevent the creation of a secondary hazard under emergency shutdown conditions and to ensure that emergency response forces are protected.

6-10. Security Intrusion Detection Systems and Weapons Access Delay Systems for Magazines. a. Where these systems are to be installed, they must comply with DA PAM 385-64 and the provisions of the NEC for the appropriate hazard class, division, and groups determined on a case-by-case basis for type of storage. In

addition, these systems must meet the same requirements as those for permanent service to magazines, except that power need not be disconnected when personnel are not working in the magazine.

b. A current record must be kept by the installation of the designated hazard class of each magazine in which these systems are installed. Any change in the type of storage that would affect the electrical hazard class of the magazine shall be approved by the installation safety official.

c. The intrusion system, including any radio frequency transmitter used to transmit intrusion signals to remote stations, shall not establish field intensities greater than 1 volt per meter (peak) in magazines, the entrance and exit paths of these magazines, and associated roads used for transporting munitions. This specification assumes a minimum transmitter frequency of 100 MHZ. If the frequency is less than 100 MHZ, the maximum allowable field intensity must be reduced proportionally with frequency, e.g., at 50 MHZ do not exceed 0.5 volt per meter, etc.

d. When configured as a system and operating in the worst case performance mode, all equipment shall exhibit both inter-system and intra-system electromagnetic compatibility. Tests shall be conducted per MIL STDS 461 and 462. Electromagnetic compatibility guidance is contained in Engineering Design Handbook, Electromagnetic Compatibility, AMC-P 706-410.

6-11. Permanent Service for Magazines. In general, permanent magazine lighting service is not considered favorably. If permanent service is essential, the lighting system shall comply with the provisions DA PAM 385-64 and the NEC for the appropriate hazard class, determined on a case-by-case basis for the type of storage. In addition, the service will be provided with a separate ground bonded to the lightning protection system or counterpoise. A disconnect switch must be located on the pole from which underground electrical service is provided to the magazine. If electrical current is provided by a portable generator, the generator must be located at least 50 feet from the magazine and must use wiring rated for extra hard usage in damp places. This service cord must be disconnected at the magazine when personnel are not working in the magazine.

6-12. Single-Phase Portable Equipment. a. Single-phase electric handtools and other single-phase portable electric equipment, used in either hazardous or nonhazardous locations, shall be listed by the Underwriters Laboratories or other recognized testing agency, and (except for those protected by a listed system of double insulation or its equivalent) shall have all exposed noncurrent carrying metal parts

grounded. Single-phase electrical equipment such as fans, typewriters, calculators, etc., which are portable in the sense that they can be moved with a minimum of effort whenever necessary, require grounding only when existing circumstances are such that lack of ground will endanger exposed personnel. Typewriters, calculators, and similar single-phase office equipment are also exempt from the requirement for approval by Underwriters' Laboratories or other recognized testing agency. Where the equipment is to be used in a class I or class II hazardous location, the device shall be approved for the specific hazard. Flexible cords supplying them shall be type S hard service cord approved for portable heaters in damp places. In nonhazardous areas that are damp, portable lighting should not exceed a maximum of 12 volts (battery lighting is preferable). Cords for equipment (except office equipment such as typewriters and calculators) in ordinary and hazardous locations shall be three-wire with the third wire, identified by green or other acceptable colored braid, acting as the ground wire for the exposed noncurrent carrying metal part of the equipment. In no case shall the white identified neutral power conductor be used to ground exposed noncurrent carrying metal parts of equipment. Splices in flexible cords are not permitted. Plugs shall be approved and shall be equipped with three prongs with the third prong acting as the ground. Exposed noncurrent carrying metallic parts of the plug shall be grounded. Ground fault circuit interrupters, portable or fixed, should be provided and used on grounded portable handtools when the handtools are not plugged into the permanent wiring of a building/structure. Double-insulated handtools require neither the third (grounding) wire nor the corresponding grounding prong. The flexible cord shall (1) be connected to supply conductors in an approved manner; (2) be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections; and (3) have suitable seals provided where the flexible cord enters boxes, fittings, or enclosures of explosion-proof type.

b. Because of the necessity of safeguarding persons against the hazards of defective portable appliances, cords, and plugs, more than ordinary care shall be exercised with regard to their maintenance. Portable tools and appliances, other than coffee pots, typewriters, calculators, lamps, and other typical office type equipment, shall be assigned a number and shall be inspected and, if necessary, tested by a qualified individual on a regular schedule. The frequency of these inspections or tests shall be determined by the degree and severity of service, and shall be sufficient to uncover any defects. A written record of the tests, defects found and repairs made shall be kept. It is recommended that the maintenance inspections and tests be made by qualified personnel of the Electrical Department and that spot checks of the equipment against the records be made by a member of the Safety Staff.

c. Employees about to use portable appliances should examine them for obvious deficiencies in the appliances, the cords, and the plugs. If any deficiency is noted, the appliances shall not be used but shall be returned to the Electrical Department for repairs.

d. If the establishment is not equipped with three-wire receptacles and plugs, two-wire devices may remain in service until the changeover is accomplished provided that three-wire flexible cords are used and the third wire grounded by means of a substantial battery clamp attached to the third wire fastened to the grounded conduit system or other satisfactory ground.

e. No single-phase portable appliance having a name plate rating of more than 230 volts shall be permitted.

6-13. Three-Phase Portable Equipment. Temporary hook-up of three-phase portable equipment, such as motor driven portable conveyors, shall follow all of the requirements of paragraph 6-16, "Single-Phase Portable Equipment," except that the voltage may exceed 230 volts and the flexible cords shall be four-wire (delta load) or five-wire (wye load) instead of three, with one being colored green and acting as the noncurrent carrying wire for the exposed metal frame or parts.

6-14. Portable Engine-Drive Generators. a. Portable engine-driven generators have proven satisfactory as a source of electric power. When in use, the exposed noncurrent carrying metallic frame and parts shall be grounded.

b. When generators are used for generating current to explosives magazines or operating facilities, the following precautions shall be taken:

(1) The generating unit shall be placed at least 50 feet from any explosives facility.

(2) The ground area between the generating unit and the explosives facility shall be clear of debris or other combustible materials.

(3) The flexible cord should be temporarily supported from the exterior of the explosives facility to the power supply in such a position as to prevent trucks or personnel from running over or otherwise damaging the cables.

(4) Refueling shall comply with requirements of paragraph 24-4. Suitable extinguishers will be kept ready for use during all refueling operations.

(5) The generating unit and the gasoline supply containers shall be so located that spillage of gasoline would flow, by gravity, away from the explosives facility. If necessary, a trench shall be built to prevent spilled gasoline from reaching the explosives facility.

6-15. Electric Welding Units. AC welding machines supplied from a primary service shall meet the requirements of paragraphs 6-16 and 6-17, "Single-Phase Portable Equipment" or "Three-Phase Portable Equipment" depending on whether single or three-phase current is supplied from the primary sources.

6-16. Battery Operated Devices. Hearing aids, electric wrist watches, calculators, and other battery operated devices; although low voltage, low current devices, cannot be considered intrinsically safe as defined by NFPA 493, Intrinsically Safe Apparatus in Division I Hazardous Locations, without certification from Underwriters Laboratories or Factory Mutual required for all other electrical devices for use in hazardous (classified) locations. Such devices are, therefore, prohibited from use in areas classified as class I or class II, division I locations unless certification of their acceptability is available.

6-17. References. a. National Electric Code, NFPA 70, latest edition, (aka ANSI 70).

b. National Electric Code Handbook, latest edition, NFPA. (Similar handbooks are also published by other than the NFPA and are also recommended.)

c. Electrical Instruments in Hazardous Locations, 3rd Edition, E. C. Magison, Instrument Society of America, 67 Alexander Drive, PO Box 12277, Research Triangle Park, North Carolina 27709. (This is an excellent comprehensive reference to area and material classification, explosive fundamentals and means of hazard reduction as well as various other related topics. It includes treatment of Canadian, British, and European hazardous locations requirements.)

d. Fire Protection Handbook, NFPA, latest edition. (In addition to being an excellent general safety/fire protection reference, it also provides a comprehensive listing of the physical and chemical properties of many dusts and gases. Although the listing specifically contains no references to explosives, the information provided is necessary for classification of areas either directly or by analogy.)

e. Handbook of Industrial Loss Prevention, Factory Mutual System, Factory Mutual Engineering Corporation, published by McGraw-Hill. Latest edition. (An excellent general safety reference, it contains one chapter on electrical equipment in hazardous locations.)

f. Classification of Combustible Dusts per the National Electric Code, National Materials Advisory Board, June 1980, Ascension Number PB80-195456. Available from National Technical Information Service (NTIS). (This publication provides an NEC classification for the extensive listing of dusts contained in 14th Edition of the National Fire Protection Handbook, ref d. Also, included is a methodology for classification of dusts. The method is based largely on conductivity and results in the vast majority of dusts falling into group G.)

g. Matrix of Combustion - Relevant Properties of Gases, Vapors, and Selected Solids, National Materials Advisory Board, 1979. Report PB-294 250, available from NTIS. (This report provides a listing of chemical and physical properties of many materials. NEC classifications are provided for most. Some explosives are included.)

h. Test Equipment for Use in Determining Classification of Electrical Dusts, National Materials Advisory Board 1979, available from NTIS. As with ref f and g, also available from: National Materials Advisory Board, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, DC 20418. (This report contains a description of test methods and equipment for classifying dusts according to the NEC. This information is also useful for area classification.)

CHAPTER 7

STATIC ELECTRICITY

7-1. General. The generation of static electricity is not in itself a hazard. The hazard arises when static is allowed to accumulate, subsequently discharging as a spark across an air gap in the presence of highly flammable material, and thus providing a source of ignition. NFPA 77 is a useful reference for static electricity and related phenomenon. Additional requirements appear DA PAM 385-64, Chapter 6.

7-2. Grounding of Equipment. Permanent equipment in contact with conductive floors or table tops is not considered to be adequately grounded. Static grounds can be made to ground cones, buried copper plates, driven ground rods, or to down conductors of lightning protection systems. Bond wires and ground wires should have adequate capacity to carry the largest currents that are anticipated (#10 AWG is a reasonable compromise between current carrying capacity, physical strength, and cost). Flexible conductors will be used for bonds that are frequently connected and disconnected.

7-3. Belts. a. Conductive conveyor belts shall have a resistance not to exceed 1 megohm (1 million ohms) as measured between two electrodes placed on the belt and between the conductive conveyor belt and the ground. Conductive conveyor belting shall be tested at the time of installation and at least semiannually thereafter. In areas exposed to large variances in relative humidity, additional measurements shall be made during times of lowest relative humidity to check the adequacy of belt conductivity. The results of the tests shall be recorded and maintained.

b. Method of test.

(1) The building shall be clean and dry, and the room shall be free of flammable gas mixtures, explosive dust, and explosives.

(2) Each electrode shall weigh 5 pounds, shall have a flat dry circular contact area 2 1/2 inches in diameter, and shall have a surface of aluminum or tinfoil 0.0005 to 0.001-inch thick backed by a layer of 1/4 inch thick rubber that measures between 40 and 60 durometer hardness as determined by a shore type durometer.

(3) Resistance shall be measured with a suitably calibrated ohm meter which shall operate on a nominal open circuit voltage of 50-0 volts DC, or a short circuit current of 2.5 milliamperes, and shall have an effective internal resistance of 2 million ohms.

(4) Both electrode-to-electrode and electrode-to-ground measurements shall be made at five or more locations on the belt and the results averaged. The average shall be below the units specified and no values shall be greater than 5 megohms. When the resistance to ground is measured, two measurements shall be taken at each point with the test leads interchanged at the instrument between measurements. The average of the two measurements shall be used as a resistance to ground at that location. All readings shall be taken with the electrodes at least 3 feet from any ground conductor (except when space precludes). If the resistance changes during the measurements, the value observed after the voltage has been applied for 5 seconds shall be considered as the measured value.

7-4. Testing Equipment Grounds. Grounding systems shall be tested for electrical resistance and continuity when installation has been completed; before equipment is returned to service following any repairs; before equipment is used after an incident which can be reasonably suspected to have caused damage to power (electrical) systems in the equipment; at intervals not to exceed 6 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months. Tests will be recorded and will identify items tested, date of last test, test equipment used, and date of last calibration. The ground system shall be visually inspected (prior to reactivation of the system) if the equipment has been inactive for more than 1 month and tested if inactive more than 6 months. All exposed explosive or hazardous materials shall be removed prior to making tests. Complete records of all AMC-R 385-100 tests shall be kept. In testing for resistance to ground, equipment should be considered as a unit except in the case of a belt-driven machine. In measuring the total resistance to ground for belt-driven machinery to assure compliance with paragraph a below, resistance of the belting is to be excluded. The maximum resistance to ground permitted for different types of equipment is as follows:

a. Hazardous locations (operations where a static spark discharge may be dangerous). All conductive parts of equipment shall be grounded so that resistance does not exceed 25 ohms. For existing equipment, the rate of static generation should be considered before changes in grounding systems are made. The resistance of conductive rubber hose should not exceed 250,000 ohms.

b. Nonhazardous locations. Nonelectrical equipment in nonhazardous locations need not be grounded unless for static dissipation, but should be grounded as part of the lightning protection system when such system is installed. For interconnection of metallic masses, the standards set forth in "Lighting Protection Codes," NFPA Standard No. 78 applies.

7-5. Conductive Floor Tests. Initial tests shall be made of all conductive floors and subsequent tests shall be made at least semiannually. The test results shall be permanently recorded and filed in a single location. Instruments used in making tests shall be used only when the room is free from exposed explosives and flammable gas mixtures.

a. Maximum floor resistance shall be measured with a suitably calibrated ohmmeter, which may operate on a normal open-circuit output voltage of 500 volts direct current and a short circuit current of 2.5 milliamperes with an effective internal resistance of approximately 2 million ohms. Minimum floor resistance will be measured with a suitably calibrated ohmmeter appropriate for the task.

b. Each electrode shall weigh 5 pounds and shall have a dry, flat, circular contact area 2 1/2 inches in diameter, which shall comprise of a surface of aluminum or tin foil 0.0005 to 0.001 inch thick, backed by a layer of rubber 1/4 inch thick and measuring between 40 and 60 durometer hardness as determined with ashore type A durometer.

c. The floor shall be clean and dry, "electrode jelly" such as brushless shaving soap or saline solution shall not be used.

d. The resistance of the floor shall be more than 5,000 ohms in areas with 110 volts service, more than 10,000 ohms in areas with 220 volts service and less than 1 million ohms in all areas as measured between a permanent ground connection and an electrode placed at any point on the floor and also as measured between two electrodes placed 3 feet apart at any point on the floor. Measurements shall be made at five or more locations in each room. If the resistance changes appreciably with time during a measurement, the value observed after the voltage has been applied for about 5 seconds shall be considered to be the measured value. An alternative to 5,000 ohms and 10,000 ohms resistance is the installation of Ground Fault Circuit Interrupters (GFCI) in the main electrical panel for circuits servicing the area where conductive floors are utilized. For table tops, mats, and metal objects/equipment grounded per paragraph 8-19, a GFCI shall be installed in the main electrical panel servicing the area. Installation of GFCI shall conform to paragraph 6-1.

e. The operation and maintenance of test instruments shall be entrusted to competent personnel.

CHAPTER 8

INDUSTRIAL SAFETY OSHA

8-1. Safety Standards. a. All facilities, equipment and operations will comply with OSHA standards, or the provisions of this regulation, whichever is more restrictive.

b. Each safety office shall maintain an up-to-date library of safety standards and references. It shall include regulatory, and should include nonregulatory standards for reference purposes.

c. Appropriate local standards for safe practices, personal protective equipment, machine guarding, process hazard evaluation, etc., may be developed, approved by the local commander and adopted. Upon adoption, the standards should be circulated to appropriate elements of the activity. All local safety standards must comply with the requirements of OSHA standards, or be consistent therewith per AR 385-10 and the AMC supplement thereto.

d. Publications of the National Safety Council are acceptable as guides in the formulation of local safety standards, insofar as they do not conflict with the requirements of this regulation or other Army or AMC regulations.

e. Reference to 29 CFR 1910 pertains to the OSHA General Industry Standards.

f. Reference to 29 CFR 1926 pertains to the OSHA Construction Standards.

8-2. Safety Review of Operations and Procedures. a. Prior to completion of plans for construction of new facilities, major modifications to facilities, purchase of high dollar value process equipment, implementation of new projects or operations, modification of operational concepts, or similar process changes within the complex, proposals will be coordinated with the installation safety office and other appropriate organizations to provide for a complete hazard analysis and safety evaluation of the proposal. This coordination must be effected sufficiently far in advance of taking action to assure adequate time is allowed for the necessary study and review. Such coordination will provide requisite safety input at a point in time where changes necessary from a safety viewpoint can be made with the least manpower and dollar cost.

b. Experience has shown that proper preplanning of facilities and operations will significantly reduce the accident potential, while increasing the efficiency of operations. Of basic concern during hazard analyses and safety evaluations will be both the physical aspects of the operation and the personnel who will be part of the operation. Typical points of review will include--

(1) Consideration of the type and intensity of lighting required.

(2) Layout of equipment within the area.

(3) Flow of materials through the process.

(4) The type and extent of materials handling and materials handling equipment required.

(5) The placement of equipment and controls in relation to the positions which personnel will be required to occupy.

(6) The presence of materials or equipment that represent a high hazard potential.

(7) Changes in the work environment which may have a bearing upon the safety of personnel.

(8) Review of SOPs.

8-3. Materials Handling. a. Production methods involving materials handling should be studied as a specific phase of the safety program for determining unsafe methods and for promoting greater safety. Movement of materials should be continuous to produce greatest efficiency and to avoid congestion by accumulation at machines and in other working spaces. Procedures should be in conformity with the following basic rules:

(1) Keep material moving uniformly through the process steps.

(2) Minimize unnecessary rehandling.

(3) Eliminate heavy manual lifting.

(4) Reduce transport distance wherever possible.

(5) Provide special handling equipment, such as conveyors, forklift trucks, etc., where practicable.

b. Materials should be delivered to each succeeding operation in units of proper size. Generally, materials should be supplied and finished parts removed at frequent intervals to eliminate congestion, blocking of aisles, and attendant hazards. The materials should be brought to each operation by conveyors, platform skids, etc., at the same height they will be used so that unnecessary manual or mechanical lifting or handling will be avoided. Equipment for handling materials should be designed to accommodate the size and type of materials being moved. Where material is handled manually, every effort should be made to eliminate the necessity for lifting, pulling, pushing, or rolling loads. If manual lifting cannot be eliminated through engineering, personnel must be instructed on correct lifting procedures. Detailed information regarding standard storage procedures may be found in TM 743-200-1, Storage and Materials Handling; DOD 4145.19-R-1, Storage and Materials handling 29 CFR 1910.178.

8-4. Loading Docks. a. Ample space at loading and unloading docks should be provided off the traveled roadways to permit efficient operation without hampering the flow of traffic. Adequate bumper rails should be installed parallel to loading docks at distances which permit trucks and trailers to back in without striking the dock. Trailer or truck wheels must be chocked, the engine turned off, and the parking brake set when materials handling equipment is working in and out of these conveyances.

b. Dock plates of proper design should be provided to compensate for horizontal and vertical differences between truck bodies and edge of the loading dock. Loading docks should be high enough to permit the placing of dock plates as nearly as possible in a horizontal plane. Dock plates shall be fastened securely to prevent displacement while in use. Brackets or other lifting devices should be provided to allow for the safe use of mechanical handling equipment in the placement of dock plates. Well-constructed skids, kept in good repair, should be carried in trucks or provided at points where they will be needed. Consideration should be given to the design, construction and use of special aids in loading and unloading operations to lessen inherent handling hazards.

c. Refer to 29 CFR 1910.30, for additional information.

8-5. Cranes. a. Operation. Cranes shall be operated only by authorized crane operators whose physical fitness for the job has been certified by the medical officer. The operator shall be governed in his/her movement of material by a uniform code of signals such as American National Standards Institute (ANSI) standard code for cranes, derricks, and hoists. All loads should be lifted vertically and side

pulls avoided. When necessary to guide the load, guy lines should be used. Gantry cranes must not be operated while workers are present on tracks unless bumpers have been placed between the crane and the workers. Before leaving the crane, the operator shall see that all hooks are clear of all moving objects below. Before lifting any unusual loads, the safety director shall be notified and his/her approval shall be secured.

b. Specifications. The control board and all exposed wiring and switches should be guarded. Access ladders for electrically-driven overhead cranes should be located so that the operator does not pass within reach of electrical conductors while approaching the controls of the crane. Where needed, an adequate rope ladder or other suitable device should be provided for the escape of the operator in an emergency. Traveling cranes should be equipped with a signal warning device to be sounded intermittently while the crane is in motion. They shall also have a positive stop in the runways to prevent the crane from going off the end. Locomotive cranes and derricks should be equipped with effective outriggers and rail clamps.

c. Special hazards. Electrical cranes shall not be used where flammable dust or vapor is present in sufficient quantities to constitute a fire or explosion hazard.

d. Inspection and testing. Safety inspection and testing shall be per TB 43-0142, Safety Inspection and Testing of Lifting Devices; 29 CFR 1910.178, ANSI/ASME B56.1, regarding dock boards and bridge plates.

8-6. Hoists. a. This paragraph includes manually-operated and power-operated hoists commonly called chain hoists, air hoists, and portable floor cranes. All such equipment shall be inspected for determination of hazards incident to its use and appropriate safety control measures shall be instituted. Inspection and testing will be per TB 43-0142 and 29 CFR 1910.179.

b. On electric and air hoists, a limit stop should be provided to prevent the hoist block from over-travel in case the operating handle is not released in time. A spreader should be used to separate control ropes, each of which should be marked; sound practice indicates that handles of different contour should be provided on each rope to avoid mistakes in operating direction. Hoists mounted on monorail or tramrail systems should not be used to lift or move a heavy object by a side pull since it may spread or break the trolley frame or loosen supports. Stops should be provided at all switches and turnouts on monorail systems to prevent the trolley from running off if the switch is left in the open position. Load capacity shall be plainly marked on each piece of equipment. Safety latches should be provided on hooks.

c. Electric hoists shall not be used where flammable dust or vapor is present in sufficient quantities to constitute a fire or explosion hazard.

8-7. Elevators. The carrying capacity of the elevator shall be posted at all entrances to the elevator and in the elevator. Elevators, unless of the automatic type, shall be operated by only qualified personnel. Elevators must be equipped with safety catches, automatic limit stops, and emergency exits. The access openings must be guarded securely by approved gates or doors. Gates or doors must be arranged so that the elevator cannot be started until the gate or door to the elevator has been closed. Elevator shafts and all elevator equipment should be inspected annually by a qualified agency. Unless specifically designed for passenger service, personnel shall not be permitted to ride in elevators. Carrying lighted materials of any kind shall not be permitted in elevators. For further information refer to latest version of ANSI/ASME A17.1; ANSI/ASME A17.2; ANSI/ASME A17.3.

8-8. Chains. a. Usage. Wrought iron or "crane chain" is an acceptable type of chain for slings, hoists, cranes, steam shovels, and marine purposes. The iron must be free from iron scrap, steel scrap, and should be lap welded for strength. Alloy steel chain is also acceptable for use in slings and hoists (see ASME B30). Chains shall be used only for loads within their rated strength. Normalizing or annealing should be done as recommended by the manufacturer of the chain. The manufacturer should be informed as to the use of the chain and, if normalizing or annealing is recommended, the intervals and procedures should be obtained. End fastenings on chains shall sustain loads up to the breaking strength of the chain. Shackles and pins should be of forged steel, preferably drop forging and weldless throughout. Pin shackles should be fitted and maintained with cotter pins or safety pins of a positive locking type.

b. Inspection and repair. Inspection, and testing and maintenance shall be per TB 43-0142; 29 CFR 1910.179; 29 CFR 1910.184. All repairs to chains shall be made only by an experienced chain person; it is preferred that chains be returned to the manufacturer for repairs. Defective links or portions of chain shall be replaced by links having proper dimensions and of material equal to that of the original chain.

8-9. Wire Rope. a. Use. Braided cable wire rope is preferable. Wire rope shall be used for loads only within its rated capacity. It should be handled in such a way that it is neither twisted nor untwisted; kinks should be avoided. Wire rope should be kept well

lubricated with the lubricant approved by the manufacturer of the rope. Eye splices shall be made in an approved manner by an experienced splicer and thimbles should be used in them except in slings, where the use of the thimbles is optional. After the equipment has been in operation for an hour after the initial installation, all nuts on the clip bolts shall be tightened, and they should be checked for tightness at frequent intervals thereafter. Fabrication of wire rope slings shall be per ASME B30. Socketing should be done with zinc (spelter) in the manner specified by the manufacturer. Wire rope should be stored off the ground, in a dry, protected place, free from any exposure to acids, alkalies and their vapors. The storage place should not be permitted to become so hot as to injure the hemp core in fiber core ropes.

b. Inspection. Special attention should be given to the end fastenings. Rope should be examined frequently at socket fittings and upon the development of one broken wire adjacent to this point, the rope should be resocketed. Portions of rope subject to reverse bends and use over small sheaves or drums should also receive close attention. Wire ropes shall be replaced, and the old one destroyed or disposed of, when the wear, the number of broken wires in a lay, or corrosion has reached a point which indicates an unsafe condition. When corrosion is present, the remaining strength of the wire rope cannot be calculated with safety. Corrosion can be controlled by proper and suitable lubrication. Refer to ASME B30 and 29 CFR 1910.184 for further detailed information.

8-10. Natural Fiber Rope. a. Ropes should be thoroughly cleaned and stored in a dry, well-ventilated place free from any exposure to acids, acid vapors, or strong alkalies, and they should not be used where they are exposed to these materials. Ropes should be kept away from radiators, steam pipes or other sources of heat. Small ropes should be hung in loose coils and large ropes coiled on gratings raised from the floor. While in use, rope should be kept free from grit and should not be dragged on the ground. Fiber rope should be protected from abrasion by padding when it is fastened or drawn over sharp or rough surfaces. Fiber rope should be handled in such a manner that it is neither twisted nor untwisted. Kinks should be avoided. When uniting two rope ends for permanent use, for ring fastening or for fastening around a block or thimble, splices should be made only by an experienced rope splicer. Fiber ropes shall be used only for loads within their rated capacity.

b. Inspection and testing shall be per TB 43-0142; ASME B30 and 29 CFR 1910.184.

8-11. Synthetic Fiber Rope. Information regarding safe working limits for synthetic fiber ropes may be obtained from either the manufacturer of the item or standard engineering reference books. Safe working limits for slings and other devices fabricated of synthetic fibers must be obtained from the manufacturer. Inspection and testing shall be per TB 43-0142; ASME B30, and 29 CFR 1910.184.

8-12. Slings. Slings should always be used at as small an angle as possible since increasing the angle between the leg of the sling and the vertical greatly increases the stress in each leg. This angle should never be greater than 45 degrees. When a multiple leg sling is used, the sling should be so arranged that the strain can equalize itself among the legs. Hooks on slings should be of the safety type and designed to lift the load without over straining any part of the hook. When plates are hoisted, they should be held by properly designed clams that hold firmly under load. When hoisting loads which require sharp bends of the sling over unyielding surfaces or over sharp corners, suitable corner pads should be used. Rope slings shall not be used where the rope is subjected to high temperature, strong alkalies, corrosive vapor or exposed to rough edges which will have the tendency to sever the strands. Refer to TB 43-0142; ASME B30; 29 CFR 1910.184 for further information.

8-13. Conveyors. a. General. The use of conveyors is a desirable method of moving materials under most conditions provided certain basic precautions are observed. Crossover walks for employees should be constructed at reasonable intervals. Crossover walks, however, should not be considered an acceptable method for providing access to an exit from a building which constitutes a severe fire or explosion exposure. Conveyors should not be placed between an operator and his/her nearest exit. Conveyors installed flush with the floor should be guarded except at the loading and unloading points to prevent workmen from stepping on the moving conveyor. Working conditions should be arranged so that employees will not be required to stand on the supports of supporting frames to unload or load materials. Guards should be installed at corners or turns where material is most likely to fall; when handling explosive materials, this requirement is mandatory. Refer to ANSI B20.1-1990 for further information.

b. Gravity conveyors. In addition to the above requirements, all sections of gravity roller conveyors should be equipped with some type of positive locking device to prevent them from working apart during operations. Supports should be sufficiently substantial to give solid support under operating conditions. Supports of the horse type with an adjustable horizontal member allowing variation of the

elevation of the conveyors, or the three dimensional block type supports have proved successful. Boxes should not be used as supports unless they are safe from overturning and are securely tied together when more than one is to be used. Containers of hazardous materials shall not be used as conveyor supports. Conveyor sections and supports should be frequently inspected for unsafe conditions.

c. Mechanical conveyors. Mechanical conveyors are usually safer than other methods for moving materials. However, certain precautions in addition to those outlined above are necessary. Devices for stopping the conveyor should be located at loading and unloading stations, at drives and take-up ends, and at other reasonable intervals along the conveyor. Emergency switches should be installed within easy reach of employees at points where their activities cannot be readily seen by supervisor or other employees. Mechanical guards should be installed around the driving mechanism and where belts travel around tail drums to prevent personnel from being caught in the equipment. Workers should not be permitted to remove material that sticks to the tail drums or pulleys while they are in motion. Fixed scrapers and revolving brushes may be used to make it unnecessary to perform this operation by hand. Practical guards should be installed where necessary when chain belts are used, particularly when equipped with prongs, lugs, hooks, buckets, or scrapers. Conveyors running in pits or tunnels should have ample clearance and should be guarded to prevent employees form being caught. Where conveyors pass from one floor to another, the openings should be closed by railings and toe boards. Screw conveyor troughs should be covered with removable covers and no attempt shall be made to dislodge jammed material without first shutting off the power. Charging openings to screw conveyors should be covered with a grating, or the opening boxed or railed-in to prevent workers from stepping into them. All power conveyors shall be electrically grounded. Conveyors running into chutes that are enclosed should have a simple mechanically or electrically operated warning device to caution that material is about to be delivered from the chute.

8-14. Intermediate Storage. The term intermediate storage refers to the temporary storage of materials at machines, work benches, and other process throughout the establishment. The intermediate storage areas should be clearly defined. Material stored should be piled to prevent collapse or tilting and piles should be orderly with the materials to be used first, on top. Wherever possible, materials should be brought to the operation and left in storage at the working level. Stocks at operations should be placed to provide adequate work space, a minimum of turning away from the point of operation, and to lessen any interference which directly or indirectly could cause an accident.

8-15. Manual Handling. Personnel should be instructed that observance of the following basic principles will assist in reducing accidents:

a. Lifting shall be with the knees bent and the back straight in order that the thigh muscles may assume the greater portion of the load. If the object to be lifted is too awkward or too heavy to be handled in this position, additional help shall be obtained to move the load. Lifts shall be made vertically and close to the body. Side lifts or off-balance lifts frequently result in muscle strains.

b. Loads which obstruct vision shall not be carried.

c. Steel-toe shoes or other approved type foot protection meeting appropriate ANSI standards should be worn by all employees engaged in material handling operations designated as hazardous to feet or toes of employees.

d. Gloves, aprons, and other items of personal protective equipment shall be worn when handling materials which are sharp, abrasive, corrosive, or which might splinter.

8-16. Handtools. a. Prevention of accidents involving handtools is largely a matter of proper instruction and training of employees and maintaining the tools in safe working condition. Handtools, as herein considered, are sufficiently light in weight to be carried by hand, and include movable tools of hand motive power and mechanical and electrical tools which when in use are carried and held by a person. Handtools should be made of good quality material and should be appropriate for the job at hand. Hand tools should be kept in good repair and they should be tempered, dressed, or repaired only by qualified persons. Racks, shelves, or tool boxes should be provided for tools not in use to assure immediate availability and eliminate the hazards created by misplaced and forgotten tools. When tools are used on ladders, scaffolds, platforms, or other elevations, special precautions should be taken to prevent their being dropped or falling from these levels. Tools should be inspected frequently by qualified employees. Defective tools should be removed from service immediately to be repaired or discarded. When being carried by a person, tools with sharp cutting edges or sharp points should be carried in sheaths for the protection of the worker. Pipes or other improvised extension handles should not be used on handtools. Portable power tools should be equipped with guards which fully enclose moving parts. All electrical contacts on power tools shall be enclosed and all exposed wiring shall be well insulated. Exposed non-current-carrying metal parts of portable electric tool shall be grounded. Some power tools are constructed in such a manner (double

insulated) that grounding is not required. Such tools shall be so identified. When the use of handtools generates injurious dusts, portable exhaust systems should be provided. Portable electric tools shall be inspected annually by competent personnel (see paragraph 6-12). The use of ergonomically designed handtools is recommended whenever possible.

b. Hammers with highly tempered steel head should not be used on hard steel. Hammers with soft material heads securely fastened to smooth handles should be used instead.

c. Heads of chisels, punches, nail sets, and other tools of the same type shall be dressed frequently to keep them in safe working condition. Without such attention, continued pounding causes mushrooming of the head to a dangerous degree. In this condition the material becomes brittle, and with each blow of the hammer, fragments are likely to fly from the tool head with great velocity.

d. Handles of tools such as hammers, axes, picks, and sledge hammers shall be replaced when broken, cracked, split, or badly splintered. Heads shall be securely fastened by wedges and if the heads can be drilled, a steel pin through the head and handle will provide greater safety.

e. All files shall be equipped with suitable handles and all recut files shall be tested for fractures.

f. Small parts being repaired should be placed in a vise. Many serious injuries have occurred as a result of holding an object in one hand and a hand tool in the other while attempting repairs, particularly when screw drivers or other sharp pointed tools are being used.

g. Knives and similar tools should be equipped with disc-type guards at the hilt to prevent the hand from slipping onto the blade.

h. Electricians shall use nonmetallic tools wherever possible. Fiber fuse pullers, foot rules without metal rims, cloth tapes without wire reinforcements, and insulated handles on those metal tools that are necessary are essential to safety.

i. Only nonsparking tools shall be used in locations where sparks may cause a fire or explosion.

8-17. Explosive Actuated Fastening Tools. a. The following precautions will be observed:

(1) Explosive actuated fastening tools shall not be used in explosive atmospheres or in other locations where nonsparking tools are required.

(2) Cartridges will not be carried in the operator's pockets. Wood, metal, or heavy cardboard containers with means for separation of individual cartridges should be provided for storage of the working supply of cartridges. Cartridges should be accounted for at the end of each workday or shift.

b. The lowest velocity explosive actuated fastening tools practicable should be used. Refer to 29 CFR 1910.241 through 29 CFR 1910.243; and ANSI A10.3-1985 for additional information.

8-18. Machine Guarding. It is the responsibility of officials procuring machines and equipment to ensure that they are guarded per OSHA standards. Machines and equipment specifications will be coordinated with the local safety office. Inspection procedures will ensure that incoming machines and equipment comply with the OSHA standards. Refer to 29 CFR 1910.212 through 221; and 29 CFR 1910.241 and 243 for additional information.

8-19. Machine Operations. a. General. Safe practices at machine operations should be developed through job safety analysis. This regulation makes no attempt to cover all safe practices in detail, but deals only with those applicable to general processes and to certain specific machines that are commonly used or that require concentration of effort on safe practices because of unusual exposure. Complete safe practices procedures which cover fully all accident possibilities arising from operations should be developed at each establishment. Refer to 29 CFR 1910.212 through 221; and 29 CFR 1910.241 and 243 for additional information.

b. Training. Safe machine operation demands that the operator be properly trained and instructed in safe practices before staring work on the assigned machine. Observation of the new operator's work shall be continued until the supervisor is fully satisfied that safe practices are being followed. A regular checkup shall be made thereafter to assure that safe methods of operations are permanently established. Only authorized employees shall operate machines.

c. Housekeeping. Good housekeeping is essential to safe machine operation. Floors of work areas should be kept dry, clean, and free from obstructions to ensure safe and secure footing. Spilled oil, material, and the like that have been dropped on the floor shall

be removed promptly. A nonslip surface covering should be provided for employees to stand on while operating machines. Nonslip characteristics must not be permitted to decrease because of accumulations of dust, dirt, oil, sweeping compounds, or sawdust. Good housekeeping at operations require the proper location of supplied stocks (see para 9-3).

d. Repairs and adjustments. Before oiling, cleaning, or adjusting machines, the machines shall be stopped, switches or other controls shall be "locked out," and the machine shall be tagged. Work of this type should be performed only by qualified personnel. A careful check should be made before staring the machine to determine that everyone is standing clear. The machine guards shall be replaced upon completion of repairs, adjustments, etc., and before switches or other controls are made operative. The design limitations of machines must be recognized and on repairs, adjustments or modification which might cause these limits to be exceeded, shall be made (e.g., grinding machines must be equipped with abrasive wheels which have been rated as suitable for use at speeds equal to or greater than that of the machine). Refer to Lock Out/Tag Out procedures contained in 29 CFR 1910.137.

e. Stationary machinery and equipment. Stationary machinery and equipment shall be placed on a firm foundation and properly secured in place before being operated.

8-20. Compressed Air. Compressed air presents one of the most serious hazards. Its use for cleaning and drying purposes should be permitted only when all other methods have failed. Brushes and vacuums are preferred and should be used whenever possible. When it is necessary to use compressed air for cleaning or drying, adequate controls must be provided to protect the user, adjacent operators and casuals. Enclosures of adequate size to house movable items to be cleaned by air should be used. These enclosures should have only one side open and should have adequate mechanical exhaust ventilation. Each air hose should be equipped with a nozzle or guard specifically designed to release air pressure harmlessly (when the nozzle is directed against a restricting surface). In addition, the following precautions must be observed:

a. The minimum amount of air pressure required to perform the specific operations must be used. Compressed air used for cleaning shall comply with OSHA 29 CFR 1910.169, 1910.241, and 1910.243.

b. All users of compressed air must be provided with and wear approved eye protection.

c. The use of compressed air for removing foreign material from the hands, arms, or personal attire is prohibited.

d. "Horseplay" with compressed air is prohibited.

8-21. Grinding Wheels. a. General. The majority of grinding wheel accidents are caused by using the wrong wheel for the job, careless handling, improper mounting, excessive speed, or too much pressure on the wheel. Failure to wear goggles has resulted in many eye injuries. Wheels shall be carefully inspected upon receipt and immediately before use; all cracked wheels shall be rejected. Only competent mechanics shall be assigned to the mounting, care, and inspection of wheels, per 29 CFR 1910.213. New wheel, newly mounted, shall be run at full operating speed for at least 1 minute before being used. During this test, the operator and other employees shall stand clear or in a protected area, to avoid injury should the wheel disintegrate as the result of hidden defects. Wheels shall never be run at speeds greater than that for which they are designed, since excessive speed can cause a wheel to disintegrate. Work must not be forced against a cold wheel, but should be applied gradually to give the wheel time to warm up. If it is necessary to use the side of the wheel for grinding, it must be watched for wear and be changed promptly when appreciably worn. No sudden or heavy pressure should be applied to the sides of wheels. Wheels should be turned regularly and tests for balance. Wheels used in wet grinding should not be allowed to stand partly immersed in water as the water-soaked portion may throw the wheel out of balance.

b. Eye protection in grinding operations. Approved goggles shall be worn by all employees on every grinding operation, and in addition, protective eye shields should be mounted at each machine. Portable or stationary screens should be erected at grinders to prevent injury to persons working in or passing through the vicinity.

8-22. Metal Working Presses. The layout of the press room or the location of any employee in the department should be carefully considered from a safety viewpoint. Press operators should not be exposed at any time to the possibility of being struck by passing trucks, tractors, or other mobile equipment, and they should be free from interference from supplied stocks and finished products. Before a press operator starts work, he/she shall not place his/her hand under the ram unless the machine control has been locked out and the ram blocked. Continued sticking of the work in a die shall be reported to the supervisor or foreman. Maintenance, repair, and safe operation will be per 29 CFR 1910.212 through 1910.221.

8-23. Circular Saws. The sharpening and conditioning of saws shall be done by an experienced mechanic who should check regularly all saws assigned to his/her care. Rip saws shall have guides parallel to and extending beyond the saw to keep work straight. Adjustments of the guide while the saw is running are prohibited. Jigs and fixtures shall be used on small pieces, especially on mitre saws so that work can be held at a safe distance from the saw. During operation of a saw, the operator should watch for and promptly report wavering of overheating of the saw which indicates that the speed of the saw is too great, the saw too thin, or that the stock is being fed too rapidly. Operators should apply a steady pressure on work being ripped to decrease the possibility of kickbacks. Hand-push sticks in lieu of hand feeding should be used to push stocks. An operator should stand to one side of the work and saw so that he/she will not be in the path of a kickback. There shall be no reaching over the saw to pick up finished material. The operator's hands shall be kept out of line of travel of the saw and placed to the side and rear of the material being sawed. Operators should be instructed concerning the necessity of keeping alert all times because fingers can be pushed into the saw while feeding even though a hood guard is provided. Additional information pertaining to operating and inspecting circular saws is found in the latest edition of ANSI Standard 01.1, Safety Code for Woodworking Machinery, and 29 CFR 1910.212 through 1910.221. Brushes should be used for cleaning off the table and the floor should be kept free from accumulation of sawdust and cuttings to ensure a sound footing for employees.

8-24. Radial Saws. Radial saws shall be operated only by assigned personnel. Adjustments shall not be made while the saw is running. A stop or gauge shall be provided to prevent the saw from traveling beyond the edge of the saw table. For installation, maintenance, repair, and safe operation, refer to 29 CFR 1910.212 through 1910.221.

8-25. Band Saws. Tension should be released from the blade when it is not in use. Qualified mechanics should check band saws regularly to ensure they run true without excessive vibration. Band saw wheels should be tested at least once a week to detect and replace wheels with cracks or loose spokes. Band saws should be kept sharp and properly set. Each saw should be suitable for the work to be done with it. Using a small saw for large work or forcing a wide saw on a small radius should be prohibited. If the operator finds that work binds or pinches on the blade, he/she should never try to back the work away from the blade while the saw is in motion. Band saws shall not be stopped quickly by thrusting a piece of wood against the cutting edge or side immediately after the power is shut down. Operators should always adjust the guide to the thickness of stock being cut. For further information refer to 29 CFR 1910.212 through 1910.221.

8-26. Wood Joiners. Only sharp and evenly balanced knives shall be used in the joiner cutting head. Machine bearings shall be checked regularly to prevent vibration. When pieces shorter than 18 inches are machined, a pusher block shall always be used. The operator should try the joiner before using it to be certain that knives are not set to make too heavy a cut which may cause a kick-back. Chips or dust shall not be removed by hand; a brush should be used for that purpose. For further information refer to 29 CFR 1910.212 through 1910.221.

8-27. Welding and Cutting. a. Probably the most difficult hazard to control in cutting and welding operations is that of sparks setting fire to combustible materials in the vicinity of the operations. Wherever possible, cutting and welding should be done in a noncombustible location. When such operations are conducted away from the shop, all combustible materials, where practicable, should be removed from the site of the operation or, if practicable, the area should be wetted down thoroughly. Under any circumstances where combustibles are present, personnel equipped with suitable fire extinguishing equipment, filter goggles, and protective equipment shall be stationed near the welder to extinguish sparks that may ignite the operator's clothing or other combustibles in the vicinity. Because welding and cutting operations generate harmful gases, fumes, and dusts, adequate ventilation is essential. Local exhaust systems should be provided to reduce the hazard and where severe conditions exist, special respiratory equipment should be used by those exposed. On all oxy-acetylene welding and cutting operations, employees shall be provided with safety goggles to protect the eyes from heat, glare, and flying fragments of hot metal. Fire resistant gauntlets and aprons shall also be worn. On electric welding operations, employees shall be provided with safety goggles and a hand-held shield or helmet equipped with a suitable filter glass of the shade required (depending upon the size of the welding rods or the magnitude of the welding or cutting current), to protect against the intense ultraviolet and infrared rays. Protective clothing, adequate to protect against the hazards of the job, and prescribed by the safety office, shall be worn. When other employees are in the vicinity of electric welding operations, the operations shall be screened so that the employees cannot see the arc. Welder's helper shall be provided with and required to wear filter goggles and other protective equipment applicable to the work. After welding operations are completed, the operator should mark the hot metal to warn other employees of the hazard.

b. Cylinders of compressed gas shall be stored and handled as described in paragraph 13-21, AR 700-68, DOD 4145.19-R-1, and 29 CFR 1910.251 through 1910.256. Hose lines from oxygen and fuel cylinders

shall be different in color to avoid confusion. Hose should be tested regularly and replaced when it becomes damaged. Flashback arrestors should be installed per manufactures instructions, e.g., Compressed Gas Association Pamphlet E-2 and ANSI Z49.1.

c. When welding or cutting is to be done in locations where explosives and highly flammable materials may be present, permits for the work must be obtained in advance and per all requirements of paragraph 12-10.

d. Valves should be shut off at the cylinders and at the torch when the torch is not in use.

e. When electric arc-welding or cutting is to be discontinued for any substantial period of time, all electrodes shall be removed from the holders; the holders shall be carefully located so that accidental contact cannot occur and the machines shall be disconnected from the power source.

f. Metal containers shall be thoroughly inspected, cleaned or purged of combustible or flammable materials, and container bungs shall be removed prior to welding or cutting. Appropriate SOPs shall be developed.

8-28. Maintenance and Repairs. a. Responsible personnel shall make certain that employees are properly trained and that supervision is competent. The safety requirements and safe practices specified here and elsewhere in this regulation shall apply to maintenance employees as well as those engaged in production activities.

b. When maintenance work entails operations that might endanger employees at work in the vicinity, the area shall be roped or fenced off. When overhead work is being done and employees must continue working immediately below such operations, they shall be provided with hard hats or otherwise protected. Unfinished repairs or installation shall be protected after working hours by roping or fencing the area to prevent access by unauthorized personnel. Excavations shall be further marked by lights at night.

c. Before repairing, adjusting, or cleaning any power driven machinery, the control switch shall be "locked out" and the machine shall be conspicuously tagged to indicate the presence of maintenance men. Where some type of switch other than a knife switch is used, fuses shall be removed from the circuit before repairing, adjusting, or cleaning to avoid confusion as to whether or not the circuit has been opened. After repairs or adjustments have been made, it shall be the responsibility of the maintenance people to replace all guards,

to remove any grease, oil or other materials spilled on equipment or floors, and to remove all tools, equipment, and spare parts from the machine area. Machines and floors shall be cleaned of any dirt resulting from repairs. Lock Out/Tag Out procedures are detailed in 29 CFR 1910.137.

d. When the use of portable grinders or other equipment results in dusts, fragments, or flying objects, the operation shall be enclosed by portable screen guards for the protection of passers-by and employees at work in the vicinity.

e. For general cleaning purposes, a safety solvent, having a flash point of 100 degrees Fahrenheit (37.8 degrees Celsius) or above, should be used. However, when the parts to be cleaned, the solvent, or the objects in the vicinity approach a temperature of 100 degrees Fahrenheit, the use of such a solvent is as hazardous as that of any other solvent at or near its flash point.

8-29. Steam and Hot Water Cleaning. a. Any water heater or steam generator should be regarded as a boiler and should be equipped with safety valves of the temperature pressure type per the ASME Code for Boilers and Unfired Pressure Vessels.

b. Adequate protective equipment should be furnished personnel engaged in cleaning operations requiring the use of steam or high water temperature.

8-30. Confined Space Entry. a. Entry into confined spaces presents unique hazards. Included is the potential presence of toxic or asphyxiating gases, oxygen rich or deficient conditions, and explosive atmospheres. In addition, more traditional hazards such as slips, trips, falls, fires, or electrical shock may be exaggerated by the nature of the confined space. To address these hazards, each installation shall develop a program for confined space entry meeting the general requirements of Title 29 Code of Federal Regulations, Parts 1910.146, 1915, and 1926. DHHS (NIOSH) Publication No. 87-113, A Guide to Safety In Confined Spaces, provides additional information. Program requirements shall be a part of the installation safety program document.

b. Entering Storage Tanks. Precautions such as, but not restricted to, those listed below are intended to offset the hazard encountered in entering tanks.

(1) Tanks, process vessels, manholes, etc., shall be thoroughly cleaned and purged of toxic, flammable/combustible gases, vapors, dusts, fumes, etc., prior to entry. Sampling of the

atmosphere of the confined space shall be performed with proper instruments to ensure that the tanks/vessels, etc., are thoroughly cleaned, purged and free of toxic, combustible/flammable vapors and that an oxygen deficiency does not exist prior to entry by personnel.

(2) The tank should be provided with special ventilation by means of forced air from an uncontaminated source.

(3) One person, on the outside of the tank, shall keep the person in the tank under observation and at least one additional person shall be available for rescue work should the person in the tank be overcome. Personnel performing such duties shall be properly trained to perform tank rescue work. Additional personnel with such training should be available.

(4) Personnel entering tanks shall be equipped with NIOSH tested and certified respiratory protective equipment, suitable life belts or harnesses, and lifelines. Lifelines will not be used where the line may become entangled in piping, impellers, and other appurtenances hampering rescue.

8-31. Ladder Inspections. a. New ladders shall be inspected promptly to assure conformity with the purchase order requirements and to discover defects. Wooden ladders shall not be painted and all painted wooden ladders shall have the paint removed since it conceals defects. Varnish, linseed oil, or shellac may be applied if preservatives are needed. When not in use, ladders shall be stored in readily accessible areas away from sources of heat and dampness. Each ladder shall be inspected at least every 6 months. To ensure regular inspection, all ladders shall be numbered.

b. Ladders shall be inspected for--

(1) Loose or broken steps or rungs.

(2) Broken, split, cracked rails.

(3) Loose nails, screws, or bolts.

(4) Missing, broken, or damaged safety shoes.

(5) Condition of hinges and spreaders.

(6) Defective locks (on extension ladders).

(7) Condition of rope and sheaves.

(8) General serviceability.

c. Safe use of ladders.

(1) Portable and extension ladders shall be placed at a "safe" angle; i.e., the distance between the foot of the ladder and the wall or object against which it is leaning should be approximately one-fourth the length of the ladder. Portable and extension ladders shall be carefully placed to ensure secure footing for both side rails. Ladders shall never be placed against a window sash; a board should be fastened securely across the top of the ladder to give bearing at each side of the window. When it is necessary to place ladders in front of doors which open toward the ladder, adequate means to divert traffic shall be taken. Where operations on the floor level are such that the security of the ladder may be endangered, an employee shall be stationed at the base of the ladder to steady it or the ladder shall be securely tied in position.

(2) Portable metal ladders or wooden ladders with metal side rail reinforcing or metal rungs shall not be used by electrical maintenance personnel.

d. Refer to 29 CFR 1910 and ANSI A14 series for additional information.

8-32. Scaffolds. Where it is necessary for employees on scaffolds to crawl out on thrust-outs or projecting beams, life lines and safety harness belts of an approved design shall be worn and anchored properly. Refer to 29 CFR 1910.28 and 1910.29 for more information.

8-33. Rollover Protection Structures and Overhead Protection. Rollover protective structure (ROPS) complying with OSHA shall be provided for the following types of material handling equipment that are used in construction work: all rubber-tired self-propelled scrapers, front-end loaders and dozers, wheel-type agricultural and industrial tractors, crawler tractors, crawler-type loaders, rough-terrain forklift trucks, and motor graders with or without attachments. This requirement does not apply to side-boom pipe-laying tractors. Refer to 29 CFR 1926.1001-1003 for additional information.

8-34. Metal Strap Banding Operation. Personnel exposed in proximity to steel-banding or band-cutting operations will wear face shields and safety eyewear. Operators handling the metal banding will also wear leather or leather-palmed gloves or gloves providing equivalent or superior protection.

CHAPTER 9

PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT

9-1. General. a. Personal protective equipment consists of garments or devices to protect individuals from specific hazards that will be encountered in performance of their jobs. These hazards must be kept to the minimum through engineering design or by changes in methods or processes. If it is impractical to eliminate a hazard, its source shall be guarded, isolated, or confined so that personnel will not be exposed. Protection by mechanical means is generally more reliable than protection which is dependent upon human behavior.

b. Personal protective equipment is not to be confused with safe work attire such as short sleeves, cuffless trousers, pocketless shirts, substantial shoes or clothes which fit properly. Provision of every day attire that is worn by prudent individuals to avoid unnecessary risk is to the responsibility of the employee and should be considered a condition of employment.

c. Refer to 29 CFR 1910 Subpart I, for additional requirements.

9-2. Determining Requirements. A Hazard Analysis will be conducted to determine the need for and specific kinds of personal protective clothing or equipment. Operations having a risk assessment code of 1, 2, or 3, as defined in AR 385-10, will have the analysis approved by the commander or his designee and documentation kept on files as long as the operation exists. Factors to be considered include: specific exposures, employee habits and unsafe acts, accident experience (including correlation of parts of body injured with agencies producing injuries), employee suggestions, and appropriate nationally accepted standards. SOPs and job-safety breakdowns will include protective clothing and equipment requirements.

9-3. Selecting Equipment. To assure compliance with applicable safety standards, items of personal protective equipment must be approved by the safety director before they are procured. Substitutions will not be made by procuring agencies without approval of the Safety Director who supports the originator of the request.

9-4. Education and Enforcement. a. Definite rules governing the use of protective clothing and equipment shall be formulated, published, and enforced. On-the-job training must include requirements for the use of personal protective clothing.

b. Supervisors should periodically cover the care and use of personal protective equipment at safety meetings. Special emphasis should accompany the introduction of new items in the plant in order to increase the level of acceptance and use. Operations foremen and supervisors shall be especially careful to wear personal protective equipment where it is required in order to set an example and to gain experience in solving problems created by the use of these devices.

c. Complaints from employees regarding the wearing of personal protective equipment should be promptly and thoroughly investigated; garments or devices should be properly adjusted to the individual and repairs made without delays.

9-5. Maintenance. a. Personal protective equipment must be properly maintained since the life of the wearer may be dependent on its proper functioning. Adequate attention to cleaning and disinfecting is especially important for equipment worn about the face. An appropriate inspection schedule should be established with the frequency of inspection dependent on the various types of equipment involved. In establishing an inspection schedule, recommendations of national standards, size of operations, and the amount of use should be given consideration.

b. The proper maintenance of personal protective equipment is an inherent responsibility of supervision, and where necessary to assure a high standard of maintenance, personal weekly inspection of the equipment should be conducted by supervisory personnel. It is the responsibility of the safety director to assure that the program is being conducted in a satisfactory manner.

c. Provision shall be made for laundering and disinfecting protective garments and devices so that decontamination and sanitary standards are met.

9-6. Special Clothing. a. Where employees are required to wear special clothing (explosive plant clothing, anticontamination clothing, impervious clothing, etc.) and this necessitates changing from street clothes, a designated location for changing clothes will be established and suitable clothing lockers provided. Special clothing that is worn at work should not be worn or taken away from the premises, since this may introduce unnecessary risk to personnel not directly associated with Army operations. Special clothing shall not be alerted except under the direction of operating officials. Cotton undergarments should be worn in any operation where the generation of static electricity would create a hazard.

b. Explosives plant clothing, generally referred to as powder uniforms, for men and women, must be fastened with nonmetallic fasteners and be easily removable. Pockets should be of the lattice type. Trouser legs, slacks, and sleeves should be tapered and the trouser legs and slack shall be without cuffs, and should extend over the tope of shoes or boots. The garment should fit snugly around the waist and neck but caution must be exercised to avoid a fit around the waistband, belt, or neck sufficiently tight to cause skin irritation of dermatitis. These garments, as well as head coverings, should be made from tightly woven, smooth fabric and shall be flame-resistant or made of material which has flame-retardant qualities which meet the requirements of MIL-C-43122. Coveralls, Explosive Handlers (MIL-C-14610) is a garment which meets the above requirements. It is treated with a durable flame-retardant and does not require retreating. Each installation shall establish the laundering conditions which will effectively remove contaminations from explosive plant clothing. Regular testing will verify the effectiveness of the laundering operations.

9-7. Flame Resistant Textiles. a. While it is not possible to make combustible textiles completely resistant to charring and decomposition when exposed to flame or high temperature, a degree of flame-resistance can be achieved. Clothing made of flame-retardant-treated fabrics shall be used by personnel working in buildings or operations where there is exposure to open flames, the possibility of flash fires, or the possibility exists of contaminating clothing with materials that could flash. All operations shall be carefully analyzed to determine the need for flame-resistant clothing for those personnel involved. To enable ready assurance during inspections that employees are properly clothed, flame-resistant clothing should be identified in a manner which is distinctive from similar clothing that is not flame-resistant.

b. An increasing range of flame-resistant treatments for natural fiber materials is becoming available, and the selection of a particular treatment is governed by the intended use of the treated fabric. Where durability to laundering or weathering is claimed, the fabric should be tested for flame-resistance after being subject to the applicable cleaning or exposure procedures. All flame-resistant textiles shall be capable of complying with the performance requirements of either the small or large scale tests (depending on the purpose the materials to be tested are to serve) established in sections 20 and 30, NFPA Standard No. 701 or MIL-C-43122 whichever is more restrictive.

c. Many factors preclude the practice of specifying a single type of flame-resistant textile or uniform for all workers and all

exposures. For example, some synthetic fabrics used commonly in industry to provide protection from flash fires have been found to shrink and decompose to a tar-like substance that burns into skin when exposed to the intense heat of certain pyrotechnic compositions. Generally, flame-retardant or flame-retardant-treated fabrics which have high moisture regain, and that carbonize with minimal shrinkage when exposed to fire should be used, and is mandatory for metal fuel pyrotechnic mixtures and handling finely divided metallic powders. Flame-retardant-treated cotton meets this requirement, and with its high moisture regain, assists in reducing the potential for static electrical charge, generation, and retention. Where static electricity is a concern, undergarments should have a high cotton fiber content.

9-8. Eye Protection. a. Suitable eye protection devices must be worn by all personnel when working or visiting in eye hazard areas including aisles and hallways. Industrial safety eyeglasses shall meet all the requirements of ANSI/ASME Standard Z87.1 and 29 CFR 1910.133. Since the Food and Drug Administrations (FDA) design requirements for impact resistance of all eyeglasses sold in the United States are not as stringent as ANSI Z87.1, eyeglasses conforming to FDA requirements will not be considered as substitutes for industrial safety glasses.

b. Photochromic lenses are objectionable because of their high transmission of near ultraviolet and infrared light, their rather slow recovery time to maximum transmission of visible light, and their tendency to darken when exposed to many types of fluorescent lamps. If absorption lenses are required for industrial use, more specific control can be provided by specific tints dictated by the hazardous exposure; however, when a bona fide visual specialist (optometrist/ophthalmologist) insists that an employee must have photochromic lenses to perform his job, photochromic lenses will be permitted. In such cases, a complete justification and rationale will be obtained from the employee's doctor citing the employee's ophthalmic problem and the prescription.

c. Contact lenses cannot be considered as substitutes for appropriate eye protection. In some instances, contact lenses may increase the hazard to the eyes. The work environment in eye hazard areas should be thoroughly evaluated to determine the advisability of wearing contact lenses. Contact lenses should not be worn in work environments where there are chemicals, fumes, smoke, dusts, particles, or molten metals. When the use of contact lenses is prescribed as necessary by a bona fide visual specialist, other eye protection, such as tight fitting goggles, shall be required.

d. Eye hazardous areas will be designated clearly by posting caution signs that require the wearing of eye protection as a condition of entry (see 29 CFR 1910.144/145).

9-9. Hearing Protection. a. All personnel exposed to noise hazards, either intermittently or when assigned to a noise hazard area, shall be provided with and shall wear hearing protective devices. The type of hearing protector to be worn will depend upon the nature of the noise exposure and other job requirements. See AR 40-5, DA PAM 40-501, and 29 CFR 1910.95.

b. Facilities shall be reviewed at least annually to determine areas to be designated and posted as noise hazardous areas.

9-10. Respiratory Protection Devices. a. Persons employed in dusty or toxic atmospheres, where adequate ventilation or engineering controls are not feasible, shall be provided with and required to wear respiratory protective devices approved by NIOSH for the particular hazard present. The governing documents are 29 CFR 1910.134 and AR 11-34.

b. For Army peculiar operations, for which no NIOSH approved respirator is available, an Army approved respirator will be used. (Army approved means approved by the U.S. Army Edgewood Research and Development Center, or the Surgeon General.) The concentration, type, and exposure duration of the toxic atmosphere contamination shall determine the necessity for such equipment. Such equipment shall be maintained in serviceable condition.

c. Respirators shall not be worn nor will workers be permitted to perform tasks that require respiratory protection when a medical determination has been made that the individual is physically unable to perform the work and use the equipment, or conditions such as a growth of beard, sideburns, a skull cap that protects under the facepiece, temple pieces on corrective spectacles or goggles, or the absence of one or both dentures prevent a good facepiece-to-face seal.

9-11. Sweatbands. Operators shall wear sweatbands when necessary to avoid perspiration falling on material such as finely divided magnesium or aluminum, which may be ignited by moisture. Where possible, such operations should be conducted in air-conditioned rooms.

9-12. Head Protection/Face Protection. Face shields shall be worn by personnel exposed to flying sparks, shavings, splashing liquids, or similar hazards. For severe exposure to these

hazards, safety goggles or spectacles with sideshields will be worn under the face shield. Safety helmets, or hard hats as they are commonly called, shall be worn where there is exposure to falling objects such as in construction work in excavations or when using pick axes or sledge hammers. Bump hats may be worn in lieu of hard hats when working in confined spaces, however, bump hats are not a substitute for hard hats. Safety helmets shall comply with 29 CFR 1910.135.

9-13. Nonconductive Gloves. a. Nonconductive gloves shall be worn in locations where the following are present:

(1) Exposed electroexplosive devices; e.g., squibs, detonators, etc.

(2) Electrically initiated items with exposed electric circuitry; e.g., rockets.

(3) Hazardous materials that could be ignited by a static discharge from the human body.

b. Leather gloves may be worn while performing manual operations involving linked, unpacked ammunition with electric primers.

c. Nonconductive gloves are permitted where work surfaces, equipment floor, item and operator (through conductive shoes) are grounded.

d. Cotton gloves may be worn in propellant handling operations to prevent unnecessary skin exposure to Nitroglycerin (NG). If cotton gloves are worn they should be changed after 1 hour if NG or products containing NG are handled. Cotton gloves should be washed daily on site to prevent contamination of operators.

CHAPTER 10

STORAGE AND HANDLING OF MILITARY PECULIAR CHEMICAL MATERIALS AND MUNITIONS

10-1. General. a. Military unique chemical materials for the purposes of this chapter include chemical agents, riot control agents, smoke, and flame materials.

b. For environmental considerations, see AR 200-1, Environmental Protection and Enhancement, and the AMC Supplement 1 thereto.

10-2. Classification. a. For purposes of storing and handling, chemical materials have been divided into groups as listed in the Joint Hazard Classification Listing and as defined below, based on the action of the agent, the degree and type of hazard, and the type of protection required.

(1) Chemical Group A - Group A includes highly toxic liquid agents which in either liquid or vapor form may be absorbed through the respiratory tract, the skin, or the eyes (e.g., nerve agent, mustard). Exposure to chemical group A agents may cause serious damage to body functions or death, depending on the degree of exposure involved. Personnel can be exposed to, or contaminated by, the chemical agents in these munitions and not be aware of it until the effects first become noticeable several minutes or hours after exposure. Guidance and procedures for the storage and handling of group A chemical surety agents is provided in AR 385-61 and DA PAM 385-61 and the Material Safety Data Sheets (MSDS) specific for the agents. Therefore, this group will not be further addressed in this chapter.

(2) Chemical Group B - Group B includes chemical materials (gaseous, liquids, or solids) which are toxic or incapacitating by inhalation, ingestion, or percutaneous absorption. Wearing of suitable respiratory protection is required for the protection of personnel against inhalation of vapors, particles, or smoke from burning agents. This group consists of choking agents, blood agents, riot control agents, and screening smokes. The chemical materials most likely to be encountered in munitions are Phosgene (CG), Cyanogen Chloride (CK), Chlorine (CL), Incapacitating Agent (BZ), Chloroacetophenone (CN), Tear Agent CNS, Adamsite (DM), O-Chlorobenzamalononitrile (CS), Sulfur trioxide-chlorosulfonic acid mixture (FS), Titanium tetrachloride (FM), Hexachloroethane mixture (HC), Burning mixture (CN-DM) (a mixture of chloroacetophenone and diphenylaminechloroarsine with pyrotechnic material), Riot control

agent (CR), and Red Phosphorus (RP). The MSDSs for bulk CG, CK, CL, FM, and RP should be obtained from the commercial manufacturers. The MSDSs for the remaining chemical group B agents may be obtained from the Hazardous Material Information System (HMIS) or by written request from ERDEC Safety Office, SCBRD-ODR-S, APG, MD 21010-5423.

(3) Chemical Group C - This group includes materials which are spontaneously combustible when exposed to air (white phosphorus (WP) and plasticized white phosphorus (PWP)) and which require special fire-fighting techniques and materials. Both WP and PWP burn with a yellow flame and gives off a large volume of white smoke. Smoke in field concentrations is not toxic, but WP fumes are toxic. WP is intensely poisonous when taken internally. PWP is finely divided WP suspended in gel of rubber and xylene. Personnel protection will be of the type that will provide protection against fire and heat. Although not included as a group C agent, red phosphorus (RP) is an amorphous form of phosphorous but is not spontaneously combustible. It is a good fuel and if mixed with oxidizing agents can form very sensitive explosives mixtures. RP may revert to WP form if unstabilized (i.e., involved in a fire), and because of some similarities, chemical group C controls may be applicable to RP.

(4) Chemical Group D - This group consists of signaling smokes and incendiary (e.g., TH, IM, NP, PTI, TEA, or TPA) material for which conventional fire-fighting methods except use of water may be used. Protection from inhalation of smoke from burning incendiary mixtures is required.

b. The same group designation as used for chemical material shall be used for chemical munitions. The chemical and storage compatibility groups of the munitions item shall be the same as that of the chemical material contained within the item.

c. Most chemical agents (except smoke) are classified as storage compatibility group K. Separate storage is required foreach of the four chemical groups A, B, C, and D to preclude mixing with each other or with other dissimilar materials. Munitions containing chemical groups A, B, C, and D materials shall be stored per figure 4-1 of DA PAM 385-64 and the Joint Hazard Classification System. In addition, each agent assigned to compatibility group K will be stored separately due to the inherently hazardous nature of these chemical agents and the differences in personal protective equipment requirements.

d. Chemical munitions of the same chemical group and possessing essentially the same toxic and explosive characteristics may be stored together (except those in storage compatibility group K). Storage compatibility mixing does not apply to the storage of

working quantities on one liter or less per container of RDT&E stocks of chemical agents when properly packaged in approved containers.

10-3. Storage Requirements. a. The fencing and security requirements for any structure or storage area must meet the criteria outlined in AR 190-59, AR 190-11, and DOD Reg 5100.76M.

b. Incendiary and pyrotechnic munitions (including riot control items designed for thermal dissemination) - smoke grenades, riot control grenades, and incendiary items shall be stored in structures appropriate to their explosive classification as determined in chapters 4 and 13 of DA PAM 385-64.

c. Chemical munitions shall only be stored in magazines whose floors are not porous or are suitably sealed to prevent absorption of agent.

(1) For munitions with chemical group B filling or bulk agents, concrete floors treated with sodium silicate should be used. Rubberoid or other floor coverings shall not be used. Chemical Group B munitions should be stored in igloo type magazines.

(2) Chemical group C munitions should be stored in fire-resistive magazines with concrete floors. Storage in igloo type or Corbetta-type magazines is preferred. Chemical group C munitions shall be stored per current drawings and/or directives. In any case, chemical group C munitions should be stored in such a manner as to permit proper inspection.

(3) See individual MSDSs for specific storage requirements.

d. Magazines and open areas used for storage of Hazard class 1 chemical ammunition shall be equipped with lightning protection as described in chapter 12 of DA PAM 385-64. Lightning protection need not be provided for outdoor storage of ton containers. Noncombustible structures in which only ton containers are stored need not be equipped with lightning protection provided combustible materials in the structure are limited to the blocking and bracing materials necessary to storage of the containers.

e. Quantity-distances for chemical agents and agent-filled munitions shall be per requirements established in DA PAM 385-61 and DA PAM 385-64. In addition, hazard zone calculations will be developed for bulk storage of chemical groups B and D.

(1) Because of the diversity of items which may be present at an installation and the wide variation of hazards associated with

maximum credible events (MCE) involving different items, it is necessary that calculations be made for each item individually. It is necessary to hypothesize an MCE to enable calculation of the magnitude of a worst case hazard. The hypothetical MCE for any given situation will be based upon the nature and characteristics of the agent involved, ammunition, its packaging (container), storage configuration and location, and nearby ammunition and/or hazardous material storage. The number of ammunition items involved, the quantity of agent released, and the percentage of agent disseminated shall be assumed, based upon available test data. In the absence of data, the best technical judgment available will be used. In the instance of a bulk container or an ammunition item without explosives components, the MCE will be developed from the hypothesis of a leak or rupture resulting in a release of agent. In the instance of ammunition with explosive components, the MCE will be developed form the assumption of an explosion of detonation of one of the most disruptive explosive components which would produce the worst results regarding release of agent. The propagation characteristics of the ammunition will be considered in developing the overall MCE. The amount of agent released and the nature of release (evaporation or explosive dissemination) as hypothesize in the MCE will then be used to make the hazard-zone calculations.

(2) Considerations of hazard zones for chemical items at each installation shall include: agents present, their amounts, and storage or handling configurations; the normal types of operations and handling to which they are subjected; and the MCE that may result directly from each operations. The chemical agent source strength which would result from the MCE that could occur in the usual storage and handling configuration or during other specialized operations shall be calculated for each chemical item. Such MCE shall be evaluated and the worst case hazard strength shall be selected, based on the type and quantity of agent released and type of release (i.e., by explosive dissemination and evaporation). These hazard sources shall become the basis of subsequent hazard-distance calculations performed per the methodology described in Department of Defense Explosives Safety Board (DDESB) Technical Paper No.10.

(3) In performing hazard calculations, prime consideration shall be given to type of agent, source strength and geometry, agent's persistency, volatility, toxicity, nature of release (explosive dissemination or evaporation), other special features, and time of day that the agent release occurs. Based on meteorological, topographical, and other local conditions, a downwind-hazard zone in which certain effects may be expected shall be calculated for accidental agent release from the potential source of agent. The D2PC Chemical Hazard Prediction

model provides practical methods of performing these hazard-distance calculations. Information on the D2PC program may be obtained from the U.S. Army Edgewood Research and Development Center, ATTN: SCBRD-RTM, Aberdeen Proving Grounds, MD 21010-5423.

(4) Public access exclusion distance (PAED) requires consideration not only of blast or fragment hazard from class 1 items, but also of the effect of release of agent because of the inhabited building quantity-distance standards for chemical agents in class 1 or class 6 items cannot be conveniently stated in the manner prescribed for other class 1 items. The downwind-hazard zone shall be calculated as indicated in paragraph (3), above. For protection and analogous to the inhabited building distance for explosives, the hazard zone calculated from the MCE shall represent that arc from the agent source containing no more than 1 percent lethality concentration. Distances will be calculated to show whether or not the hazards from the chemical agents exceed the safety zones required to protect against the explosive hazards if both are present. The hazard distances should then be displayed as the radius of a circle drawn on a map of the installation boundaries. Positive means shall be taken to assure that no persons, not directly associated with chemical weapons operations, enter areas so defined. In the event this calculation results in a lesser distance than that required by the associated blast or fragment hazard, the blast or fragment distance shall be applied as determined for class 1, divisions 1 through 4. Positive control of an area which can assure that all persons can be removed prior to exposure in the case of an MCE may be developed in lieu of absolute exclusion. Full details of such control must be presented in the site plan as required in DA PAM 385-64.

f. Some Chemical group B have special storage requirements. Some nonpersistent group B agents are under pressure when in containers, bombs, or projectiles, and internal pressure increase rapidly when they are exposed to heat. Bombs have a manually operated venting device to relieve excessive pressure.

(1) Surveillance. Periodic pressure testing and, in some instances, sampling of agent containers is required to detect increases of internal pressure before they become dangerously high. Surveillance also includes inspection to detect leaks, breaks or other defects in containers and valves.

(2) Valves. Valves of containers filled with nonpersistent agents must be opened slowly with the correct wrench or tool. The valve should first be "cracked" by opening it one-quarter turn and then closing immediately.

(3) Inspections. When a magazine containing chemical group B munitions is opened, a foreman or other responsible person familiar with work in magazines containing this material must be present to determine whether or not munitions in the magazines are leaking. Specific detection requirements will be determined during SOP development based on the hazard analysis and information contained in specific MSDSs. If munitions are leaking, protective masks shall be worn and doors and ventilators will be opened. The leaking projectile or container shall be located and disposed of.

(4) Handling unboxed projectiles and containers. Unboxed projectiles and containers may be handled without protective gloves unless contamination is noted, except for liquid acid-type agents.

g. Limited temperature control is required for group C munitions during storage because the white phosphorus filling in the munitions becomes liquid at 111 degrees Fahrenheit.

(1) When exposed to air, WP will ignite; and, in cases where a burster is in the projectile it may explode. Below 111 degrees Fahrenheit the filling is solid and will not leak. For this reason, it is important that the temperature be kept below 111 degrees Fahrenheit.

(2) Where the temperature is likely to reach 111 degrees Fahrenheit, munitions shall be stacked in an upright position sitting on their base so that a subsequent drop in temperature will not solidify the WP in such a position as to affect the ballistics of the item.

h. A report of any leaking or damaged chemical items shall be made immediately to the supervisor of the storage area who will initiate procedures to process the material toward disposition of correction and accomplish appropriate reporting.

i. When damaged, leaking, or otherwise unserviceable items are discovered, they shall be marked for identification. These items will be removed from the storage area promptly, if practicable. If immediate disposition is not practicable, then leaking munitions shall be contained and segregated in a structure or area reserved for storage of defective items.

10-4. Personnel Protective Clothing and Equipment. a. Each individual who is involved in operations with chemical items shall be properly fitted with respiratory protection which will be assigned to his/her and for which he/she will be held

responsible. The respirators must be readily available to all persons working in these magazines. For normal operations, NIOSH approved respirators will be issued. Military mask may be issued for emergency escape purposes uses only.

b. Personal protective equipment such as protective masks, impermeable clothing, self contained breathing apparatus, coveralls, gloves, aprons, boots, etc., will be issued according to the needs established by the hazard analysis and incorporated into the SOPs for individual operations or for emergencies.

c. Personal protective equipment shall be placed at a location which will permit immediate access for use. The quantity and type of equipment required to be on hand shall be posted in the SOP. Centrally located protective equipment shall be inspected prior to and after each use, and on a regularly scheduled basis thereafter. Equipment that becomes unserviceable shall be replaced promptly.

d. Appropriate first aid and decontamination equipment shall be readily available at each work site and each employee shall be instructed in the use of this equipment. First aid procedures shall be included in operating SOPs.

e. Change houses and showering facilities, either stationary or mobile, shall be provided at the work area. Personnel shall be required to wash their hands thoroughly with soap and water after handling chemical munitions, particularly before eating.

10-5. Chemical Hazard Symbols. a. The chemical hazard symbols are illustrated in figure 3-5 to 3-7 of DA PAM 385-64. The chemical agents most used in ammunition and the combinations of chemical hazard symbols required in storage are specified in table 3-7 of DA PAM 385-64. Storage and operational facilities and transport vehicles containing any chemical munitions or bulk quantities will display the appropriate symbols.

b. Protective clothing and apparatus prescribed by symbols 1 and 2 in figures 3-5 and 3-6 of DA PAM 385-64 are for fire fighting purposes only and do not necessarily apply to normal operations.

c. Fire fighting personnel equipped with normal heat-resistant clothing (bunker suit) and gas mask/self-contained breathing apparatus do not require the protective clothing identified as sets 2 and 3 when fighting fires involving material in which sets 2 or 3 are specified in table 3-7 of DA PAM 385-64.

10-6. Packing, Marking, and Shipping. Chemical materials, munitions and components shall be packed, marked, and prepared for shipment per current drawings and specifications for the item involved. In addition, all applicable DOT regulations governing the shipment of chemical materials and munitions shall be observed.

CHAPTER 11

FIRE PROTECTION

11-1. Scope. All AMC installations and activities shall institute an effective program designed to carry out the steps necessary to prevent and fight fires. Program elements and responsibilities are outlined in ARs in the 420 series, TMs in the 5 series, TBs in the 385 series, the provisions of the National Fire Protection Association (NFPA) standards, OSHA standards and Military Handbook 1008. Where appropriate for the purposes of this regulation, some of these documents are referenced in the following paragraphs of this chapter.

11-2. Infrared Ray Drying. If sealed items containing explosives are to be subjected to infrared drying processes, prior tests to determine maximum internal temperatures to which explosives will be raised by such processes shall be conducted on duplicate sealed containers with inert filler having a thermal conductivity and specific heat similar to that of the explosives. Conveyor speed, time of exposure, and intensity of exposure to infrared rays will be adjusted so that the maximum internal temperatures to which explosives are subjected do not exceed the lowest of the following temperatures:

a. Twenty five degrees Celsius (77 degrees Fahrenheit) less than the ignition temperature of either the dust layer or vapor cloud ignition temperatures of the material involved, whichever is less (values to be determined through the use of references a-e, para 6-22).

b. Twenty five degrees Celsius (77 degrees Fahrenheit) less than the auto-ignition temperature of the material as determined by differential thermal analysis.

c. Fifty degrees Celsius (122 degrees Fahrenheit) less than the 5-second explosion temperature of the material involved, reference AMC-P 706-177.

11-3. Limitation of Fire Areas. a. Buildings not containing explosives shall be separated by clear space in compliance with MIL HBK 1008.

b. Buildings containing explosives or ammunition shall be separated per chapter 15 of this regulation.

11-4. Control of Vegetation. a. Local, State, or Federal forest service officials should be consulted with respect to periods of greatest danger of forest and grass fires in the locality and with

respect to equipment which has proven most effective in extinguishing such fires. The information received shall be used in developing a Land Management and Vegetation Control Plan which will minimize the danger of forest and grass fires on land under Government control and spread of fire from adjacent land to land within the installation boundary. This plan shall be incorporated into the Land Management and Grounds Maintenance portion of the Natural Resources Management Plan. Vegetation in the form of grass, undergrowth, weeds, etc., the density or nature of which constitutes a fire hazard or which is likely to become a fire hazard to Government property, shall be controlled. The use of bare ground firebreaks is discouraged. Installation perimeter firebreaks, forestry firebreaks, and similar firebreaks should be established in appropriate grass species. Periodic maintenance should be accomplished by mowing or application of herbicides. Where complete removal of vegetation is necessary to provide an effective firebreak, but would tend to create an erosion problem, the firebreak should be covered with noncombustible materials such as gravel. During calm weather and when adequate precautions are taken to prevent the spread of fire, burning may be used to control vegetation. Burning, however, shall not be permitted within 200 feet of any aboveground-type magazine or outdoor storage pad containing explosives or ammunition, or within 50 feet of any earth-covered magazine containing explosives or ammunition. During burning operations, all windows, doors and ventilators of magazines shall be closed. Control, cutting, or cleaning of woody vegetation (down or standing) will be accomplished per the appropriate portions of the approved Natural Resources Management Plan. Requests for assistance and questions concerning vegetation control should be directed to AMC Installations and Services Activity, ATTN: AMXEN-IB.

b. Forestry operations shall be reviewed and monitored by the local safety office. When such operations are underway, the following distances and conditions shall be maintained between explosives locations, and forestry operations:

(1) Active operating buildings and explosives handling facilities (i.e., with explosives) - unbarricaded intraline distance.

(2) Inactive operating buildings (i.e., without explosives) - in the immediate vicinity. Heat-producing devices will comply with paragraph 11-4 and AR 420-90.

(3) Magazines with doors closed (i.e., no operations) - in the immediate vicinity. Heat-producing devices will comply with paragraph 11-4 and AR 420-90.

(4) Magazines with doors open - unbarricaded intraline distance.

11-5. Firebreaks in Restricted Areas. a. Firebreaks in and around magazine areas should be maintained wherever deemed necessary. A firebreak at least 50 feet wide and free from combustible material shall be maintained around each aboveground-type magazine, holding yard, interchange yard, and around each outdoor storage pad containing ammunition or explosives. The use of bare ground firebreaks is discouraged. Installation perimeter firebreaks, forestry firebreaks, and others should be established in appropriate grass species. Periodic maintenance should be accomplished by mowing or application of herbicides. Temporary magazines with exterior covering which may be readily ignited; magazines with fire resistant construction where the fire-resistant materials do not completely cover the combustible framing, plates, sills, and supports; and outdoor ammunition storage pads containing combustible packing materials, dunnage, or other framework must be protected by a 50-foot firebreak in all directions on which no materials or vegetation capable of supporting combustion are permitted to exist. Magazines with fire resistive exterior covering, completely protecting the combustible framing, sills, and plates, and outdoor ammunition storage areas holding munitions with heavy castings (e.g., heavy case high explosives (HE) bombs), which are somewhat resistant to fire, must be protected by a firebreak beginning at the magazine or pad and extending 50 feet in all directions. This firebreak need not be devoid of vegetation but the growth must be controlled to prevent rapid transmission of fire to the pad or magazine. Mowing, combined with chemical herbicides, will satisfy this requirement.

b. The maintenance of firebreaks around earth-covered magazines and the cutting of grass covering these structures is not normally required. If the local commander believes that conditions at this installation are exceptional, he should so advise the Commander, AMC, ATTN: AMXEN. In emergencies, however, the local commander may take whatever action is deemed necessary to eliminate the hazard. Excess vegetation and dry debris on earth-covered magazines, and large trees, the root system or weight of which may damage these magazines, shall be cut and removed. Once initial control is achieved, excess woody vegetation can be controlled by applying herbicides on an as-needed basis. Growth of vegetation around ventilators on earth-covered magazines must be controlled to prevent rapid transmission of fire and to provide visibility of the ventilator flag from ground level. Nonselective herbicides can be used to control unwanted vegetation around ventilators. While mowing can be used, routine mowing is costly. Therefore, herbicides should normally be used to control vegetation on or around roof ventilator of earth-covered magazines. All pesticide (e.g., herbicide, insecticide, rodenticide) application must be coordinated with the installation Pest Management Plan and the installation Pest Management Coordinator to ensure compliance with Army regulations on pesticide application and DoD initiatives to reduce use of pesticides.

c. Vegetated firebreaks should be maintained around other areas or buildings housing hazardous operations or containing materials of high strategic value.

11-6. Hazards of Fires Involving Explosives. a. General.

(1) At no time will auxiliary or mutual aid firefighters be exposed to any building fire which may contain ammunition, explosives, or chemical warfare weapons.

(2) The minimum withdrawal distance for essential personnel at accidents shall be determined by emergency authorities on site. Emergency authorities shall determine who are essential personnel.

(3) Fires involving ammunition and explosives will be fought according to their classification in fire divisions and the stage of the fires and the procedures specified in subparagraph (2)(a) through (e) below.

(4) Ammunition containing both explosives and chemical agents requires special attention and precautions in firefighting. Such ammunition may belong to different fire divisions depending on the kind and quantity of explosives contained. Fire involving ammunition containing both explosives and chemical agents will be fought per their hazard class characteristics, but also taking cognizance of the additional hazards resulting from the effect of the chemical agents and the associated special measures required in the fighting of those fires; e.g., fires of WP ammunition.

b. Specific.

(1) Fire symbols 1 and 2 include ammunition and explosives in hazard classes 1.1 and 1.2 (excluding nuclear weapons - see TB 385-2). When involved in a fire, these materials can be expected to detonate with a moderate to severe fragmentation hazard. Therefore, no attempt to fight fires involving fire symbols 1 and 2 material shall be made except for manual activation of installed fire protection systems and fire alarm equipment while escaping. Personnel evacuating the building have a reasonable degree of safety in the open at distances given in subparagraph d(1)(d) above from the building in question. When exit drills are held, employees shall be instructed as to the safest line of travel to shelter or to a destination which is the required distance away. If the fire in a fire symbol 1 or 2 building is in nonexplosive material and is small or in a separate container, an attempt may be made to extinguish the fire with a portable extinguisher or other means readily at hand. However, the placement

of fire extinguishing equipment designated for hand use adjacent to fire symbols 1 and 2 material must carefully be scrutinized. After notifying the fire department, the superintendent or other responsible person shall travel as far as possible in the direction from which the firefighting forces may be expected in order to advise them as to the nature of the fire and the kind of material involved or likely to be involved. When fire symbols 1, 2, or 3 materials are known or suspected to be directly involved, the firefighting forces shall not approach closer than the distances specified in the latest edition of the Department of Transportation Emergency Response Guidebook, and the mobile equipment shall be kept at a protected location. If it is known that a considerable distance or effective screening separates burning nonexplosive materials from fire symbol 1 or 2 materials, or if an explosion has already occurred with assurance that only the heat of burning wreckage exposes other buildings whether containing explosives or not, and the fire chief and person in charge are in agreement on the procedure, firefighting forces may approach to extinguish the fire or protect adjacent buildings. However, no person shall reenter a fire symbol 1 or 2 building in which there is a fire to determine the conditions surrounding the fire. The safety of personnel in fighting a symbol 1 or 2 fire depends on the accuracy of the information available to the firefighting forces. When the question of safety is in doubt, no effort shall be made to fight the fire.

(2) Fire symbol 3 includes ammunition and explosives hazard class 1.3. They present a mass fire hazard. Personnel in the immediate vicinity should do everything possible to activate the fire protection system and give the alarm without incurring undue personal hazard. Unless the fire is of a minor nature and does not involve the explosive itself, and there appears to be a chance to control it, the firefighting forces shall confine their operation to preventing the spread of fire to other buildings. Fire in these materials produces intense radiant heat over a wide area, which is dangerous to personnel and equipment in the vicinity. Extreme caution should be taken by the firefighting forces.

(3) Fire symbol 4 includes ammunition and explosives in hazard class 1.4. They present a moderate fire hazard. Fires should be fought with all available firefighting equipment until the fire has been brought under control. Some hazard may be expected to firefighting personnel from fires in these materials and precautions should be taken against them.

11-7. Evacuation Drills and Alarms. To facilitate the prompt evacuation of all personnel from buildings, a manual system shall be installed in each explosives operating building. The alarm system for buildings containing explosives shall be arranged so that in case of fire or explosion in any one of the buildings of an operating line, personnel in all buildings of the line shall be warned. In case of fire in any inert building within an operating line, the personnel in that building shall be warned, and the personnel in the entire line may be warned by manual methods. Where buildings or processes are protected by automatic fire extinguishing systems, these systems may be used to actuate general alarms, eliminating the need for special alarm systems.

11-8. Deluge Systems. a. General. The deluge system is an instantaneous response (millisecond) ultra-high-speed system controlled by flame detectors (usually ultraviolet or infrared). They are used primarily to protect personnel, process equipment, and buildings from the fire and thermal hazard presented by energetic material involved in high hazard explosive operations such as melting, mixing, blending, screening, sawing, granulating, drying, pressing, extrusion, and pouring. Deluge systems with heat actuated devices (HAD) are not ultra-high-speed deluge systems and should not be used for personnel protection.

b. Design and installation. The design and installation of ultra-high-speed deluge systems for ordnance applications involves a technology which is substantially different from that associated with automatic sprinkler systems. Due to the speed of water delivery from all the nozzles, ultra-high-speed deluge systems are highly dependent on the detection system, piping network, nozzles, and water supply characteristics; the design, specification, and installation of the deluge systems must be performed by experienced designers, engineers, and installers who thoroughly understand the limitations and capabilities of these systems.

c. Sequence of operation. When the flame detector senses a fire within its scanning range, notification that a fire condition exists is sent to the controller. The controller in turn sends an electrical impulse to open the valve. At the same time signals are sent to operate audible and or visual alarms and to shut down process equipment. The deluge system consists of the following components:

(1) Detector. The most commonly used detector is the flame detector. It is an optical device that responds to the

radiant energy that is given off by a flame. When a flame or ignition source occurs within the field of view of the detector, the resulting electromagnetic radiation travels toward the detector at the speed of light. The detector responds to the radiant energy in milliseconds, sending a signal to the electronic controller. Two types of detectors are commonly used in ultra-high-speed deluge systems: ultraviolet and infrared. The ultraviolet (UV) detector senses electromagnetic energy in the UV spectrum and is used primarily to observe open area operations such as ammunition assembly and renovation operations. The infrared detector senses energy in the infrared (IR) spectrum and is used primarily to observe operations in enclosed process equipment. The detectors should be constantly scanning and capable of responding and signaling when a flash or flame is detected. Each detector should have a method for automatically or selective remote verification of optical supervision and cleanliness. Detectors normally have about an 80 degree cone of vision. A third type of sensor is the fast acting (millisecond) pressure sensor. It responds to the pressure generated by a deflagration.

(2) Controller. The controller contains all the electronic circuitry for processing the signal from the detector to actuate the relays that control the deluge valve. The controller should be self-supervising with independent relay contacts, field adjustable sensitivity, plug-in modules and relays, and switches to put the system into a standby or bypass. The controller should have coded readouts of the system faults as they occur displayed prominently on the front panel. The controller should also contain the necessary instrumentation to monitor detectors, energize the audible and/or visual alarms indicating systems activation or malfunction, to transfer these signals to remote designated locations and to automatically stop the process equipment in the affected areas. The control panel should be located where it is easily accessible. A backup electrical power system should be provided. The backup system should be able to meet the electrical requirements of the system for 8 hours and still be capable of activating the deluge system.

(3) Valve. There are two common types of valves used in ultra-high-speed deluge systems. The squib operated valve uses an electrically fired explosive primer to open the valve permitting water to flow. The solenoid activated valve uses an electrically operated solenoid to open a poppet valve releasing pressure from the pilot line which permits the main valve to open and water to flow. A third type of valve is the electrically initiated rupture disc.

(4) Piping. The diameter, length, number of bends, and friction coefficient limits the effective flow rate of water that

can be transported at an effective pressure by the piping system. Pipe runs should be kept to a minimum, and all horizontal runs should be sloped at least ¨ inch per 10 feet of run, with air bleeders at all high points. The looping of deluge piping systems may improve response time by improving pressure and effective flow rate.

(5) Nozzle. The design of the orifice determines the dispersion pattern, water droplets, and turbulence of the water flow which in turn, directly affects the water velocity. Nozzles should be installed with priming water being held back at the nozzle with blowoff caps, rupture disc, or the poppet valve when utilizing pilot operated nozzles. Nozzle discharge rates and spray patterns should be selected to meet the hazard condition being protected.

d. Hazard analysis. All munition production, maintenance, renovation, and demilitarization operations will be subject to hazard analysis in order to identify potential fire and thermal threats and to assess the level of risk. The hazard must be accurately defined. The risk assessment should include factors such as: initiation sensitivity; quantity of material; heat output; burning rate; potential ignition and initiation sources; protection capabilities (operational shields, clothing, etc.); personnel exposure (including respiratory and circulatory damage); munition configuration; process equipment; process layout; and building layout.

e. Design. Once the hazard has been accurately defined, the deluge system can be properly designed. The design and installation of ultra-high-speed deluge systems for ordnance applications involves a technology which is substantially different from that associated with automatic sprinkler systems. Ultra-high-speed deluge systems are fire detection and suppression systems capable of water delivery from all nozzles in milliseconds following the detection of a fire. The deluge system is part of the total protection provided for an operation. Other protective features such as clothing, remote operations, protective construction, operational shields, venting, etc., must be considered. Factors such as water pressure, water density, water flow rate, pipe size, number of nozzles, nozzle design (spray pattern), pipe configuration, deluge valve location, water travel distance from nozzle to target detector location, number of detectors, and distance from detector to the hazard must be considered. Where no applicable data exists, experimental fire extinguishment should be performed in a safe location. Nozzles and detectors should be located as close as possible to the exposed energetic material to provide the best possible response time.

f. Performance. The deluge system must be capable of preventing propagation of a fire from the cell or bay to another. In conjunction with personal protective equipment required for workers at the operation, the deluge system shall prevent significant injury to the worker. The workers should not receive more than first-degree burns as the result of any thermal threat. The effectiveness of the deluge system shall be demonstrated by tests against actual or equivalent threat. These tests should be conducted with the maximum quantity of energetic material expected to be in the cell or bay. In lieu of testing, a small deluge system (design flow of 500 GPM or less) shall have a response time of 100 milliseconds and a large deluge system (design flow of more than 500 GPM) shall have a response time of 200 milliseconds or less, provided the hazard analysis indicates that a faster response time is not required. The results of tests or the use of the 100 or 200 milliseconds or less response time will be retained on file by the installation for the life of the system. Response time is defined below.

g. Density. The required density will depend upon the type of energetic material involved, process layout, and whether the aim is extinguishment, prevention of propagation, prevention of serious injury, or a combination of these. A commonly used density for preventing propagation and structural damage is 0.5 GPM/SQ FT. For protection of personnel and process equipment or extinguishment of pyrotechnic materials, significantly higher density rates may be necessary. These may be as high as 3.0 GPM/SQ FT for area coverage or 200 GPM for point of operation coverage.

h. Water supply. An estimate of the maximum flow rate and pressure that would be required by the deluge system should be made. The capabilities of the existing water supply and distribution system to meet these requirements should be evaluated. If the required flow rate and pressure is not adequate, arrangements must be made to provide the required flow and pressure. The water pressure necessary for proper functioning of a deluge system must be available instantaneously, usually from an elevated tank or pressure tank. The instantaneous flow cannot be produced by starting a fire pump; however, a fire pump can be used to provide the required flow and pressure after the system has started to operate. The water supply should have a duration of at least 15 minutes. No allowance is required for hose lines. All valves on water lines between the water main and the deluge systems will be supervised to ensure the valves are not accidentally closed.

i. Explosive vapors, gases, or dusts. When explosives vapors, gases, or dusts may enter nozzles and interfere with their operation,

nonmetallic internally spring-held caps should be placed on the nozzles. The design must provide immediate release of the cap upon exertion of water pressure with the nozzle. Caps should be attached to the nozzles with small nonferrous chains to prevent their loss in equipment upon activation of the deluge system.

j. Manual activation. The deluge valve should be arranged for automatic and/or manual activation. Manual activation devices should be located at exits, in addition to the requirements of paragraph 5-9, and may be located at the operator's station when the hazard analysis determines the risk to the operator to be acceptable.

k. Response time. It is defined as the time in milliseconds from the presentation of an energy source to the detection system, to the beginning of water flow from the critical nozzle under test. The critical nozzle(s) is usually located closest to the hazard or as determined by a hazard analysis.

l. Measurement of response time. Two methods are commonly used to measure response time.

(1) Digital timer. A millisecond digital timer is started by a saturated UV source (IR for IR detectors) held directly in front of the detector and is stopped by the actuation of a water flow switch at the critical nozzle(s). This method does not measure the time lag of and water travel time from the nozzle to the target. It is normally used for routine testing.

(2) High-speed video recording system. A high-speed video camera and recorder (at least 120 frames/second) can be used as it permits very accurate measurement. The time from ignition to detection and water travel time from nozzle to target can also be measured. The video recording system can be used for contract compliance or when measurement of total response time is required.

m. Testing and maintenance. Deluge systems shall be tested and maintained per the criteria of TM 5-695 and para 11-18k. A good preventive maintenance program is required to reduce the number of false alarms and other system problems. Systems in laid-away or inactive facilities are exempt; however, they will be tested when put back into service. Records of the tests should be kept on file at the installation.

(1) A full operational flow test shall be conducted at interval not to exceed 1 year, including measurement of response time. The results of tests will be retained on file by the installation for the life of the system.

(2) Detectors shall be tested, inspected for physical damage and accumulation of deposits on the lenses at least monthly.

(3) Controllers will be checked at the start of each shift for any faults.

(4) Valves on the water supply line shall be checked at the start of each shift to ensure they are open. Unless the valve is secured in the OPEN position with a locking device or is monitored by a signaling device that will sound a trouble signal at the deluge system control panel or other central location.

n. Melt kettle and closed containers of molten explosives. They will normally not be equipped with internal flame detectors or deluge nozzles for the following reasons: The detector lenses or viewing ports are usually obstructed by molten explosives or moisture; the internal temperature of the kettle or container usually exceeds the maximum operating temperature of flame detectors (typically 150 degrees Fahrenheit); the adverse and potentially violent reaction of water from leaks and condensation with molten explosives, especially those containing materials such as powdered aluminum and powdered magnesium; and the adverse effect of large quantities of cool water hitting the molten explosives. The exterior of the kettles and closed containers should be protected by ultra-high-speed deluge systems, especially openings where materials are placed in them. The hazard analysis requirements of paragraph 11-18d must be considered.

11-9. Firebreaks in Ramps. a. The need for firebreaks and or installed fire protection systems in combustible conveyor galleries and ramps must be addressed on a case-by-case basis. The primary concern is to prevent propagation from building to building via the galleries or ramps.

b. Combustible ramps that are totally enclosed, partially enclosed, and open sided should be provided firebreaks as follows:

(1) Ramps not over 300 feet shall have a 30-foot firebreak in the center of the ramp.

(2) Ramps over 300 feet shall have a 30-foot firebreak located within 100 feet of each building serviced by the ramp.

c. Noncombustible ramps do not require firebreaks.

d. If the fire hazard is severe, a deluge system may also be required to prevent propagation of a fire from building to building via a combustible ramp. The need for deluge systems should be

evaluated by means of a hazard analysis. Flammable and combustible material will not be stored in combustible ramps.

11-10. Control of Wax Pots. a. All wax pots, regardless of size, must be equipped with pilot lights and must be placed on noncombustible surfaces.

b. Wax pots with a capacity in excess of 1 gallon must be equipped with dual temperature controls.

c. A wax pot of 1 gallon or less capacity need not be equipped with dual temperature controls provided--

(1) The operator is in constant attendance while the electrical switch is in the ON position.

(2) The wax pot is isolated by noncombustible partitions or by adequate distances so that a fire involving the wax pot will be prevented from spreading to other areas.

11-11. Portable High-Speed Deluge Systems. a. The portable ultra-high-speed deluge system is a self contained fire protection system used to protect short-run (usually lasting less than a week) ammunition operations involving production, maintenance, renovation, demilitarization, and surveillance. The portable deluge will normally utilize at least two detectors and two nozzles and a pressurized water tank. It is designed to provide spot protection such as the removal of propellant increments from a mortar round or dumping of propellant from a cartridge case into a hopper or container.

b. The water supply of the portable deluge system is very limited (typically 100 gallons). Whenever possible, a backup water supply should be provided. This can be done by tieing into the building water supply system. The first choice is an existing fire protection system. The second choice is the domestic water supply. The connection between the portable deluge and the building water supply can be accomplished by means of a flexible hose, similar to the hose connection on a fire department standpipe system. When this is not feasible, the use of a second pressure tank should be considered. The primary purpose of the backup water supply is to prevent re-ignition of the energetic material after the flames have been extinguished.

c. Whenever possible, the portable deluge system should be tied into the building fire alarm system.

d. The portable ultra-high-speed deluge system is intended for use in short duration operations and may not be used as a substitute for installed ultra-high-speed deluge systems.

CHAPTER 12

SPECIFIC CHEMICALS

12-1. General. This section covers specific chemicals used at AMC installations. It provides basic guidance for the establishment of local Safety regulations. Publications listed below are acceptable as guides in the formulation of safety standards except where they conflict with the requirements of this regulation:

a. DOD 4145.19-R-1, Storage and Materials Handling.

b. Material Safety Data Sheets (MSDSs).

c. Chemical Data Sheets, National Safety Council.

d. Liquid Propellant Handling, Storage and Transportation, CPIA publication No. 194 dtd 1970.

e. Patty's Industrial Hygiene and Toxicology.

f. Industrial Fire Hazards Handbook.

g. Dangerous Properties of Industrial Materials - Sax.

h. NFPA National Fire Codes and NFPA Standards.

i. 29 CFR 1910 Subpart Z.

12-2. Buildings Constructed for Acids. Buildings where acids are stored, handled, or used should be built of materials resistant to the action of the vapors produced or of the liquids themselves. Examples of such materials are acid-resisting brick, tile, asphalt-painted concrete, acid-resisting cement and steel covered with acid-resistant coatings. Use of wood and other carbonaceous materials should be avoided. Floors should be acid-resistant material, sloped to drains that are connected to sumps. Drains from the sumps shall not be connected to the industrial and sanitary sewers. In lieu of drains, floors may be constructed with acid proof retaining walls to prevent the escape of acid should leaks occur. Earth floors should have dikes, and should be covered with crushed limestone sized from 1 inch down with not more than 10 percent lime dust.

12-3. Acid storage. a. General. Acids are often stored in the drums or carboys in which they are received at the establishment. These containers shall be stored in a cool dry place away from the direct rays of the sun and other heat sources. Because of the

potential hazard of igniting hydrogen gas which is generated by the action of certain acids when stored in metal tanks or drums, the use of heat producing equipment should be controlled as outlined in DA PAM 385-64 paragraph 3-7a. For storage of concentrated sulfuric acid, the temperature should be maintained above its freezing point. Certain strong oxidizing acids should be isolated to positively prevent mixing with other stores. Such mixing may create an extremely hazardous condition involving fire or explosion; e.g., perchloric acid should be isolated from acetic, citric, nitric, and sulfuric acid. Special properties of individual acids should be taken into account when designing storage locations and establishing storage procedures. Examples of such properties are the ability to cause nitration, the ability to form hazardous mixtures with other chemicals, and the reaction with water.

b. Tanks. Storage tanks should be located to permit complete inspection of the tanks, piping, valves, etc. They should not be located in areas containing underground tanks, highly flammable materials, or chemicals which can react with the acid to form dangerous products. Overflow lines from the top of storage tanks should be installed and equipped with a flow detector and alarm to give warning when overflowing occurs. Tanks should also be equipped with an external gauge to show the quantity of acid in the tanks. New tanks should preferably be designed using pumps to transfer acid from the top of the tank to provide a more positive means of transfer. Tanks with bottom outlets should be equipped with standard safety plugs. Tank areas should be suitably diked.

c. Carboys. Glass carboys should be elevated from the floor to keep the bottoms of the crates dry and prevent rotting. Carboys may be stored in tiers not over two high with care taken to ensure that the bottoms of the upper row do not touch the glass necks or the wooden hoods of the lower carboys. At least one side of each carboy must be exposed to permit detection of leakers. Generally, when shipments of acids in glass carboys are received, the stoppers should be loosened carefully and then re-tightened. Carboys constructed of materials other than glass must be stored in such a manner that the carboys are not damaged and to permit inspection for damaged or leaking containers.

12-4. Handling Acids. a. General.

(1) Handling and transfer of acids should be kept to a minimum. Where possible, acids should be procured in containers that are suitable for operational use. Handling by pumps is preferred to a gravity system. With either method, the piping should be arranged so that the liquid will drain out of the piping when the supply pump is shut down, or when the discharge valves are closed.

(2) Transfer by compressed air systems or blow cases is the least desirable method. Blow cases should be designed to conform to the ASME "Code for Unfired Pressure Vessels." Unless the vessel is constructed to withstand main line pressure, a pressure reducing valve shall be installed between the main air line and the pressure vessel. A check valve should also be installed on the air line to prevent acid from being drawn into the air line after the pressure is relieved. In addition, a safety valve and pressure gauge shall be installed between the reducing valve and the vessel. Because of the corrosive effect of the acid on the valve, safety discs may be used in place of safety valves. Compressed air systems will be inspected at frequent, regular intervals. Blow cases shall be located in pits which shall be kept dry. Blow cases shall be inspected internally and externally periodically by qualified personnel and shall be tested frequently for leaks. During actual blowing operations, all employees should retire from the immediate vicinity and the apparatus operated from a protected position. A signal light or horn shall be used to warn employees that the equipment is in operation.

(3) Acid pump glands, valves and fittings must be approved for the type of service. Pump and valve packing must be compatible with the material being handled; e.g., when mixed or nitrating acids are being handled, pump and valve packing must be of a material that is not subject to nitration. Acid pump glands, flanged fittings and valve stems shall be provided with splash shields or collars where personnel are exposed to potential leaks or sprays from equipment. The use of transparent splash shields will facilitate the finding of leaks. Danger signs shall be posted to indicate active leaks until the repairs can be made.

b. Tank cars. When loading or unloading tank cars, warning signs (blue flags) must be placed on the railroad tracks at both ends of the car. All valves in the line from the tank cars to the storage tank should be checked to make certain they are in the proper position for the flow. A rigid pipe with several joints should be used to connect the tank car to the permanent line. At the completion of the transfer, the pipe used to connect the car and the permanent line should be washed thoroughly.

c. Carboy handling. Carboy trucks, inclinators or special carriers should be used in the manual handling of carboys of acids. Inclinators, safety siphons, or pumps that do not apply pressure to the container will be used to empty carboys. Emptied carboys should be inverted and thoroughly drained.

d. Protective equipment.

(1) All employees (acid workers who handle acids on a regular basis) shall be provided with approved rubber gloves, boots, goggles,

aprons and hats. In all cases, the minimum protective equipment when using acids shall be acid proof goggles and rubber gloves; i.e., when filling a battery with acid. Acid workers shall wear woolen or other approved type outer clothing. Where acid fumes have a toxic, corrosive or asphyxiating effect, suitable approved respirators will be worn.

(2) Safety showers with integral eye washes (designed to deliver large quantities of water without subjecting personnel to excessive pressure from water spray) equipped with quick-operating valves shall be readily available for removing acid spilled on employees. Such showers and eye washes shall be easy to operate by a temporarily blinded person, capable of functioning under all weather conditions and be tested monthly and prior to the start of operations for proper operation of valves/controls and water flow.

(3) Eye-wash squeeze bottles and other such plastic devices are not appropriate emergency eye-wash systems and should not be used under any conditions.

(4) In all areas requiring an emergency eye-wash capability, every effort will be made to install permanent eye wash fountains.

(5) No portable eye-wash fountains will be permitted in areas where a chemical splash hazard exists and where there is a continuous source of clean water available.

(6) Portable eye-wash fountains may be allowed in remote areas when no continuous flow of fresh water is available, when the installation of a fresh water system is not economically feasible, and when the hazard to chemical splash is minimal, e.g., in bulk storage areas.

(7) Portable eye-wash stations must meet the requirements of ANSI Z358.1.

e. Repairs to equipment.

(1) Before a pipeline, pump, or other equipment exposed to acid is dismantled for repairs, it shall be completely drained and washed down with water. In breaking a flange, the bottom bolts shall be loosened first and the first line allowed to sag slightly, permitting the liquid to run out by gravity. When repairs are completed, all spilled liquid shall be carefully washed away with water. All chemical pipelines shall be considered as containing liquid unless proved otherwise.

(2) A careful check shall be made to see that all pressure is relieved and all necessary valves, switches, etc., are properly tagged or locked to prevent accidental application of pressure or the introduction of acid into the line. The installation lockout/tagout program will be followed. Particular attention should be paid to branch lines where pockets may exist. All pumping on the system connected with parts under repair should be stopped with starters tagged and locked unless blank flanges are installed in the lines to cut off the affected parts from the pump.

(3) Two types of hazards exist in repairing used steel acid tanks. If all traces of weak acid and weak acid sludge are not removed, the weak acid reacts violently on the metal causing the generation of gases which may result in an explosion if welding is carried out on the tank, or if men work inside the tank, serious poisoning from the gases may take place. The tank should be washed out and then filled with water and drained before repairs start. If all acid is not removed, it may be necessary to resort to soda ash solution and steam followed by filling with water, etc. If entry into a tank is required, confined space entry program requirements must be met.

f. Neutralizing spills. Slaked (hydrated) lime shall be made available for neutralizing large quantities of acid in event of a spill. For cleaning acid from floors or equipment, a 10 to 20 percent solution of sodium bicarbonate is satisfactory. Neutralization generates heat and must be used with great care when large quantities of acid are involved. All places made slippery by acid shall be adequately neutralized with soda or other alkaline solution and washed with water to completely remove the acid contamination.

g. First aid treatment. Immediate first-aid treatment for all acid burns, except from oleum, consists of flushing the affected parts with copious quantities of clean water. Oleum should be wiped off first before flushing with water. First-aid treatment should be administered by fully qualified, well-trained personnel.

h. Mixing acid with water. When diluting a significant quantity of acid with water, the acid shall be added to the water and never vice versa. Acid should be added slowly with agitation. Similar precautions should be taken when using a weak acid instead of water as a diluting agent. Thorough mixing should be accomplished, particularly in a steel tank.

12-5. Mixed Acids. Mixed acids refer to mixtures of sulfuric and nitric acids used in the nitration of various explosives constituents. Carboys of mixed acids sometimes rupture violently due to the pressure of liberated gases. Mixed acids can start fires and cause explosions by generated gases, and give off poisonous oxides of nitrogen. Mixed acid containing not less than 10 percent of nitric acid will not freeze at ordinary temperatures and will not actively attack steel storage tanks.

12-6. Waste Acids (Spent Acids). Waste acids usually contain small amounts of nitrobodies and dust present the hazard of explosive material. Spent acid from the manufacture of nitroglycerin is particularly hazardous.

12-7. Oxidization Agents. Examples of inorganic oxidizing agents are the chlorates, perchlorates, peroxides, and nitrates of barium, sodium, potassium, strontium, ammonium, etc. Organic oxidizing agents such as nitrobenzene are often violent explosives. Oxidizing agents in the pure state present only a fire hazard but because of their ability to furnish oxygen, the hazard is greatly increased and violent explosions may occur when they are mixed or contaminated with even small quantities of certain carbonaceous and combustible materials such as wood, paper, metal powders, sulfur, etc. The violence of reaction depends upon subdivision, intimacy of mixtures, degree of contamination, degree of confinement and the type of initiation afforded. Impregnation of combustible materials including leather shoes, clothing, etc., with dust or solutions of oxidizing agents is equally dangerous as an intimate mixture of finely divided oxidizers and fuels. The mixtures described are very sensitive to heat, friction, and impact.

12-8. Handling oxidizing agents. a. Oxidizing agents shall be stored and processed only in rooms or buildings of fire-resistive construction. They shall be separated from supplies of fuels, flammable materials, metal powders, and acids until the process requires incorporation. Rooms used for processing oxidizing agents shall not be used for the processing of fuels or combustible materials, including metals powders.

b. Equipment for the processing of oxidizing agents shall not be used for the processing of fuels, flammable substances, metal powders, etc. Processing equipment for oxidizers should be constructed of noncombustible materials only.

c. Solutions of oxidizing agents shall be placed only in nonabsorbent and noncombustible containers.

d. Damaged combustible containers shall not be repaired in the storage building because they may be impregnated with oxidizing agent and ignited during repairs. Discarded containers should be burned in the open and should not be sold for other uses. Combustible containers impregnated with oxidizing agents burn fiercely if ignited and may explode.

e. Employees handling oxidizing agents shall wear flame resistant clothing as a minimum protection. The clothing shall be stored in metal cabinets when contaminated. Clothing shall be laundered frequently to minimize the hazard.

f. Spills of small quantities of oxidizing agents during processing must be cleaned up immediately. Such spills shall not be salvaged. If large quantities are spilled, the uppermost layers may be salvaged if there has been no opportunity for it to have become contaminated.

12-9. Chlorates. a. Chlorates mixed with sulfur, sulfides or other readily oxidizable material may result in spontaneous ignition. Sulfur presents a greater hazard than sulfides. The addition of phosphorus to a sulfur-chlorate mixture produces an even more dangerous composition. Shellac, potassium or sodium nitrate with petroleum derivatives, and powdered metals render chlorates sensitive; and mixtures of trinitrocresol or picric acid and chlorates should be avoided since they are particularly sensitive. Chlorates must never be mixed with ammonium salts since the ammonium chlorate which may be formed may explode spontaneously. Moisture to the extent of 0.5 percent or more in mixtures containing chlorates is regarded as a contributing element of danger due to the possible formation of chloric acid.

b. In any of the above described mixtures, the substitution of sodium chlorate for potassium chlorate increases the hazard.

c. Ammonium chlorate decomposes spontaneously and when mixed with perchlorates constitutes a major hazard.

d. Barium chlorate is very toxic in contact with the skin, when inhaled as a dust and when ingested. It is the consensus that barium chlorate is more dangerous than potassium chlorate for storage.

e. Zinc chlorate when in contact with certain organic materials will explode under the influence of slight friction, percussion, or shock. It is a serious hazard to life when involved in a fire.

f. Containers for shipping and packing chlorates are described in paragraph 12-14b.

g. Storage of chlorates should be arranged to preclude contact with other combustible organic or inorganic material. Broken or damaged containers should be removed and spilled material swept up promptly and destroyed.

h. Fires involving chlorates should be fought with solid streams of water or with water fog, depending upon circumstances. The use of solid streams enables fighting the fire from a greater distance but introduces the possibility of steam explosion against which precautions must be taken. Water fog offers the advantage of quicker cooling. Its normal smothering action, however, is obviated by the ability of chlorates to furnish oxygen to the fire.

12-10. Perchlorates. Perchlorates form slightly less sensitive mixtures than do chlorates and should be substituted whenever possible. Advantages of using perchlorates include a lesser sensitivity to impact and friction, the nonformation of a free acid when moisture is present, and greater safety in the event of accidental contact with weak acids which form the principal part of many of the gums such as rosin used in binding pyrotechnic mixtures.

a. Ammonium perchlorate alone is an explosive but is exploded with difficulty. It is stable at ordinary temperatures, but decomposes at a maintained temperature of 302 degrees Fahrenheit (150 degrees Celsius). It has the same degree of sensitivity to impact as picric acid. It becomes a high explosive when mixed with flammable materials and metal powders.

b. All damaged and broken containers must be removed from the storehouse and spilled material swept up promptly and destroyed.

c. Fires involving perchlorates alone may be fought with water.

12-11. Peroxides. a. General. Solid peroxides decompose easily in the presence of moisture to liberate oxygen and must, therefore, be stored in a cool dry place. They present a dangerous fire hazard, particularly when incorporated with combustible materials. Sodium peroxide must be protected from contact with water in as much as it then becomes explosive. Hydrogen peroxide of approximately 30 percent strength is unstable, liberates oxygen, and exhibits much the same characteristics as the solid peroxides.

b. Fires. Fires involving peroxides, except sodium peroxide, may be fought with water. Sodium peroxide fires must be smothered with sand, ashes, dirt or rock dust.

c. Organic peroxides. For information and precautions to be taken with organic peroxides such as benzoyl peroxide and methyl ethyl ketone (MEK) peroxide, see NFPA 33, paragraph A-14; and NFPA 43B.

12-12. Nitrates. a. General. Many nitrates are not flammable in themselves. They are usually stored in wooden boxes, kegs, or barrels. Ammonium nitrate, however, is normally shipped in special waterproof bags or metal containers. Barium nitrate is sometimes stored in iron drums. Regardless of the type of container it must be moisture proof and nitrates must be stored in a dry place since they cake in the presence of moisture.

b. Ammonium nitrate.

(1) Ammonium nitrate in confinement sometimes detonates with the violence of a high explosive but a relatively heavy initiator is ordinarily required. Ammonium nitrate will decompose when heated. Contamination with chlorides, sulfur, nitrobodies, charcoal, metallic nitrates, metal powders, petroleum derivatives and oxidizable carbonaceous materials sensitizes ammonium nitrate, accelerates its decomposition, and increases the violence of the reaction. Zinc or lead contamination lowers the decomposition temperature to 200 degrees Fahrenheit (93.3 degrees Celsius). Galvanized metals and lead solder must not, therefore, be used in the vicinity of ammonium nitrate operations. The burning of ammonium nitrate and combustible material, as for example wood or paper containers, has been said to produce a mixture of gases which under proper conditions of pressure may detonate with sufficient force to initiate the detonation of ammonium nitrate. Fires involving ammonium nitrate must be vented to the greatest practicable extent because air acts as a diluent for the hazardous gases, minimizing the probability of explosion

(2) In high pan (evaporating) operations, deluge systems must be provided over the pans for use in case of fire. Temperatures used to heat the liquor shall not exceed 317 degrees Fahrenheit (saturated steam at 100 psi). High pan operations must be located at class 1.1 distances from adjacent structures other than the graining building. The graining building, however, must be protected from the high pans by an approved barricade. The class 1.1 distances specified above may be based on the maximum quantity of ammonium nitrate contained in any one high pan.

(3) Fires involving nitrate should be fought with large quantities of water but never with streams. Solid hose streams enable the fire to be fought from a greater distance but introduce the

hazard of steam explosion particularly if the nitrate is molten; therefore, the hose streams must be directed from behind a protective barrier. Under some circumstances where the fire is in the incipient stage and accessible, water fog may be used to advantage but it will have no smothering action since the burning material provides its own oxygen.

(4) Storage of ammonium nitrate in explosives storage magazines is preferred. When stored in an area where there is a possibility that explosives may be projected into the nitrates, the regulations for class 1.1 explosives are applicable. When stored in an area with fire hazards only and separated by more than intraline distances from areas containing ammunition, ammonium nitrate may be stored per the regulations governing the storage of class 1.3 solid propellant.

(a) Buildings, other than earth-covered magazines, used for the storage of ammonium nitrate must be of a type easily vented in the event of fire in order that the gases produced during combustion, and considered potential sources of explosion to the commodity, are dissipated. The floors of such buildings must be of a type to prevent hazardous impregnation by the nitrate.

(b) Stacking within storage buildings other than earth-covered magazines should anticipate stacks no larger than 12 by 12 feet plan dimension, and not higher than 7 feet. Aisles not less than 3 feet wide must be maintained around each stack and between the sides of the building. The use of wood dunnage should be restricted to reduce the quantity of combustible materials present.

(c) Broken packages or containers shall be removed from the building and the spilled material swept up promptly and destroyed.

12-13. Powdered Metals: Aluminum, Magnesium and Aluminum Alloys. a. Since a rise in the temperature of metal powders can result from contact with water and ignition may ensue, all practicable precautions must be taken to prevent water from contacting the material. All buildings where powdered metals are stored or processed must be adequately vented at the highest point of the room or building to prevent the accumulation of evolved hydrogen gas which results from the reaction between powdered metals and moisture, except when stored in watertight containers.

b. Exposed material which may be at a low temperature should be brought to or near the room temperature under conditions of low relative humidity before being placed in the operating room.

c. Heating equipment (to be approved for safety by the Safety Office, prior to installation) must be installed in service magazines, where required to bring the closed containers and contents to a temperature approximating that of operating building.

d. Humidification as a means of reducing the potential of electrostatic discharge. National Fire Protection Association article 77, "Recommended Practices on Static Electricity (1983)," states that humidifying to control electrostatic discharge will work only if the surfaces involved can absorb water (absorbing water decreases resistance to current flow aiding dissipation to ground). Therefore, the central question is "Are any of the surfaces in the discharge path capable of absorbing moisture?" If the answer is "NO," give no further consideration of humidification as a means of control of electrostatic discharge. If the answer is "YES" further analysis focused on how humidification may help and what alternatives might be available to accomplish the same end is appropriate. Humidifying to control electrostatic discharge should be used only when other methods are not practical.

e. Operators must be cautioned to wear sweatbands on their foreheads and take other precautions to avoid perspiration falling upon powdered metals.

f. Care must be exercised regarding the location of pipes to prevent droplets of water from forming by condensation upon cold pipes and falling upon hazardous material. The possibility of leaking water pipes causing ignition should not be overlooked.

g. Powdered metals in metal containers with tight covers may be stored in general warehouses provided that they are remote from oxidizing agents. The storage place must be dry.

h. When compounded with oxidizing agents, powdered metals present a dangerous fire and explosion hazard.

i. Very fine suspended dust from powdered metals is an explosive hazard comparable to that of explosive gases and may be easily initiated by discharges of static electricity.

j. Powdered metals exposed to air are dangerous fire hazards and burn with intense heat. When in drums, in all probability the fire will confine itself to the place of origin if not disturbed, since experience indicates that it will be effectively blanketed by the metallic oxide formed by the burning.

k. The amount of powdered metal which may become involved in a fire should be limited. Fires must not be fought with

ordinary streams of water because of the danger of liberating large quantities of hydrogen gas which may be a severe explosion hazard. Fires involving small quantities of powdered metals may be successfully combated with a fog nozzle or specially designed commercial extinguishing powders applied gently so as not to spread the fire. If large quantities of powdered metals become involved in a fire and escape from their storage containers, fire-fighting efforts must be primarily directed to prevention of fire spreading to other facilities. In certain locations where friction sensitivity is not of concern, smothering fire with sand may be effective.

l. Proper personal protective equipment shall be provided for personnel handling powered metals.

m. Competent personnel only shall be permitted to repair or maintain buildings or equipment where metallic powders are involved, and then only with the following precautions: powder or dust must be removed, nonsparking tools must be used, hammer impacts that may cause sparks must be avoided, flashlights should be of approved type, equipment must be grounded, undue friction must be prevented, and open flames must not be used. See NFPA National Fire Codes and NFPA Standards Nos. 63 and 48.

n. Zirconium powder has been known to explode violently when in contact with cupric oxide or lead oxide. Other metallic powders exhibit this property under certain conditions. NFPA 491M contains useful information regarding reactions between metallic powders and other chemicals.

12-14. Charcoal. a. Charcoal is subject to spontaneous ignition in the presence of moisture although pit charcoal is less likely to react than the chemical byproduct charcoal, and softwood charcoal is less so than hardwood charcoal. The following conditions promote the spontaneous ignition of charcoal: forced cooling after burning; drying after absorbing moisture; contact with alcohols and oils, and particularly charcoal in which a fire has been extinguished. Pulverized charcoal is a definite fire hazard. The gases from burning charcoal contain carbon monoxide and are toxic.

b. Permanent or reserve storage of large quantities of charcoal is not recommended. Bulk storage of charcoal is prohibited. It should be stored in airtight containers or in bags piled in tiers with skeleton or gridwork floors between tiers to provide ventilation. It should be isolated and remote from oxidizing agents.

12-15. Sulfur. a. Sulfur compounded with chlorates and several other oxidizing agents forms highly sensitive explosive mixtures.

Sulfur presents a spontaneous ignition hazard when mixed with carbon, lamp black, fats, and oils. Burning sulfur produces toxic gases and fumes.

b. Sulfur may be stored in wooden boxes, kegs, or barrels. Large quantities may be stored in bulk. It should be isolated and remote from oxidizing agents with which it forms highly sensitive explosive mixtures.

12-16. Degreasing. a. In degreasing operations chlorinated hydrocarbons may be used if care is taken to prevent water and moisture from getting into the degreasing agent and to assure that the magnesium, aluminum, or other metal pieces being processed are dry before entering the tank. Water hydrolyses chlorinated hydrocarbons to form hydrochloric acid. A reaction takes place in the bottom of the degreasing tank, heat is generated, and a serious fire or explosion is created.

b. All chlorinated hydrocarbons are toxic to some extent. Wherever possible the least toxic chlorinated hydrocarbon or a different type of solvent should be used.

c. Welding operators shall be segregated from area where halogenated degreasing is performed. Toxic carbonyl compounds may result from vapors in the presence of ultraviolet light from welding.

12-17. Industrial gases. a. Compressed gas cylinders will be stored and handled per AR 700-68. All cylinders shall be adequately secured against accidental displacement. When cylinders of flammable gases or oxygen are stored out-of-doors, a separate storage facility shall be provided. Storage facilities of over 6,000 cubic feet total capacity shall be at lest 25 feet from any important building and facilities with a capacity in excess of 15,000 cubic feet shall be at least 50 feet from any important building. Cylinders should be stored in groups as small in area and height as is practicable, with aisles between groups wide enough to minimize the spread of fire. Cylinders shall be arranged to permit inspection at periodic intervals. Defective or leaking containers shall be removed immediately from the storage area or area of use. Covers of noncombustible or fire-retardant materials should be used to protect cylinders from the direct rays of the sun and accumulation of ice and snow. Tarpaulins used as covers must be flame-resistant. Ventilation must be provided under outside storage covers to carry off gas leakage. An airspace of at least 18 inches shall be provided between the cover and the cylinders to keep the temperature of cylinders below 125 degrees Fahrenheit. Empty cylinders shall be stored with valves closed and caps in place. Anhydrous ammonia cylinders shall be stored per Title 29 CFR 1910.111 - Storage and Handling of Anhydrous Ammonia.

b. Oxygen may create a dangerous fire hazard it if escapes or leaks into combustible materials. Compressed oxygen in the presence of oils and greases is almost certain to cause fire.

c. Hydrogen, acetylene, natural and similar gases form explosive mixtures with air. Where hydrogen and acetylene are used together, special equipment complying with pertinent industrial standards must be provided. Buildings where cylinders of hydrogen and acetylene are stored should be isolated and used solely for that purpose when practicable.

d. If a patient is unconscious from prolonged exposure to ammonia gas, he should be removed to fresh air and given artificial respiration. Skin burns should be flushed with water and medical treatment should be obtained promptly.

e. Containers of compressed gases shall be handled carefully to avoid striking them against any solid object; common wire rope slings and electromagnets are not suitable equipment for safe handling.

f. Smoking shall be prohibited within 50 feet of compressed gas cylinder storage and "No Smoking" signs conspicuously posted.

g. DOD-owned compressed gas cylinders shall be marked per MIL-STD-101B, Color Code for Compressed Gas Cylinders and Pipelines.

12-18. Flammable Solids. Guanidine nitrate, dinitrophenol, DNT and dinitrobenzene are sometimes considered low explosives. These materials are stored in wooden boxes or barrels lined with moisture proof paper. They are preferably stored in magazines, but, in any event, must be stored in a fire-resistant location. When strongly initiated they may act as explosives. Dinitrobenzene is toxic. Dinitrophenol may explode at elevated temperatures. It is extremely toxic and respiratory equipment may be required as well as gloves and special clothing to avoid skin contact.

12-19. Volatile Flammable Liquids. a. Common examples of volatile flammable liquids are ether acetone, gasoline, ethyl alcohol, methyl alcohol (wood alcohol), benzene, toluene, xylene and amyl acetate. These liquids are quite volatile and at room temperature, if unconfined, may evolve vapor in concentrations in air within the explosive range for the vapor concerned. Ethyl and isopropyl ethers have a tendency to form explosive peroxides, especially when anhydrous. Evaporation to near dryness must be prevented. Volatile flammable liquids must not be used to wash or clean equipment or parts of buildings except where specifically authorized as process requirements.

b. Some flammable liquids such as linseed oil, paints, varnishes and enamels may, under certain conditions, be subject to spontaneous ignition and must be kept where any heat produced will readily dissipate. They shall also be kept away from sources of heat. Only noncombustible sweeping compound should be used for cleaning up materials of this type.

12-20. Calcium Carbide. Small quantities of calcium carbide may be stored in general warehouses in airtight tin cans or iron drums. A separate building of noncombustible construction, or detached weatherproof shed should be used solely for the purpose of storing large quantities of this material. The storage place should be dry and well ventilated and special precautions should be taken against moisture. Calcium carbide in itself is a slight fire hazard, but reacts violently with water to liberate large quantities of acetylene gas which form explosive mixtures with air.

12-21. Carbon Tetrachloride. Carbon tetrachloride may be stored in general warehouses in airtight drums. It is very toxic and its use shall be avoided whenever possible by substituting chemicals of lesser toxicity. Where carbon tetrachloride is used under controlled supervision, adequate ventilation must be provided to reduce vapor concentrations to a safe limit for workers. Since this vapor is heavier than air, exhaust intakes should be located at or near the floor. Carbon tetrachloride is not combustible but gives off toxic vapor.

12-22. Sodium-Hydroxide (Caustic Soda) - and Potassium Hydroxide. These materials may be stored in general warehouses in airtight iron drums. Permanent storage of large stocks is not recommended. These chemical products may become a fire hazard when mixed with nitro-compounds or other material. They are also very corrosive and caustic in their action. When mixed with water, large quantities of heat are evolved.

12-23. Metallic Sodium. Metallic sodium may be stored in airtight steel drums. It reacts violently with water, liberating hydrogen gas and evolving heat, producing a very serious fire and explosion hazard. Sodium may also be stored under kerosene or nitrogen, but never chlorinated hydrocarbons.

12-24. Nitrocellulose and Derivatives. Nitrocellulose includes various types of nitrated cotton or wood pulp depending on the nitrogen content. Nitrocellulose when dry is extremely sensitive

to shock and friction and readily accumulates static charges. It is highly flammable and explosive, burning rapidly producing very little smoke or residue. Impure, it is subject to spontaneous ignition. Storage of dry nitrocellulose is not permitted as it possesses all the hazards of a sensitive and easily ignited high explosive. Nitrocellulose containing 25 to 30 percent moisture is stored in zinc lined boxes or metal drums and is substantially nonexplosive when stored in an area where explosives or ammunition cannot be projected into it.

12-25. Red Phosphorus (RP). Red phosphorus forms very sensitive mixtures with oxidizing agents and is a dangerous fire hazard. It may be stored in general warehouses in metal drums or metal containers enclosed in wood boxes. Phosphine gas may be formed in containers of red phosphorus and protective measures should be employed upon opening. If RP has been in a fire, it must be stored in the same manner as WP waste.

12-26. Pentachlorophenol (PCP). Material treated with PCP and dried properly, represents a minimum hazard to personnel. It shall, however, be handled with caution and skin contact or inhalation prevented. Personnel must wear leather palmed gloves for handling all properly dried treated items. Such gloves, and all clothing which contacts the treated items should be replaced or laundered frequently to prevent accumulation of PCP. Rubber gloves and aprons shall be worn to prevent physical contact with material showing areas of wetness or tackiness or evidence of PCP crystallization on the surface. Personnel shall not eat, drink, or smoke in areas containing PCP. Personnel shall also wash prior to eating, drinking, or smoking and after each shift. An obvious odor of PCP, or irritation of the eyes, nose, or throat is an indication of airborne PCP, and ventilation sufficient to reduce the irritation to an unnoticeable level shall be provided. An industrial hygiene survey of airborne pentachlorophenol shall be made and if the permissible level is exceeded, organic vapor respirators tested and certified by the National Institute for Occupational Safety and Health are required until engineering or administrative controls are instituted.

CHAPTER 13

EXPLOSIVES AND AMMUNITION

13-1. Properties of Initiating Explosives. Initiating explosives include lead azide, mercury fulminate, lead styphnate and tetracene. They are very sensitive to friction, heat, and impact. When involved in a fire, they can be expected to detonate without burning. Quantities in storage and in process must be limited to the smallest practicable amounts. Bulk initiating explosives will be stored in conductive containers and if more than 10 grams are stored for more than 4 hours, they shall be kept wet with water or with water-alcohol mixtures. Every effort shall be made to prevent the liquid from freezing, and if frozen, explosives material itself shall not be handled. Whenever processing requires the scooping or pouring of dry initiating explosives, the operation will be done by remote control. Dust from initiating explosives operations shall be collected with a wet-type aspirator system. The aspirator bottle or container shall be located as close to the dust intake point as practicable. The aspirator bottle will contain an approved desensitizing agent or be housed in a protective shield. No valves, where explosives may lodge, shall be in the vacuum line. The vacuum will be controlled to preclude excessive bubbling. Because explosives may be present, extreme caution will be used when disassembling the system to clean it. Contaminated sections of vacuum systems shall be cleaned daily by circulating an approved desensitizing solution through the tube or pipe. Dry-type collection systems will not be used. Emphasis must be placed upon cleanliness and general housekeeping since contamination of these explosives with foreign or gritty material markedly increases their sensitivity. Rooms in which initiating explosives are handled shall have floors of lead or other non-sparking flooring material. Flooring shall always be of conductive finish. Walls of the rooms should be covered with waterproof material having a smooth hard gloss finish. Frequent washing of the rooms with a neutralizing solution is necessary. Drying of the explosives is usually accomplished in muslin squares on a drying table or by a special air blowing device with temperatures limited to between 122 degrees Fahrenheit and 140 degrees Fahrenheit (50 degrees Celsius and 60 degrees Celsius). Bulk initiating explosives shall be packaged and transported per current DOT regulations pertaining to the specific initiating explosive.

a. Lead azide. Lead azide is a crystalline, cream-colored compound which is practically insoluble in water. Care must be taken, however, to assure that the water used is free of bacteria-forming impurities which may react with the dextrinated lead azide to

form gas. Lead azide, and killed or treated solutions of lead azide, allowed to come into contact with copper, zinc, or alloys containing any concentration of such metals can cause the possible formation of other azides which are more sensitive than the original lead azide. Rooms in which lead azide is handled shall be washed thoroughly and regularly with a desensitizing solution. Facilities and operating procedures shall avoid exposing lead azide, wet or dry, to ultraviolet (UV) light. Lead azide decomposes when exposed to UV light.

b. Lead styphnate. This explosive is particularly sensitive to discharge of static electricity, and the dry material can be readily ignited by static discharges from the human body. Lead styphnate is approximately as sensitive as mercury fulminate to impact and has about the same order of friction sensitivity as lead azide. It should be stored under water in conductive rubber containers. Where practicable, lead styphnate should be in the water-wet state while being processed. Water should be removed by decanting. It is usually dried by suction filtering, washing with alcohol, and drying in an oven at 50 to 60 degrees Celsius. The alcohol wash is needed to prevent caking since breaking up caked explosives is hazardous. Conventional methods of de-watering explosives such as placing material in cloth then squeezing and draining on inclined smooth surfaces such as glass are not recommended. To remove styphnate from receptacles, a stream of water should be used to wash the material from the inclined container. If this procedure is impractical, the styphnate may be carefully removed by hand, provided rubber gloves are worn. The use of spatulas, rakes, or scoops should be prohibited. Containers equipped with removal rubber liners facilitate handling of the wet explosives and are recommended. Lead styphnate tends to form a sensitive scaly deposit on the sides of the containers and collection sumps. The scale can be removed with 5 to 10 percent sodium hydroxide or sodium acetate solutions. The removal of the scale with tools or other instruments shall not be attempted. Operations should provide for eye protection. Conductive flooring and table tops, without cracks or crevices in which explosives can lodge, are required. Conductive footwear is required. All equipment shall be electrically grounded.

c. Mercury fulminate. The precautions given for lead styphnate and lead azide shall be used as guides for the handling of this explosive. Mercury fulminate either wet or dry should not be permitted to come into contact with certain materials such as aluminum, magnesium, zinc, brass, or bronze. This material is no longer used to any extent in military explosives.

d. Tetracene. Tetracene is a colorless or pale yellow crystalline fluffy material. It is as sensitive to impact as

mercury fulminate and diazondinitrophenol. It is the ease of ignition and its relatively high heat of explosion and gas volume that render it useful in priming compositions and along with lead azide in explosive rivets.

13-2. Handling Low Energy Initiators. Whenever manufacturing, processing, using, or testing low energy initiators (can be initiated by 0.1 joules (1 million ergs) of energy or less) the following regulations in addition to those precautions (barricades, safety glasses, etc.) normally used when handling explosive items shall be followed wherever applicable:

a. All metal parts of equipment shall be bonded together electrically and grounded.

b. Personnel shall wear proper clothing. This means powder uniforms, cotton under garments and conductive shoes with cotton socks or stockings. Just prior to an operator entering the room or area where low energy initiators are being processed, his/her conductive shoes shall be tested with a resistance meter.

c. Personnel positioned at operating locations where low energy initiators are handled shall be directly grounded by an approved wrist strap. This grounding strap shall be checked daily while on these operators and the resistance reading shall be less than 250,000 ohms when measured form opposite hand to ground. Special contact creams may be used to decrease the resistance to the required value.

d. When glass, acrylic or polycarbonate materials are required for transparency in barricades, they shall be coated with an antistatic wax to prevent build-up of static electricity. This coating should be renewed every 2 months.

e. In areas which are monitored by static electricity alarm devices, work shall be discontinued when the device warns of a static electric charge until cause has been determined and corrective action taken to eliminate the condition. In each area at the time of installation, a survey will be made to determine the maximum setting of the alarm which will give ample warning but will not cause cessation of operations needlessly.

f. In air-conditioned areas, work shall not be started until the relative humidity and temperature are at their proper levels as called for in approved SOPs for the job.

g. All metal surfaces exposed to a rubbing or friction action shall not be painted. If lubrication of such unpainted surfaces is necessary, it will be of such a composition as not to increase surface resistance of the metal materials above 25 ohms.

h. All work on or with initiators shall be performed in areas equipped with conductive floors and conductive table tops. Exceptions may be made when approved in writing by the local safety office when the initiators are properly packed, or are part of a completed metallic end-item affording a complete shield for the initiators.

i. Work shall not be done in the vicinity of electromagnetic or electrostatic fields or where they may be produced. Examples of electrostatic or electromagnetic sources are (a) radio transmission, (b) electrical storms, (c) transformer stations, (d) high voltage transmission lines, (e) improperly grounded electric circuitry, and (f) rotating equipment, belts, etc. Adequate lightning protection and ground for electric storms and adequate resistances for fixed sources of energy shall be established for areas where low energy initiator operations shall be shielded to afford protection against mobile radio transmission in the vicinity.

j. All electrical equipment shall be so located that it cannot be reached or touched by an operator working with a low energy initiator. Soldering shall never be performed with a connected electric soldering iron. An iron with a permanently grounded tip may be remotely heated, disconnected, and then used.

k. Initiators, not part of an end-item or end-item subassembly shall be transported from one area to another only when properly packed according to the latest packing specifications for low energy initiators. Army components shall be placed inside of a suitable metal box.

13-3. Boostering Explosives. Explosives used for this purpose include tetryl, RDX, PETN, and RDX with additive ingredients. These explosives have intermediate sensitivity between initiating explosives and explosives used a bursting charges such as TNT. They may be ignited by heat, friction, or impact and may detonate when burned in large quantities.

a. PETN. PETN (Pentaerythritol tetranitrate) is more sensitive than either tetryl or RDX, and is considered an initiating agent by the DOT. In its pure form, PETN is a white crystalline material, but it may be a light gray color due to impurities. It must be shipped wet with not less than 40 percent by weight of water in the appropriate DOT specification shipping containers. It is extremely sensitive to initiation.

b. Tetryl. Tetryl is a fine crystalline yellow material, insoluble in water, but soluble in acetone, benzene and other similar solvents. It is toxic when taken internally or by skin

contact and special precautions are necessary to protect personnel. Tetryl is stable at all temperatures encountered in storage.

(1) Existing data indicates that tetryl is a weak to moderate mutagen in bacterial systems. Personnel exposures to tetryl should be minimized.

(2) Recommended control procedures:

(a) Handling precautions. Minimize skin contact and dusting.

(b) Protective clothing. Wear powder uniforms (to include associated hygiene practices of hand washing, showering, clothes change lockers, etc.) with emphasis on the use of gloves where hand contact is probable. NIOSH approved toxic dust respirators should be worn if atmospheric value of tetryl exceed those stated in (e) below.

(c) Medical surveillance. Periodic surveillance should emphasize the skin effects and pulmonary function. Semiannual SGOT and hematrocrit should be determined.

(d) Engineering controls. Personnel exposures should be controlled by other than personal protective measures. Emphasis should be placed on methods to minimize dusting in the employees' breathing zone. This can be accomplished by local exhaust ventilation, enclosed process systems, automatic handling devices, etc.

(e) Atmospheric exposure levels. The OSHA exposure limit for tetryl is 1.5 mg/m3. Refer to the current American Conference of Governmental Industrial Hygienists, TVL for tetryl is also 1.5 mg/m3 along with a skin notation and a Short Term Exposure limit of 3.0 mg/m3.

(3) These and other standard industrial hygiene practices deemed locally appropriate should be followed.

c. RDX (Cyclonite). RDX is a white crystalline solid. It is usually in mixtures with other explosives, oils, or waxes and is rarely used alone. It has a high degree of stability in storage.

13-4. Bursting Charge Explosives. Bursting charge explosives include explosive D (ammonium picrate), amatol, picric acid, TNT, tetrytol, pentolite, picratol, tritonol, RDX compositions, HMX compositions, torpex, DBX, and HBX. Alkaline cleaning agents or other alkaline products shall not be permitted in buildings where bulk high explosives are handled.

a. Amatol. Amatol is a mixture of TNT and ammonium nitrate in various percentages. It is mixed at the time of loading and there should be no occasion for storing it in bulk form. In general, the sensitivity is slightly less than TNT. Deluge systems controlled automatically by quick-acting detectors are desirable to protect melting units and other process machinery. It is believed to form sensitive compounds with copper and brass.

b. Explosive D (ammonium picrate). Ammonium picrate is stored in the same manner as TNT, but is less hazardous. Lead in any form shall not be permitted in buildings where this explosive is handled. Sprinkler and deluge systems are recommended in connection with drying and assembling processes but lead fusible links and solder type heads shall not be used in the systems. Sprinkler and deluge systems will be of service in preventing the spread of fires rather than extinguishing fires in the burning material. Fire involving large quantities of this material may result in an explosion. Cleanliness in all processes involving the handling of this material should be assured. Special precautions must be taken against its toxicity. Ammonium picrate is soluble in water.

c. DBX. DBX is an aluminized explosive which closely resembles torpex in sensitivity, strength, and brisance. DBX is somewhat hygroscopic and reacts with metals in the same manner as amatol.

d. HBX. HBX is an aluminized explosive having the same order of sensitivity as composition B. Like certain torpex explosives, HBX may produce pressure within a casing due to reaction with water to produce gassing.

e. HMX compositions. HMX is of the same order of sensitivity to impact and friction as RDX, but is more stable and has a higher explosion temperature test value than RDX. HMX compositions (mixtures of HMX, other explosives ingredients, and desensitizers and plasticizers) are used where special requirements exist for powerful explosives with a high degree of thermal stability.

f. Pentolite. Pentolite is a mixture of PETN and TNT. Pentolite may have a tendency to separate into its ingredients, consequently, pentolite should be handled as carefully as PETN. Pentolite lumps found in screen operations should not be broken with the aid of handtools or by rubbing through the screen. Melt units for pentolite should be steamed out at least once every 24 hours. Acetone should not be used for thread cleaning.

g. Picratol. Picratol is a mixture of TNT and explosive D (ammonium picrate). It has the same general properties as TNT.

All the precautions made necessary by the characteristics of TNT and ammonium picrate must be observed in the handling of picratol.

h. Picric acid. Picric acid which is used in the manufacture of ammonium picrate is a nitrated product of phenol. It may be stored either wet or dry in magazines. It is highly acidic and corrosive as well as a toxic hazard. The hazards of manufacture include those of handling its various raw material components. Drowning, deluge, and automatic sprinkler systems are successfully used in combating fires in the manufacture and handling of this material. Fires involving picric acid may be extinguished with automatic sprinkler systems. Large quantities have burned completely without explosions; however, the possibility of detonation should not be overlooked. In the nitration process, ample ventilation must be provided. Lead compounds with picric acid are very dangerous and lead in any form shall not be permitted in buildings where it may contact picric acid. Picric acid is lemon yellow in color, slightly soluble in water, and soluble in organic solvents. It stains the skin and hair of workers, and colors clothing and whatever else it contacts. It is stable and has no tendency to decompose at temperatures normally encountered in storage.

i. RDX compositions. RDX compositions are mixtures of RDX, other explosive ingredients, and desensitizers or plasticizers. The RDX compositions most frequently encountered are--

(1) Composition A-5.

(2) Composition B-4.

(3) Composition C-4.

j. Tetrytol. Tetrytol is a mixture of tetryl and TNT, intermediate to tetryl and TNT in sensitivity. Care must be taken in the manufacture and subsequent use of tetrytol to ensure a uniform mixture and to avoid a partial segregation of tetryl which would increase its sensitivity over that normally expected. Tetrytol is stable in storage but exudes at 65 degrees Celsius (149 degrees Fahrenheit). Magnesium-aluminum alloys are slightly corroded by dry tetrytol. Wet tetrytol will slightly corrode copper, brass, aluminum, magnesium, magnesium-aluminum alloy, mild steel, and mild steel plated with cadmium.

k. Trinitrotoluene (TNT). TNT is a light brown or straw-colored material whose appearance varies with the degree of purity. It is insoluble in water but soluble in ether, acetone, alcohol, and the like. Although TNT is less sensitive to friction and impact than many other high explosives, it can be detonated by moderate force when

confined between metal surfaces such as on threads of bolts, etc. In thin unconfined layers it usually burns without explosion. Burning or rapid heating under confinement may cause detonation. TNT is stable and does not form sensitive compounds with metals. It will, however, form sensitive materials in the presence of alkalies. TNT exhibits well-recognized toxic properties.

l. Torpex. Torpex is an aluminized explosive used mainly in underwater ordnance. Torpex is nonhygroscopic and noncorrosive. It is stable in storage although it may gas (hydrogen) and produce pressure in its casing as a result of the gas. Precautions must be taken in the manufacture and loading of torpex to avoid inclusion of moisture.

m. Trigonol. Trigonol is a mixture of TNT and aluminum powder and exhibits a greater blast effect than TNT or Composition B. It is more sensitive to impact than TNT. Because of the aluminum content, the inclusion of moisture into the mixture must be avoided.

n. Plastic bonded explosives. Plastic bonded explosives are conventional high explosives with plastic binders (i.e., polystyrene, viton, estane). Their sensitivity varies with the type of explosive and the amount of binder used. The series most frequently encountered are identified by prefix LX or PBX followed by a number.

13-5. Propellants and Other Explosives. a. Black powder. Black powder is an intimate mechanical mixture of potassium or sodium nitrate, charcoal, and sulfur. It is very sensitive to friction, heat, and impact. These properties make black powder one of the most dangerous explosives to handle. It will deteriorate rapidly on absorption of moisture but retains its explosives properties indefinitely if kept dry. Black powder may be desensitized by placing it in water and discarding the water separately from the residue, for wet black powder when permitted to dry out may regain its explosive properties. Combustible materials which have absorbed liquors leached from black powder constitute a severe fire hazard and may become explosive. In black powder manufacture and operations, it is essential that special attention be given to dust prevention and control, and to the prevention of contamination. Permanent magnet type separators have been found effective in controlling contamination. Deluge systems are of value in preventing the spread of fire in black powder operations. Lumber or combustible material from black powder buildings must not be released for reuse.

b. Nitroglycerin. Nitroglycerin is usually manufactured only as required in the manufacture of other products of which it is a constituent. It is stored only in buildings constructed for the specific purpose, where it must be kept under constant surveillance until used. Nitroglycerin is extremely sensitive to impact and friction and the manufacturing processes are hazardous. All machinery, equipment, and tolls used are specifically designed for the particular process and with full consideration of safety features. Buildings in which nitroglycerin vapor is present may become dangerously contaminated and frequent cleaning of the building and equipment with a neutralizing solution is required. The vapor is also toxic. Frozen nitroglycerin is less sensitive than the liquid compound; however, upon thawing, it may produce internal changes accompanied by sufficient evolution of heat to cause explosion. Nitroglycerin containing moisture or decomposition products can explode at temperatures lower than the explosion temperature at 220 degrees Celsius (428 degrees Fahrenheit) for pure nitroglycerin. The lower temperature of 41 degrees Celsius (105 degrees Fahrenheit) applied to a sample for 5 hours results in slow decomposition until an explosion occurs.

c. Solid propellants. Solid propellants used by the Army include single base, double base, triple base, and composite types. Solid propellants are a severe fire hazard. They burn rapidly and under suitable conditions of initiation some may detonate. Solid propellants that are sufficiently sensitive to initiation to detonation by fire or explosion are included in hazard class 1.1, while those of lesser sensitivity to such stimuli are included in class 1.3. Propellant dust and powder normally are sensitive to friction, flame, and sparks. The stability of propellants can be adversely affected if they are stored for long periods in a damp atmosphere and/or subjected to high temperatures; the eventual effect of such conditions may be the spontaneous ignition of the propellant. The stabilizer level of all nitrocellulose-based propellant in storage must be determined to ensure it is safe for continued storage (see SB 742-1300-94-2).

13-6. Military Pyrotechnics. a. General. Military pyrotechnic compositions in general consist of such compounds as perchlorates and nitrates to provide oxygen; powdered metals for fuel; salts of sodium, barium, or strontium for color; and binding and waterproofing materials. They are sensitive to heat, flame, static electricity discharges, and particularly to friction. Compositions containing chlorates are especially hazardous. Since pyrotechnic compositions contain powdered metals, they may become hazardous in the presence of moisture. Compositions in process, and pyrotechnics in storage, must be protected from moisture, and items showing evidence of moisture should be destroyed.

b. Hexachloroethane (HC) smoke mixtures. HC smoke mixture is sensitive to heat, flame, friction and static electrical discharges from the human body. HC mixtures react with moisture to produce heat, and in some cases, hydrogen gas; therefore, the use of small quantities of water on a fire in HC smoke mixtures is dangerous. Large quantities of water will effectively reduce the severity of fires. Firefighters must avoid breathing heavy concentrations of HC smoke. HC smoke pots must not be used inside buildings to simulate fire during fire drill demonstrations.

c. Thermite. Thermite is a fire hazard. Fires are extremely difficult to extinguish when thermite is ignited. Control frequently lies in holding fires in check until the thermite has burned itself out.

CHAPTER 14

SAFETY REQUIREMENTS IN HAZARDOUS LOCATIONS

14-1. Hunting. Hunting, fishing, and trapping are authorized provided the installation has written policy with procedures and requirements that include the following:

a. Written permits will be issued to each individual authorized to hunt, fish, or trap. The use, possession, or being under the influence of alcoholic beverages, illegal drugs, or controlled substances during or immediately prior to coming onto the installation to hunt, fish, or trap is strictly prohibited, and will be cause for revoking the permit.

b. A map shall be prepared to clearly define hunting, fishing, and trapping areas. A copy of the map will be issued to each hunter, fisher, and trapper who must become familiar with the respective areas prior to hunting or fishing, as approved by the Safety Office.

c. Rifles, shotguns, muzzle loader/black powder, and bows and arrows are approved for hunting; however, cartridges having a muzzle velocity greater than 2300 feet per second will not be used within an establishment containing explosive materials. All rifles, muzzle loaders, and shotguns using a single solid projectile and having a velocity not in excess of 2300 feet per second will observe a 1200-foot minimum distance from aboveground magazines, outdoor ammunition storage locations, workshops, other aboveground ammunition facilities, and the installation boundary. This does not apply if techniques and procedures are used which will ensure that firing is directed away from these exposures.

d. Shotguns using multiple shot (bird or buck shot) will observe a 600-foot minimum distance from aboveground magazines, outdoor ammunition storage locations, windowless workshops, or other aboveground ammunition facilities. Shotguns using multiple shot (bird or buck shot) will observe a 1200-foot minimum distance from workshops with windows and the installation boundary. This does not apply if techniques and procedures are used which will ensure that firing is directed away from these exposures.

e. In the igloo area, weapons will not be fired in the direction of igloo doors.

f. Personnel permitted to hunt, fish, or trap in explosives areas will be restricted to assigned military personnel, installation

employees, and other selected personnel as may be specifically authorized by the installation commander. Procedures will be established to assure that there will be no dense concentrations of personnel as could be expected at athletic fields, picnic areas, or other similar recreational facilities.

g. When hunters and fishermen are allowed access to the area encompassed by public access exclusion distance (PAED) for lethal and incapacitating chemical agents, the evacuation procedures of the chemical accident/incident control (CAIC) plan will address the removal of those personnel from potential exposure to an agent release to the atmosphere. As a minimum, the hunters and fishermen will be briefed on the meaning of warning signals and the preferred evacuation routes prior to entering the controlled area.

h. All installation hunting and fishing plans, procedures, and policies will conform to all applicable State and Federal regulations and be approved by the installation safety office.

i. Installation commanders may impose more stringent controls based on their particular installation's requirements.

14-2. Fencing and Placarding Restricted Areas. a. Fencing required for security or other purposes should not be placed closer to magazines than magazine distance nor closer to explosives operating buildings than intraline distance.

b. Where fencing of a single magazine or groups of magazines is required for special security purposes, the fence may be placed in close proximity to the magazines, with the following conditions:

(1) A gate should be installed adjacent to each magazine door. The gate width should not be less than the width of the doorway. Fences shall not be installed in a manner that would hinder the control of vegetation around or on the earth cover or barricades of magazines.

(2) All gates should be kept open at all times when personnel are within the fenced area.

14-3. Boundary of Reservations. The boundary of each Government reservation in which explosives or ammunition areas are located shall be fenced and posted as required by AR 190-11, and AR 190-13.

14-4. Parking of Privately Owned Vehicles. a. Parking of privately owned vehicles within an AMC establishment shall be controlled to minimize fire and explosion hazards and prevent congestion in event of emergency. Vehicles shall be parked in designated areas only.

Locations outside of restricted areas are preferred. Vehicles should not be parked near enough to a building or structure to either enable spread of fire from a vehicle to the building or prevent easy access of fire fighters.

b. Parking areas for privately-owned or rental vehicles will be separated from potential explosion sites by unbarricaded intraline distance, if they serve only the workers assigned to a particular line or area. Only vehicles transporting ammunition or government vehicles directly related to the operations are permitted to park inside this distance.

c. Private vehicle parking in administrative areas will be a minimum of public traffic route distance from the nearest potential source.

14-5. Housekeeping in Hazardous Areas. a. Structures containing explosives shall be kept clean and orderly.

b. In explosives areas, waste materials such as oily rags, combustible and explosive scrap, and paper shall be kept separate from each other. Such waste should be placed in approved, marked containers for each, preferably located outside the buildings. Containers for scrap black powder, scrap initiating explosives, scrap explosives of similar sensitivity, and rags contaminated with these explosives must be approved with covers and contain enough water (No. 10 mineral oil or fuel oil for certain pyrotechnic, tracer, flare, and similar mixtures) to cover the scrap or rags. Where water is used in containers for scrap pyrotechnic, flare, and similar mixtures, the possibility that dangerous gases may be evolved must be recognized. In order to minimize the hazards from such gases, scrap should be introduced in a manner to provide for immediate immersion. Combustible or explosive scrap shall not be left in buildings when unoccupied.

c. Exudate from ammunition shall be removed by use of approved solvents such as acetone or as specified in the appropriate TDP or DMWR. Unpacked ammunition, loose explosives, or those not in process, and combustible materials shall not be permitted to accumulate and must be placed in designated receptacles or in designated storage space.

d. Explosives, explosives dusts, and other hazardous materials shall not be allowed to accumulate on structural members, radiators, heating coils, steam, gas, air, water supply pipes, or electrical fixtures.

e. Spillage of explosives and other hazardous materials shall be prevented so far as practicable by proper design ofequipment, training

of employees, provision of catch pans, etc. For example, hoppers shall be large enough to comfortably accommodate the size of charges used. A painted stripe on the inside of the hopper will serve as a reminder of the proper filling height. Catch pans or splash pans shall be provided beneath draw off pipes and TNT flakers, around transfer piping, beneath powder bags on small arms ammunition charging machines, etc. Spillage must be removed promptly.

f. A regular program of cleaning shall be carried on as frequently as local conditions require for maintaining safe conditions. General cleaning should not be conducted while hazardous operations are being performed. Explosives and ammunition should be removed from the building prior to general cleaning operations, when practicable.

14-6. Sweeping Compounds. Hot water or steam should be used wherever practicable for cleaning floors in buildings containing explosives. Sweeping compounds which are nonabrasive and compatible with the explosives involved may be used where the use of steam or hot water is not practicable. Such compounds may be combustible but must not be volatile (closed cup flash point must not be less than 230 degrees Fahrenheit). Sweeping compounds containing wax shall not be used on conductive flooring. Where nitrated organic explosives are involved, which may form sensitive explosive compounds with caustic alkalies, the use of cleaning agents containing caustic alkalies is prohibited.

14-7. Brushes. Wire brushes may be used in cleaning explosives processing equipment only when other methods of cleaning are ineffective. If wire brushes are used, thorough inspection should be made after cleaning to ensure that wire bristles do not remain in the equipment. Where practicable, nonferrous wire brushes should be used. This applies also to cleaning magnesium ingot molds and molds for any other metal which may be used as an explosive constituent. Use of fiber brushes in place of hair brushes is recommended to reduce generation of static.

14-8. Packing Materials. The working supply of packing materials, such as excelsior and shredded paper, should not exceed the capacity of bins or boxes provided for the purpose. These bins should be built of metal-lined wood or noncombustible material, having an automatic or self-closing cover.

14-9. Procedures in Event of Electrical Storms. a. When buildings containing explosives are evacuated during periods of electrical storms, operations requiring attention at all times shall continue to be manned by the minimum number of personnel consistent with safety requirements. When the process has been brought to a condition in

which it is considered safe to leave and when it would not produce rejected components requiring reworking with accompanying hazards, the building shall be completely evacuated. Every effort shall be made to anticipate shutdown and, during such critical periods, any explosives process requiring complete attention should not be started unless absolutely necessary. Because of the possibility of power failure, alternate emergency power equipment should be manned during such times.

b. Whenever an electrical storm approaches the installation, personnel shall be evacuated from locations at which there is a hazard from explosives which could be initiated by lightning. Such locations include--

(1) Operating buildings or facilities without approved lightning protection systems, which contain explosives or explosive-loaded ammunition, and locations within intraline distance of such facilities.

(2) Buildings containing explosives dust or vapors, whether or not equipped with approved lighting protection systems and locations within intraline distance of such buildings.

(3) Magazines, open storage sites or loading docks, which are not equipped with approved lightning protection systems, and vehicles and railroad cars on ungrounded tracks containing explosives and explosive-loaded ammunition, and locations within magazine distance of such structures, sites, vehicles, or cars.

(4) Locations (with or without lighting protection) where operations involving electroexplosive devices are being performed.

c. When personnel are to be evacuated from explosives operations, the operations shall be shutdown, windows and doors closed, and electric switches thrown to the off position.

d. A responsible and qualified person shall be empowered with final decision as to the necessity for evacuation. Where operations are of such nature as to require advance warning for shutdown, a net of volunteer observers or an electronic static detector (lightning detection system) may be used.

e. In an operating line, evacuated personnel shall be relocated to approved suitable protective shelters located at intraline distance from operating buildings or other hazardous locations. In a magazine area, evacuated personnel should be relocated to such approved shelters at magazine distance from magazine or other hazardous locations, or to empty earth-covered magazines. When such shelters

are not available, personnel shall be withdrawn to places at inhabited building distances from the hazardous locations.

f. Personnel in direct charge of railroad trains and motor trucks containing explosives should, when possible, move the equipment to locations of comparative safety before retiring to designated bomb proofs or change houses.

g. Action to be taken in the event of electrical storms, utilities or mechanical failures and the like, occurring during the manufacturing, handling, or processing of explosives and other hazardous materials shall be set forth in SOPs required by paragraph 14-17 or shall be set forth in separate SOPs prepared specifically for such purposes.

14-10. Prohibited Articles in Hazardous Areas. Personnel shall not be permitted to carry matches, cigarette lighters, and other flame-producing devices into hazardous materials restricted areas. In addition, personal articles of metal, such as keys, knives and coins shall be prohibited in such areas when they increase the existing hazards.

14-11. Photographing Hazardous Areas. Magnesium flashlights, photo flashbulbs, or electronic flash attachments shall not be used in photographing locations where exposed explosives, explosive dusts, flammable gases, or vapors are present. After all explosive or highly flammable materials have been removed and equipment prepared, as for major repairs, such photographic aids may be used.

14-12. Experiments. No experiments or tests other than routine work shall be undertaken in an explosives building without first notifying the persons in charge. If the tests add to the general hazard and can be performed elsewhere, they must not be done during operations or with more than the minimum necessary number of persons present. All experiments must have prior approval by the commanding officer or his designated representative. Each experiment shall be thoroughly documented on a step-by-step basis.

14-13. Explosives Recovery and Reuse. a. All loose explosives recovered as sweepings from floors of operating buildings shall be destroyed. Explosives which are recovered from other than ammunition breakdown operations or from operational equipment shall be thoroughly inspected by operating supervisors and reused, screened, reprocessed, or destroyed as the situation warrants. Explosives which are contaminated with dirt, dust, grit, or metallic objects must be processed to remove all foreign matter before they can be reused, otherwise they must be destroyed. Melt-loaded explosives known to be contaminated shall not be reused unless it is practicable to remelt and draw off clean material.

b. Explosives salvaged from loaded ammunition shall be stored in buildings by themselves.

14-14. Maintenance and Repairs to Equipment and Buildings. a. Before being placed into routine operations, all new or newly repaired process equipment for use in hazardous operations must be examined and actually tested to assure that it is in safe working condition. If machinery or equipment does not appear to function properly, operations shall be discontinued if the immediate stoppage does not create a new hazard.

b. Before repairs are permitted on any equipment that has been exposed to explosives, a tag signed by a certifying official, as specified in TB 700-4, shall be placed on the equipment certifying that explosives have been removed. If it has been impossible to clean some part, it shall be noted on the tag together with adequate instructions to maintenance personnel concerning safe methods of handling.

c. Major repairs or changes shall not be undertaken in a hazardous building during regular operations without removal of the hazard material and without the knowledge of the employee in immediate charge of the building

d. Only competent persons shall be permitted to effect repairs. Before repairs are started in an explosives location, the immediate area shall be inspected for the presence of explosives and dust, and all such material shall be removed from equipment, crevices, beneath floors, within walls and pipes, and under fittings where explosives may be ignited. The entire area should preferably be wet or should be washed down thoroughly.

e. When machines and equipment have been oiled, repaired, or adjusted, all tools used for the repairs shall be removed. All operators must inspect their equipment to be assured of its safe operating condition before resuming work.

f. Certain operations require that nonsparking tools be used. If the maintenance department, in repairing a machine where nonsparking items are normally required, must use steel tools, not only shall the machine and surrounding area be cleaned, as indicated in subparagraph b, c, and d above, but all explosives operations in the immediate vicinity shall be discontinued to guard against accidental ignition of materials by flying sparks. Where steel tools are used in such maintenance operations all contact surfaces should be oiled to reduce likelihood of sparks.

g. Maintenance personnel entering buildings in which conductive shoes are required shall wear conductive shoes or conductive overshoes with ankle straps. Since electricians shall not be allowed to work on live electrical equipment while wearing conductive shoes, all exposed explosives and other static sensitive hazardous material must be removed before electrical work is done.

h. Safe practices elsewhere specified in this regulation shall apply to maintenance employees as well as to those engaged in actual production.

i. Maintenance offices and tool rooms in an operating line shall be separated from explosives by intraline distance. When intraline distance separation cannot be provided, protection equivalent to that afforded by a substantial dividing wall must be provided.

14-15. Agitation. Nitrators, washers, and other machines which, because of the hazard of the process and the possibility of decomposition of the process material, are equipped with mechanical agitators, shall have at least two means of agitation, each operating from independent sources of power to maintain agitation in event of failure.

14-16. Nitration. Nitration involves explosion, fire, and toxic hazards in addition to those incident to handling acids. Efficient ventilating systems are required. Nitration buildings shall be provided with adequate safety exists and necessary safety appliances such as suitable neutralizing solutions and emergency showers. When necessary, personnel shall be provided with personal protective clothing and equipment which is impermeable to acid or which is acid resistant.

14-17. Standing Operating Procedures. a. Prior to starting any operation involving ammunition, explosives, or other hazardous operations, adequate SOPs shall be developed and then approved by the Commanding Officer of the activity or by a qualified member of his staff who has been delegated the responsibility for review and approval of SOPs. All active SOPs shall be reviewed annually by the proponent and the local safety office to assure they are current with respect to the safety aspects of the operation. Workers shall receive training on the SOPs they work under on a quarterly basis. Controlled tests may be necessary in order to establish SOPs for certain operations. SOPs shall include, as a minimum, such items as safety requirements, personal protective clothing and equipment, environmental treatment, storage, disposal, spill requirements, personnel and explosives or material limits, equipment designation, and location and sequence of operations. No deviation from SOPs shall

be permitted without the approval of the commanding officer or his designated representative. A Hazard Analysis Working Group (HAWG) will be convened for development of hazard analyses for all explosive operations. A copy of the hazard analysis will be maintained with the file copy of the SOP.

b. All personnel involved in these operations shall become cognizant of their respective duties. Supervisors shall be responsible for assuring this is accomplished.

c. Applicable portions of the approved SOPs shall be conspicuously posted convenient to all stations involved in the operation for the guidance of all personnel. Supervisory personnel shall maintain copies of the overall SOPs and be responsible for the enforcement of all provisions.

14-18. Electrical Testing of Ammunition and Ammunition Components. a. Type of test equipment. Electrical (including electronic) test equipment shall use the weakest possible power source. Battery-powered equipment should be used in lieu of that with a 110-volt source. The power source shall be incapable of initiating the explosive item under test. Where greater power must be used, positive means must be provided to prevent delivery of power to the explosive item, in quantities sufficient to initiate the item. The possibility of human error on the part of operators and other personnel must be recognized and safeguards provided.

b. Layout of test equipment. As indicated in paragraph 6-4, test equipment should not be placed in hazardous atmospheres unless absolutely necessary. When the test equipment or parts thereof must be placed in hazardous atmospheres, its suitability must be attested to by Underwriters' Laboratories approval or specific approval must be obtained from the Commander, AMC. Special attention must be given to equipment containing vacuum tubes because of inherent ventilation requirements. Unless the test equipment, under any circumstances, is incapable of initiating the item being tested, operational shields are required for protection of personnel. The most reliable means for attaining and retaining this initiation incapability is to protect the test equipment, including leads, from electromagnetic (induction and radiation fields) and electrostatic energy and to provide the test equipment with a weak power source.

c. Use of test equipment. Test equipment shall be used only in the manner and for the purpose for which approval is granted. The equipment shall be maintained in good working order by qualified personnel. Operator adjustments must be limited to those required by design of the equipment.

d. Precautions. When electrically testing or firing electric initiators, regardless of electrical sensitivity, there shall be a visual, positive, grounded break in all leads between any electric initiator and any source of electric power until all personnel in the vicinity are adequately protected. One of the following methods may be used to accomplish this break:

(1) Lead wires on electric initiators are long enough to permit making connection outside of test barricade after barricade door is shut or operators are out of line of fire.

(2) Mechanical-visual-disconnects on test barricade doors or on barriers placed in the path of the operator which the operator must open before setting up area. Doors of barriers for walk-in areas shall be so designed that door cannot close while operator is inside, or if door does close electrical connection cannot be made.

(3) Disconnect boxes with disconnecting device secured to the operator in such a manner that when the operator is setting up electric initiator, it is physically necessary that the disconnect device be removed from the box by the movement of the operator before handling the electric initiator.

e. Testing. When testing electric initiators or components containing electric initiators, the test lead wires from the test instrument to the test fixture or to component being tested shall be electrically shielded. Shield shall be grounded at test instrument end and at test fixture on component tested end. Test leads may be shielded individually or be contained within a single shield. However, test leads shall not be placed within a shield containing power or other unrelated leads.

14-19. Heat Conditioning of Explosives and Ammunition. a. All ovens, conditioning chambers, dry houses and similar devices and facilities shall be provided with dual independent automatic heat controls. For devices or facilities heated by steam only, the requirement for dual automatic heat controls shall be satisfied if the steam pressure is controlled by a reducing valve (maximum pressure of 5 psi, unless otherwise authorized) on the main building steam supply and a thermostat on the device or in the facility.

b. Heat conditioning devices shall be constructed to effectively vent overpressure resulting from an internal explosion. Blow-out panels, doors and other venting apparatus should be restrained by barriers or catching devices to prevent excessive displacement in the event of an accidental explosion.

c. Heat conditioning devices shall be effectively vented to permit the escape of dangerous gases that may evolve during the conditioning process.

d. Steam shall be used as the heating media for the conditioning devices wherever practicable. Whenever electric heating elements must be used, the elements shall be located where there is no possibility of contact with explosives or flammable materials.

e. If the heat conditioning device uses a fan for circulation of air, the blades shall be of nonsparking material and, where possible, the electric motor shall be installed on the exterior of the device. The air used for heating shall not be recirculated if the heating surfaces exceed a temperature of 228 degrees Fahrenheit or if the air contains materials which may collect on the heating elements.

f. Electrical equipment and fixtures in or on a blast conditioning device used for explosives or flammable material shall be approved for operation in the appropriate hazardous atmospheres (refer to chap 6).

g. The interior of heat conditioning devices should be free of crevices and openings and other difficult to clean protuberances where dust or flammable material may lodge.

h. All non-current-carrying metal parts of a heat conditioning device shall be electrically interconnected and grounded.

i. Heat conditioning devices should be installed in an isolated location and arranged to afford maximum protection to personnel from the effects of an incident. Operational shields and other personnel protection measures should be used when warranted.

j. Heat conditioning devices should be separated from each other by distance or protective construction to prevent an explosive incident in one device from propagating to adjacent devices. No hazardous materials shall be stored or located in a room or cubicle containing a heat conditioning device unless it can be shown that an incident in the conditioning device will not involve the other materials.

k. Heat conditioning device operating procedures shall include the following conditions:

(1) The explosive materials in the device shall be limited to the type and quantity authorized for the specific device.

(2) The critical parameters of explosives compositions shall be known before processing in a heat conditioning device. Care will be exercised to ensure that the conditioning device does not exceed limits established for the hazardous composition being conditioned.

(3) Heat conditioning device temperatures will be checked during operation at specified intervals. The checks should be conducted at more frequent intervals during periods of conditioning.

(4) The conditioning devices, ducts, vacuum lines, and other parts of the equipment subject to contamination by hazardous materials, shall be cleaned prior to introducing a different item or composition for conditioning.

CHAPTER 15

STORAGE OF EXPLOSIVES AND AMMUNITION

15-1. General. Additional information on quantity distance and storage of ammunition and explosives may be found in DA PAM 385-64.

15-2. Types of Magazines. a. Earth-covered magazines include igloo, steel arch, Stradley, special type, hillside and subsurface-type magazines. Earth-covered magazines are preferred for the storage of all items of ammunition or explosives.

b. Standard ammunition magazines (commonly called "Standard Magazines") are classed as aboveground magazines. These magazines usually measure 51 feet 7 inches by 218 feet 8 inches, are usually spaced 300 feet apart, and have concrete foundation walls and piers, hollow-tile walls, steel frames and concrete floors.

c. High explosives and black powder magazines, classed as aboveground magazines. They are usually 27 feet 6 inches wide and 43 feet 4 inches long and are usually spaced 800 feet apart. They have concrete foundation walls and piers, hollow-tile walls filled with sand, steel frames and concrete floors covered with spark proof mastic or the equivalent. The magazines were originally designed for the storage of 250,000 pounds of explosives, but in order to assure adequate aisle space for inspection and shipping and convenient height of piles, theamount of storage is usually limited to approximately 100,000 pounds.

d. Primer and fuze magazines are classed as aboveground magazines. These magazines are usually 27 feet 6 inches wide, 43 feet 4 inches long and are usually spaced 300 to 400 feet apart. With respect to construction details, they are similar to high explosive and black powder magazines, except the hollow tile walls are not sand filled and the floor is not covered with spark-proof mastic.

e. For quantity-distance purposes, ammunition and explosives storage magazines used by AMC are referred to by type as follows:

(1) Standard igloo magazines - earth-covered, reinforced concrete, arch type magazines (includes Stradley (Yurt) magazines).

(2) Special use igloo magazines - standard igloo magazines used for maximum quantities of 100,000 pounds or less of mass-detonating ammunition or explosives.

(3) Earth-covered, corrugated steel, arch-type magazines - igloo type magazines constructed of corrugated rolled structural steel plate.

(4) Special type magazines - igloo type magazines with steel or wood (instead of reinforced concrete) arches and steel, wood or reinforced concrete end walls, and earth-covered reinforced concrete magazines (such as dome or box type).

(5) Aboveground magazines - any type of magazines constructed above grade, other than standard igloo magazines and special-type magazines. Richmond type magazines are considered to be barricaded aboveground magazines.

f. Other structures not of approved magazine type shall not be used for the storage of explosive and ammunition except when authorized by the Commander, HQ AMC, ATTN: AMCSF.

15-3. Earth Cover for Magazines and Barricades. a. Material for earth cover over magazines and for barricades shall be reasonably cohesive (solid or wet clay and similar types of soil should not be used as they are too cohesive). The cover shall be free from damaging organic matter, trash, and debris. If the magazine was constructed or upgraded after March 1966, stones heavier than 10 pounds or larger than 6 inches in diameter shall not be present. The larger stones should be limited to the lower center of fills and not used for earth cover over magazines. Compaction and surface preparation shall be provided as necessary to maintain structural integrity and avoid erosion. Where it is impossible to use a cohesive material, for example in sandy soil, the barricade or the earth cover over magazines should be finished with a suitable material to ensure structural integrity.

b. The earth fill or earth cover between igloo magazines may be either solid or sloped per the requirements of other construction features, but a minimum of 2 feet of earth cover must be maintained over the top of each magazine and a minimum slope of 1´ to 1 starting directly above the spring line of each arch must be maintained to meet explosives safety requirements. Facilities constructed in the future should have a slope of 2 horizontal to 1 vertical to reduce erosion and facilitate maintenance operations.

c. Barricades shall be inspected not less than annually to determine the degree of settling. When settling has occurred to the extent that the barricade no longer provides effective protection, fill shall be added in the amount necessary. Inspection shall also be made of wood revetted barricades, and rotted timbers of planking, affecting the strength or effectiveness of the barricade, shall be replaced.

15-4. Quantity of Explosives. The explosives content of ammunition or components is shown on approved AMC drawings, Storage Safety Data Sheets, Interim Hazard Classifications, or the Joint Hazard Classification System. The total quantity of explosives in a magazine, operating building, or other explosives facility shall be the net weight of the explosives calculated upon the following basis. Such calculations are intended for use with the quantity-distance tables in DA PAM 385-64.

a. Mass-detonating explosives compositions. The net explosives weight (NEW).

b. Non-mass-detonating explosives.

(1) Propellants. The net propellant weight.

(2) Pyrotechnic items. The sum of the net weights of the pyrotechnic composition and the explosives involved. Dyes and colored smoke loaded in pyrotechnics are excluded.

(3) Bulk metal powders and pyrotechnic composition. The sum of the net weights of metal powders and pyrotechnic composition in containers.

(4) Other ammunition. The weight of HE plus a suitable contribution, if any, from propellant, pyrotechnic components, or propelling charges. Group A, B, and C chemical agent, colored smoke, dyes, irritants, and pyrophoric agent TPA loaded in munitions are excluded.

c. Ammunition items. The net weight of any high explosives plus a suitable contribution, if any, from pyrotechnic components, or propellant materials. When testing has not established that pyrotechnic or propellant contributes less than 100 percent equivalent high explosive weight, the weight used will be the total weight of all the energetic material in the items.

15-5. Magazine Construction. a. Magazines are usually not wired for electric lights, but when electricity is used, the installation shall conform to the requirement of DA PAM 385-64.

b. Openings, other than doors, in magazines should be screened to prevent entry of insects, rodents, and reptiles.

15-6. Magazine Area Arrangement. a. Ammunition and explosives storage areas shall be subdivided into blocks of storage facilities per the following:

(1) No limit to the number of magazines with earth cover on the top and at least three sides and with earth-covered or reinforced concrete front walls. Revetted outdoors storage sites may be located between these magazines if applicable quantity-distance criteria are met and site approval has been obtained.

(2) Not more than 100 storage facilities of other types may be located in a single block.

b. It is preferred that magazines with earth cover on the top and at least three sides and without door end barricades (separated by applicable quantity distances) be oriented as follows:

(1) Unbarricaded door ends facing the same direction.

(2) Exterior faces of unbarricaded front walls of adjacent magazines all on one imaginary straight line.

c. Storage blocks consisting of magazines with earth cover on the top and at least three sides and with earth-covered or reinforced concrete front walls shall be separated from blocks consisting of magazines of other types by a distance of not less than 1200 feet.

d. Storage blocks consisting of facilities of other than the earth-covered type should be separated from each other by a minimum distance of 1200 feet if storage therein is restricted to categories (04), (08), and (12) of class 1.2, and classes 1.3 and 1.4.

e. Magazines within a storage block shall be separated from each other by distances not less than those prescribed in applicable quantity-distance tables.

15-7. Magazine Operational Regulations. Flammable liquids, except when used as the chemical filler of ammunition, or as a prepackaged storable liquid propellant, shall not be stored in magazines containing explosives.

15-8. Operations Permitted in Magazines Containing Explosives or Ammunition. Adjustment of the level or composition of liquid in which an explosive is stored is permissible. Sensitive explosives shall be maintained wet only by adjustment of the level of the liquid. Care shall be taken to guard against use of nondistilled water since bacteria may produce gassing. Explosives, which may become dry due to evaporation of some of the liquid, shall not be pushed or forced down into any liquid remaining in the storage container. Additional guidance for conducting operations in magazine areas are addressed in chapter 19.

15-9. Operations Permitted Outside of Magazines. Boxes or containers of hazard class 1.3 or 1.4 material may be opened outside of magazines for the purpose of visual examination in connection with prescribed surveillance operations with the following conditions:

a. The inspection site is located at greater than intraline distance from magazines or other sites that contain hazard class 1.1 or 1.2 material. This separation distance may be determined on the basis of the total explosive weight of the item that will be located outside the magazine for surveillance inspection purposes.

b. The inspection site is located as far as practicable from magazines containing hazard class 1.3 or 1.4 material.

c. Magazine doors are maintained closed while the boxes or containers are open.

d. The quantity of items or materials located outside the magazine for inspection purposes will be the minimum required for safe and efficient operations.

15-10. Separation of and Within Areas. a. Explosives and ammunition operating lines and storage areas shall be separated from each other, inert areas (warehouses, shops, administrative facilities, etc.) and the installation boundary by appropriate inhabited building distance. Explosives and ammunition operating lines shall be separated from each other and from storage areas by inhabited building distance. Where adjacent operations lines present similar hazards they may be separated from each other by intraline distance, although survivability considerations may dictate the need for greater protection.

b. A building, group of buildings, or operation conducted in the open, when serving more than one explosives line or area, constitutes a special area and shall be separated from these lines or areas by inhabited building distance. A facility or activity that serves a single explosives line or area may be separated from the line or area by intraline distance; however, it must be separated from all other lines or areas by inhabited building distance. These general principles shall govern in all cases except--

(1) Facilities listed in d(1) and d(2) below.

(2) Normal maintenance operations may be performed in a magazine area when authorized by the Commander, AMC per paragraphs 19-2c and d. Normal maintenance of small arms ammunition may be performed in magazines containing small arms ammunition only.

(3) Ammunition workshop buildings shall be located at a minimum of inhabited building distance from magazines, based on the material in the workshop building or magazine, whichever requires the greater distance.

(4) Where sufficient backup capacity is available such that the loss of a facility, building, or operation will not reduce the production capacity for all remaining lines, an existing facility serving more than one line may be located at intraline distance from one of these lines and inhabited building distance from the remaining lines.

(5) Sumps or catch basins containing less than 15 pounds of explosives in water or in a wetted (desensitized) state and wet scrubber facilities containing no more than trace amounts of explosives, serving a single facility, are exempt from quantity distance requirements with respect to the facilities which they serve. The explosives limit of the building served by these facilities will include the maximum amount of explosives permitted in the sump/catch basin and scrubber facility, whichever is closer.

c. Buildings forming an operating line shall be separated from each other by intraline distance. Outdoor operations or operations conducted under sheds within an operating line shall also be located at intraline distances. Where fragments may be a hazard, intraline distances may not provide sufficient protection, in which case a barricade should be provided as additional protection. This is particularly important where personnel concentrations are high, such as lunchrooms and change houses.

d. Miscellaneous structures in a magazine area--

(1) Field offices, ammunition surveillance buildings, bombproofs, and other personnel shelters shall be separated from magazines containing class 1, division 1 materials by intraline distance and from magazines containing other classes of materials by a minimum of magazine distance.

(2) Change houses, lunchrooms, packaging and shipping buildings, dunnage preparation buildings, and lumber storage for magazine areas shall be located at a minimum of intraline distance from magazines.

e. Inhabited building distances need not be applied to facilities for the housing of security personnel who are required by their mission to have a quick reaction capability in the

immediate vicinity of a potential explosion site. Such security facilities may be sited so as to provide a minimum of barricaded Intraline Distance protection. Because at this distance from an explosion, peak incident overpressures of 8 to 11 psi would render personnel militarily ineffective, hardening the facility to blast effects is advisable. Strengthening the facility to resist small arms fire will provide protection against fragments and debris from an explosion but not from blast overpressures.

f. Separate facilities that do not contain explosives and that are used solely in support of a single explosives operating building will be separated from the operating building served by a minimum distance of 100 feet. If the support building is of noncombustible construction as defined in TM 5-812-1 and limited to occupancies described in TM 5-812-1 as light industrial or storage of ordinary combustible or noncombustible materials, the minimum separation distance between the support facility and the operating building served may be reduced to 50 feet. The support facility must be separated from all other facilities in the operating line that contain explosives by a minimum of intraline distance.

g. Training of troops who are not directly participating in the installation mission shall be separated from ammunition and explosives not being used in their training by public traffic route distance when the troops are in the open and inhabited building distance when the troops are in unhardened structures.

15-11. Magazines and Magazines Areas. A segregated area shall be set aside for the exclusive storage of ammunition and explosives, with the following exceptions:

a. All magazines or open revetted sites in the magazine area may be used for the storage of ammunition-related inert items.

b. Magazines can be used to store nonammunition items or materials if the results of a hazard analysis by the local safety office indicates there are no unacceptable risks involving exposures of personnel/material from adjacent ammunition sites or of the nonammunition material exposure to adjacent ammunition sites. Non-ammunition-related inert material will not be stored in magazines containing ammunition or explosives.

15-12. Loading Docks. a. Loading docks, including elevated docks, pads, container transfer sites, or other locations at which ammunition or explosives are transferred to and from

vehicles, including railway cars, shall be located at not less than the following distances:

(1) Magazine distance from magazines, based on the quantity of material in the magazine or on the dock, whichever is greater.

(2) Intraline distance from the operating line or ammunition workshop building the dock serves, based on the quantity at the dock or building(s), whichever requires the greater distance.

(3) Inhabited building distance from administrative areas, inert areas, operating lines or ammunition workshops which are not served by the dock, installation boundaries, and other unrelated facilities.

(4) Magazine distance from other loading docks.

(5) Intraline distance from less-than-carload (LCL) buildings, ammunition surveillance buildings, and other miscellaneous structures in the magazine area.

b. The quantity of class 1.1 materials at one loading dock shall not exceed 250,000 pounds, except that two railcars containing more than 125,000 pounds each are permitted.

c. The use of loading docks for purposes other than for which they were originally intended should be discouraged. When used for purposes other than shipping or receiving explosives and ammunition, the quantity of explosives at the dock shall be the minimum required for efficient safe operation and must not exceed that permitted by the appropriate quantity-distance table.

15-13. Permitted Open Storage. a. Open storage of ammunition/ explosives material will not be used in lieu of covered storage employing standard facilities and/or methods.

b. When circumstances dictate that long term open storage (in excess of 30 days) must be used for storage of Army-owned material, the storing installation will submit a request for waiver per paragraph 1-6 of this regulation. Requests involving material owned by another service will be forwarded through the same channel (through HQ AMC, ATTN: AMCSF) to the owning service. Approval of short term open storage (less than 30 days) is at the discretion of the local commander.

c. Bulk solid propellants, bagged propelling charges, pyrotechnics, bulk high explosives, and critical items shall not be placed in open storage.

15-14. Special Requirements for Open Storage. a. General. Inhabited building distance and public traffic route distance shall be maintained around open storage sites as specified in DA PAM 385-64.

b. Sites between earth-covered magazines. Sites may be located midway between adjacent earth-covered magazines which are 400 feet apart, provided the sites are barricaded. Ammunition in such sites should not be stored beyond lines drawn through the fronts and backs of magazines in the same row. Barricading does not reduce the required inhabited building or public traffic route distances. The storage of class 1.2 between earth-covered magazines is not desirable and should be resorted to only when necessary.

15-15. Storage of Bulk Initiating Explosives. Bulk initiating explosives must not be stored dry and shall not be exposed to the direct rays of the sun. Glazed earthenware crocks of ample size to hold the double bag of material, and with covers of the plastic cap type to prevent evaporation and eliminate friction of abrasion when removed, are used for normal storage. Proper selection and use of covers is required to prevent friction and pinch points. If long-term storage in shipping containers is contemplated, the container must be equipped with a cover having a port for observation of the level of liquid therein. The viewing port must be covered with a transparent plastic which is known to be compatible with the initiating explosives being stored. As an expedient only, bulk initiating explosives may be stored in shipping containers that are not so equipped, provided they are stored in frostproof earth-covered magazines, with containers on end, only one tier high, and with passageways for inspection and handling. Bags of initiating explosives in storage containers must be under distilled water. Alcohol may be added to the distilled water to prevent freezing.

15-16. Solid Propellants. Propellants shall not be stored or shipped in damaged containers. When leaking containers are discovered, an examination of the contents shall be made for the nitrous odor of decomposing propellant. If any such conditions are observed, the propellant shall be segregated or properly disposed of. Propellants and propelling charges in containers should be stored so that they can be readily inspected. They shall not be exposed to the direct rays of the sun.

15-17. Small Arms Ammunition. Boxed small arms ammunition shall not be used as barricades or dividing walls between stacks of other types of ammunition.

15-18. Separate-Loading Ammunition, HE Loaded Except Explosive D. a. Separate-loading projectiles must be handled with care. They shall

not be stored without fuze-well closing plugs. Metal dunnage should be used where practicable.

b. Class (18) 1.2 quantity-distances are the minimum acceptable for class (18) 1.2 items, regardless of the quantities of HE involved. For class (18) 1.2 separate-loading projectiles, storage must comply with AMC Drawing 19-48-4102-1-2-14PE1001 in order to limit distance requirements to those prescribed by the class (18) 1.2 quantity-distance table. If those projectiles are equipped with core-recessed lifting plugs, the class 1.1 quantity-distance table applies when the total quantity of HE involved exceeds 15,000 pounds in aboveground magazines, even if storage complies with AMC Drawing 19-48-4102-1-2-14PE1001.

15-19. Separate-Loading Ammunition, Explosive D Loaded, Class (12) 1.2. Except where permanent block type storage methods are used, this type of projectile may be stored with distances between stacks not more than that required to permit inspections.

15-20. Fixed and Semi-Fixed Ammunition. Boxed fixed and semi-fixed ammunition shall not be used as barricades or dividing walls between stacks of other types of ammunition.

15-21. Rockets and Rocket Motors. a. Whenever practicable, rockets and rocket motors that are in a propulsive state should be stored nose down. Rockets and missiles may be stored in standard earth-covered magazines without regard to direction in which they are pointed except that they will not be pointed toward the door of the magazine.

b. In aboveground magazines where nose down storage is not practicable, items (in a propulsive state) shall be pointed in the direction which offers the least exposure to personnel and property in the event of fire or explosion.

c. Rockets should be stored in a dry, cool magazine, out of the direct rays of the sun. They should not be stored in locations where temperatures exceed 120 degrees Fahrenheit. Prolonged exposure of rocket ammunition to either high or low temperatures may increase the normal rate of deterioration or render the motors more susceptible to ignition if subsequently handled improperly.

15-22. Telephones in Magazine Areas. a. Telephone communication should be provided in ammunition and explosives magazine storage areas. All telephones that are located outdoors shall be protected from the weather.

b. The following may be used as a guide for telephone locations:

(1) One per magazine block.

(2) One per mile and readily accessible from the installation roadway and railroad systems, especially loading docks.

(3) One per operating building (other than storage magazines) within the magazine area.

(4) One per manned gate entrance or exit.

c. Telephones will be tested periodically to ensure they are operational.

15-23. Hazardous Ammunition. Ammunition that has degraded (e.g., low stabilizer) or is suspected of having defects that may result in spontaneous reactions shall be segregated and stored separately (separate magazine) from serviceable munitions based on the normal quality and distance standards for the quantity and class of munitions concerned.

15-24. Storage of Ammunition Containing Depleted Uranium (DU). Ammunition stored and handled at AMC installations will be per conditions stated in the Nuclear Regulatory Commission licenses and ammunition storage drawings prepared by the U.S. Army Defense Ammunition Center and School. In addition, general storage and handling rules in the following paragraphs shall be followed.

a. Magazines containing depleted uranium (DU) ammunition shall be posted with signs indicating "Caution - Radioactive Materials."

b. Activities storing DU ammunition shall post the following documents in sufficient locations to permit individuals engaged in maintenance and transportation of DU ammunition to observe them on their way to and from the storage locations.

(1) Title 10, Code of Federal Regulations, Parts 19, 20, and 21.

(2) Form NRC-3, Notice to Employees.

(3) A copy of the NRC license authorizing the storage or handling of DU ammunition at that location.

(4) Section 206, Energy Reorganization Act of 1974.

(5) Any notice of violation involving radiological working conditions. If posting of the above documents is impractical, the activity may post a notice which describes the documents and states where they may be examined.

c. The local fire department shall be notified of the location of each magazine used to store DU ammunition. The fire department will also be provided with training concerning the hazards of DU.

d. Igloos containing DU ammunition shall be surveyed by the radiological protection officer (RPO) per the conditions of the applicable Nuclear Regulatory Commission (NRC) license(s) but not less that annually.

e. Inspection of DU ammunition will be per the applicable technical manuals. Wipe tests will be performed using properly calibrated radiation measurement or counting instrumentation

f. Publications containing information on handling DU ammunition are listed below.

(1) AMC Handbook 385-1.1-89, Safety Procedures for Processing Depleted Uranium, August 1989.

(2) AMC Pamphlet 385-1, Fundamentals of Health Physics for the Radiation Protection Officer, September 1983.

15-25. Inspection of Magazines and Storage Sites. a. All in-use ammunition and explosives storage magazines and sites will be inspected at least annually for compliance with safety requirements and standards, and to detect any encroachment into quantity distance (QD) arcs that could require changes in explosives limits.

b. Explosives safety inspections performed by Quality Assurance Specialist, Ammunition Surveillance (QASAS) personnel may be used to satisfy the annual safety inspection requirement. The inspection reports must be provided to the safety office, reviewed by safety office personnel, and copies of the reports maintained in safety office files.

c. Safety office personnel will perform an annual inspection of at least 5 percent of all magazines and storage sites containing ammunition and explosives when QASAS inspections are used to satisfy the annual inspection requirement.

d. Service magazines in use will be considered to be operating buildings for inspection frequency purposes and will be inspected at least quarterly.

15-26. Explosives Storage Facility Licensing Policy. a. Each Major Subordinate Command and Separate Reporting Activity that has ammunition or explosives storage locations shall implement an explosives licensing process that complies with chapter 9, DA PAM 385-64.

b. Explosives storage licenses will be reviewed annually by the cognizant installation safety manager. This review will consider the results of inspections conducted as prescribed in paragraph 15-25. If inspections performed by QASAS personnel are used to satisfy annual inspection requirements, the report format must include verification of magazine contents and a statement regarding encroachment, even if negative. The review will also include a recomputation of quantity limits per the latest QD standards.

15-27. Storage of Research, Development, or Test Explosive Substances and Articles. a. Explosive articles and substances produced for research and development (R&D) or other test purposes (herein referred to as "test items" or "test substances") will not be transported from the installation where they were assembled or manufactured without an interim or final hazard classification assigned by a proper authority as specified in TB 700-2, Department of Defense Ammunition and Explosives Hazard Classification Procedures. The Major Subordinate Command (MSC) Safety Office Chiefs may determine the hazard class, division, and storage compatibility group of each test item or substance to support storage only, in lieu of or pending the receipt of an interim hazard classification. This authority may be delegated to installation and activity safety offices. The storage class/division of test substances whose hazard characteristics have not been established by appropriate test methodology prescribed in TB 700-2 shall be 1.1.

b. Test items and substances should not be stored indefinitely, without planned use or purpose. When substances (nitrocellulose based propellant, for example) could become hazardous because of deterioration, they must be disposed of or periodically tested for stability, or otherwise determined periodically to remain stable and safe.

c. A test item storage safety data sheet for each different test article or substance will be posted in the room or magazine in which the test article or substance is stored. A copy of the data sheet will be maintained at the office of record for storage operations and at the local safety office. The sheet will include at least the following information:

(1) Item or substance description.

(2) Date the item or substance was placed in storage.

(3) Storage location (building number and room number, or other description of similar specificity).

(4) A list, including weights, of each explosive/energetic substance contained in the item or container.

(5) The hazard class, division, and storage compatibility group, and explosive weight, per item. The weight will be the total weight of all energetic materials in the item or container unless testing has established a lower percentage contribution by propellant or pyrotechnic substances to a detonation reaction of high explosives in the item. The name of the person who determined this classification will be included. If an interim or final hazard classification by an authority listed in TB 700-2 has not been received, include the following statement: "THIS HAZARD CLASSIFICATION IS FOR STORAGE ONLY. THE TEST ITEM OR SUBSTANCE TO WHICH IT PERTAINS MAY NOT BE OFFERED FOR TRANSPORTATION FROM THIS INSTALLATION UNTIL AN INTERIM OR FINAL HAZARD CLASSIFICATION HAS BEEN OBTAINED IN PER TB 700-2".

(6) Safety inspection and/or test criteria.

(7) The name and telephone number of the responsible custodian (owner) of the item or substance.

CHAPTER 16

PREPARING EXPLOSIVES AND AMMUNITION FOR SHIPMENT

16-1. General Requirements, Compliance with Department of Transportation Regulations. The general requirements governing the marking, packing, and shipping of military supplies are set forth in AR 385-64 and DA PAM 385-64. These operations will also comply with Department of Transportation regulations. This chapter and chapter 17 contain additional requirements applying to the marking, packing and shipping of explosives and ammunition.

16-2. Marking. a. Whenever explosives or ammunition containers or ammunition and ammunition components are repainted, the new painting or marking shall correctly identify contents of items. The marking of empty or inert loaded ammunition items for display purposes is governed by the provisions DA PAM 385-64.

b. Explosives, ammunition, and loaded ammunition components obtained from salvage operations, and material which has lost its identification markings shall be clearly marked to show the explosive nature of the material. Explosive material or items which cannot be definitely identified as to their explosive nature should be disposed of by technically trained personnel per paragraph 21-5.

16-3. Temporary Storage in Shipping and Receiving (Less-Than-Carload (LCL)/Less-Than-Truckload (LTL) Buildings. a. In buildings specifically designated and used as shipping and receiving buildings for ammunition and explosives, temporary storage is permitted subject to the following limitations:

(1) Incoming shipments will not be allowed to accumulate and will be distributed as soon as practicable after receipt.

(2) Items for outgoing shipment will not be accumulated prior to receipt of orders covering each specific shipment.

(3) Processing and handling within the facility will be limited to explosives, ammunition and compatible items or materials.

(4) Exposed explosives will not be permitted in the shipping and receiving building. Items processed or handled will be finished munitions or bulk explosives packaged in approved shipping containers.

(5) Lethal and incapacitating chemical agents, and munitions containing such agents, will not be located, handled, or processed in a shipping and receiving building concurrently with conventional ammunition and explosives.

(6) Operations within the facility will be limited to temporary storage and activities associated with the preparation of items and materials for shipment. Renovation, modification, rework, assembly, disassembly, and testing activities will not be permitted within the shipping and receiving building.

(7) Incompatible items of ammunition and explosives will be segregated during storage and during preparation for shipment by protective construction as indicated in paragraph b, below.

b. Separate rooms or bays shall be provided for the temporary storage of ammunition and explosives. The storage rooms or bays will be separated from areas used for the preparation of items for shipment, from offices and areas used for operations that do not involve explosives or ammunition, and from each other, by 12-inch reinforced concrete walls as a minimum. Dividing walls of this type may be used for segregation of materials incompatible in storage, however, substantial dividing walls (para 5-6) must be used to subdivide quantities of explosives or ammunition in the facilities for the purpose of reducing the minimum separation distance.

c. The controlling quantity of explosives for quantity-distance determinations will be the sum of the maximum quantities permitted within the building, on building docks and platforms, and in railcars and other vehicles located at less than intraline distance from the shipping and receiving building. Effective subdivision of explosives locations by substantial dividing walls (para 5-6), or other approved barriers, may be used to reduce the controlling quantity of explosives for quantity-distance determinations.

d. The following requirements are applicable to new construction of shipping and receiving buildings, and to modification of existing facilities to serve as shipping and receiving buildings, in which temporary storage of ammunition or explosives is anticipated:

(1) Total facility automatic sprinkler systems will be installed. The protection will be consistent with that stipulated for moderate hazard occupancies in TM 5-812-1, as a minimum. Dry pipe systems should be used for installations subject to freezing.

(2) Electrical installations will comply with NEMA 4 standards (watertight), as a minimum.

(3) Alarm systems will be installed as prescribed by AR 190-11.

16-4 Containers. Hazardous materials in bulk or liquid form must be transported in containers which will prevent leakage. Containers used in intraplant transportation and service storage of explosives and explosives mixtures such as initiating explosives, pyrotechnic compositions, and tracer materials should be made of material in the following order of preference:

a. Conductive rubber.

b. Plastics (conductive type only).

c. Nonferrous metal-lined boxes without seams or rivet heads under which explosive dust can accumulate.

d. Paper-lined wood boxes.

e. Fiber drums. Fiber drums (DOT 21C) of bulk explosives and propellants should be shipped only by motor carrier or trailer-on-flat car. Glass containers should not be used because of their fragility and severe missile hazard.

16-5. Black Powder Containers. a. Standard containers for black powder are built per drawings that meet DOT specifications.

b. When black powder is shipped or received, each container shall be inspected for holes and weak spots, particularly holes made by small nails and which are visible only upon close examination. Damaged containers must not be repaired; the content shall be transferred to new or serviceable containers.

c. Empty black powder containers may be reused, and may be transported empty provided they are clean. Empty metal containers which are not to be reused and will be salvaged shall be thoroughly washed inside with water.

d. Black powder containers must be carefully opened. When it is necessary to open containers by puncturing, the operation will be conducted by remote control.

16-6. Containers for Solid Propellants. a. Solid propellants shall be packed per approved AMC drawings that comply with DOT specifications.

b. Double-based solid propellants, single-perforated solid propellants, and all-solid propellants with web thickness not greater than 0.019 inch should not be packed in all-steel boxes. Metal lined wooden boxes should be used.

c. Unstable, condemned, or deteriorated solid propellant must be packed submerged in water, in containers meeting requirements of 49 CFR.

16-7. Containers for Ammunition and Bulk High Explosives. a. Ammunition and bulk high explosives shall be packed per approved AMC drawings that comply with DOT specifications.

b. Containers used for packing bulk high explosives should be lined with strong cloth or paper bags, or liners with cemented seams to prevent sifting.

16-8. Handling. a. Explosives or ammunition. Packaged ammunition or bulk explosives shall not be roughly handled, thrown about, tumbled, dropped, or walked over other explosives or ammunition.

b. Propelling charges. Rough handling may open seams in the containers or loosen the covers. The content of damaged containers shall be examined carefully by qualified personnel for moisture, signs of deterioration, or foreign material before repacking. Propelling charges must not be exposed to the direct rays of the sun. If igniter pads on propelling charges are broken, the charges should be handled using the safety precautions prescribed for black powder.

c. Fuzes, primers, boosters, and detonators. All loaded components must be handled with special care, as these are extremely sensitive to shock and friction.

d. Other loaded items. Suitable plugs or closures shall be used to protect exposed explosives in items during transfer within the installation, such as transfer of projectiles from de-fuzing or de-boostering building to the explosives washout building or to the burning or demolition ground.

e. Spotting charges. Spotting charges for practice bombs filled with black powder shall be stored, handled, and shipped under the regulations for black powder.

f. Use of conveyors. When the precautions noted in subparagraph a above are observed, explosives, ammunition and bombs, packaged per AMC approved drawings, may be handled on power and roller conveyors. Loaded ammunition items should not be left on conveyors during nonoperating periods.

16-9. Ammunition subjected to undue or abnormal forces. Live ammunition items or components which have been subjected to any undue or abnormal forces for test purposes, (drop test, vibration test, etc.) will not be offered for shipment by commercial carrier nor be transported over public transportation systems by Government conveyance except --

a. Items containing small quantities of explosives and constructed or packaged so that their explosive forces will be self-contained if they function.

b. Explosives items for which both the testing agency and the project manager or appropriate major subordinate command agree in writing can be safely transported.

CHAPTER 17

TRANSPORTATION

17-1. Railroad Transportation. The operation of railroads within an AMC establishment shall be per applicable current directives particularly FM 55-21, Railways Operation and Safety Rules, AR 55-355, Defense Traffic Management Regulation, 49 Code of Federal Regulations, and this regulation.

17-2. Specifications for Equipment. a. The regulations of the Department of Transportation, the Federal Railroad Administration, and the Association of American Railroads (AAR), pertaining to safety devices, safety guards, design of equipment, etc., are mandatory for railway equipment involved in transporting materials between establishments. Railroad equipment that does not meet DOT, FRA, and AAR regulations may be used on tracks solely controlled by a military installation with the condition that the cars shall be inspected at least annually to assure that they are safe to use under the controlled conditions that exist on military installations: e.g., low speeds, short distances, and frequent use. Inspection must be performed to determine--

(1) Brakes, wheels, journal boxes, springs, couplings, hoses, and all other functional components are in good working condition.

(2) Roof, doors, floor, and cargo space are in good condition to protect and contain the load and that the floors are free of explosive contamination and debris. In addition, the person in charge of the loading crew should make a visual inspection before loading a car to determine that there are no obvious defects that would be cause for rejecting the car. Car certificates are not required for movement within an installation.

b. Locomotives and other rail vehicles used within an establishment shall be designed and equipped to prevent starting of fires. Diesel or gasoline-powered and other self-propelled rail vehicles shall have spark arresters properly installed on exhaust stacks. The spark arresters shall be adequately maintained. The Electro-Motive spark arrester manifold is approved for use on diesel-powered locomotives. Portable fire extinguishers (a minimum of one class 40BC) must be carried on all diesel locomotives and self-propelled vehicles.

c. Locomotives and rail equipment shall be painted to increase their visibility per current regulations.

d. Minimum clearance from centerline of standard gage tracks to near edge of loading docks, walls near depressed tracks, building load platforms, etc., should not be less than 8 feet. The minimum distance between track centers should be not less than 13 feet. The minimum overhead clearance from top of rail to a wire or structure should be 22 feet; the minimum vertical clearance from top of rail to any high tension wire shall be per the requirements of the Association of American Railroads specifications and ANSI C2.

e. Where side clearance is inadequate for a man on the side of a car, warning signs shall be posted at approaches to the obstruction.

f. Tracks in classification yards should be so arranged that the center-to-center distance between tracks is not less than 13 feet. Enough crossovers shall be provided to switch cars and permit rapid removal of cars in case of threatened disaster in the classification yards, holding yards, and holding tracks at backup stations. Classification yards, holding yards, and interchange yards shall be located per the provisions of chapter 5 of DA PAM 385-64.

g. Narrow gage or industrial tracks shall have a horizontal clearance not less that 18 inches from the side of the widest car used and a minimum headroom of 7 feet. Center to center of parallel tracks shall be at least 2´ feet more than the width of the widest car.

h. Dead-end tracks, wherever located, shall be provided with substantial bumper blocks or similar equipment unless it has been determined by the installation safety office that the absence of such equipment does not create a hazardous situation.

17-3. Railways. a. Periodic surveys should be made of roadbeds, crossties, rails, spikes, switches, signals, derails, bumpers, etc. Where the system is electrified or grounded, inspection for proper bonding and grounding of rails should be included in the surveys.

b. Grating should be installed to cover track hoppers under tracks used for unloading materials from dumping cars.

c. On trestles where persons may walk, a walkway shall be provided on one side extending at least 5 feet from the nearest rail. Standard handrails with midrail and standard toeboards shall be installed at the outer edge. On multitrack trestles the walkway may be between the tracks and guardrail need not be provided.

17-4. Signs and Signals. Suitable types of switch target lights which are visible to switch crews working at night should be used. Hand-signal lanterns shall be of an approved electric type.

a. Automatic signals or automatic signals and gates shall be installed at railroad grade crossings where a study of the crossing indicates a need for advance warning of the approach of trains. The study should be based upon the volume of traffic, visibility, and past experience at the location. The highway pavement should be marked 100 feet ahead to warn motor vehicle operators of the location of railroad crossings where the prevailing speed of highway traffic is 40 miles per hour (MPH) or greater. During periods where crossings are heavily traveled (shift changes), a traffic patrolman should be assigned to control vehicular and pedestrian traffic, or engines should be required to stop at all main highways within the area until a member of the crew can act as a flagman and direct the leading railcar across the highway. Openings between rails shall be suitably filled at grade crossings.

b. Locomotives shall approach crossings under full control. When approaching a grade crossing the locomotive whistle shall be sounded (two long, one short, and one long blast) and the bell rung continuously until the locomotive has cleared the crossing. The speed of the locomotive should not be greater than 5 MPH while making the crossing.

17-5. General Intraplant Operation. a. The operating requirements given in this paragraph are in addition to the rules and regulations in other current applicable regulations (see para 17-1).

b. Personnel shall be on the alert at all times to detect defective or unserviceable track or equipment, suspicious or unusual conditions or any condition which may be dangerous to effective operation, and shall promptly report such conditions to proper officials.

c. Personnel shall be informed of the location of obstructions where clearances are close. They must not stand on track in front of an approaching engine or car to board it.

d. All trains must be run carefully during and after heavy storms, particularly where tracks may be affected. When fog, storms, or other conditions obscure the track, the speed of the train must be reduced to permit strict observance of rules and ensure safety.

e. Trains must be fully protected against any known conditions which may interfere with their safe operation.

f. Unauthorized persons must not be permitted to ride on trains.

g. All movements in the classification yards are considered as switch movements. All other movements are considered as transfer movement. Before any movement of a car or cars containing explosives or other hazardous material and before making transfer movements, irrespective of the contents of a car or cars, all air hoses shall be coupled, air brakes cut-in and are in proper working order. Cars shall not be uncoupled while in motion nor pulled apart by locomotive power. Proper safety precautions shall be observed in breaking air hose connections.

h. When single cars are spotted, the hand brakes shall be set and the wheels properly chocked. When more than one car is spotted and the engine detached, the hand brakes shall be set on at least two-thirds of the cars or a cut of cars to assure that sufficient breakage is provided. The hand brakes shall be set on the down-grade end of the cut of cars. Reliance must not be placed on the automatic air brakes to hold spotted cars.

i. While moving a car by using a car mover, a person must be stationed at the hand brake.

j. For transfer movements within installations, when cars are moved by locomotives, loads in partly and completely loaded cars shall be blocked and braced sufficiently to prevent movement or shifting of the load. In such cases, the car doors shall be closed when the cars are moved by a locomotive.

k. When transfer movements are made at night, a member of the train crew must take a position on the leading end of the lead car and display a light.

l. Locomotives must not be left in front of buildings and loading docks containing hazardous materials longer than necessary to "spot" cars for loading or unloading. Cars at a building should be located so that employees in the building will not be required to run the length of the building should an emergency arise and personnel must be evacuated quickly.

m. Riding on the forward footboard or on the footboard between the locomotive and cars is prohibited.

17-6. Rail Baggage and Express Cars. a. When ammunition, explosives, or other hazardous materials are loaded in baggage and express cars, the requirements of subparagraphs b through h below must be met in addition to the requirements of other parts of this section.

b. DOT regulations must be followed.

c. Electric light switches shall be cut off prior to loading or unloading.

d. End and side doors shall be locked and sealed. Doorway protection shall be provided in cars when lading extends into the space between the side doors of the cars.

e. End walls of the car shall be properly dunnaged.

f. All glass windows in side or end doors of the car shall be covered with lumber.

g. Composite cars; i.e., one-half passenger or mail, shall not be used for transporting ammunition and explosives.

h. Steam-heating valves inside the car shall be shut off. Explosives and ammunition shall not be stacked against steam pipes.

17-7. Car Inspection. Wood floored cars must be equipped with spark shields.

17-8. Leaking Cars or Packages. Leaking tank cars containing compressed gases shall be switched to a location distant from habitation and highways and proper action taken for transferring contents under competent supervision. Cars containing leaking packages or leaking tank cars must be protected to prevent ignition of liquid or vapors by flame from inspectors' lanterns or torches, burning fuses, switch lights, switch thawing flames, fires on side of track, or from other sources.

17-9. Handling Accidents on Installations Involving Cars with Explosives. a. Preventing fire. When an accident does not cause the immediate ignition or detonation of the explosives, the first and most important precaution after caring for the injured is to prevent fire. Before beginning to clear a wreck, all unbroken packages of explosives shall be removed to a place of safety. Broken packages and as much of the contents as possible will be gathered up and removed for destruction or repacking. The danger of sparks igniting and causing possible detonation of loose explosives (that cannot be immediately removed) should be reduced by covering or mixing earth with the explosive. When, PETN, lead azide, or black powder is involved, the area shall be wet down thoroughly. After removal of the wreckage, the wet ground must be removed to a safe place and burned. Otherwise, if the ground dries, explosions may occur when the area is stepped upon or struck.

b. Fire fighting (See para 11-6). When a fire occurs near a car containing explosives, every effort should be made to remove the car to a safe place. No attempt shall be made to fight a fire where hazardous articles are directly involved, and all persons shall be evacuated to distances provided in Chapter 3, DA PAM 385-64.

c. Broken packages. Broken or damaged packages of explosives may be repaired or repacked when it is practicable and not dangerous to do so. Explosives shall be repacked wet if so packed in original containers.

17-10. Containers. Containers of explosives or ammunition must not be opened or repaired in any railway car excluding railway cars used as inspection points.

17-11. Technical Aid and Assistance in Event of an Incident Involving Ammunition and Explosives. a. AR 75-15 with AMC supplement authorizes the Commander, AMC, to extend technical aid and assistance as deemed necessary in connection with the moving, salvage, demolition, neutralization, or other disposition of Government-owned shipments of explosives and other dangerous articles being transported or stored by carrier. Commanders of AMC installations where explosives and ammunition (including guided missiles an rockets) are handled, are authorized to act for the Commander, AMC, in this regard. AR 75-15 with AMC supplement outlines the responsibilities to be assumed by carriers when assistance is rendered and procedures to be followed when assistance is requested.

b. In extending requested assistance, commanders should instruct their representatives to cover the following points as a minimum:

(1) Upon arrival at the scene, report to the official in charge who requested an AMC representative to be present to render technical advice and assistance.

(2) Determine if the scene of the wreck is adequately patrolled (day and night) by railroad personnel or local police and if persons other than those working on the wreck are prohibited from approaching the scene. If this matter is not being properly handled, suggestions should be made to the official in charge for correction. Emphasis should be placed on the danger of picking up any hazardous material involved for souvenirs.

(3) Suggest to the official in charge that smoking and the use of matches or flames in the area be prohibited if such action had not already been taken.

(4) The condition and position of wrecked cars and the condition of bracing and contents should be noted. Inspect containers noting particularly any leaking containers of explosives, ammunition, or other hazardous material.

(5) Confer with officials (including wreck master) and discuss, from the safety viewpoint, procedures for handling the wreck, with emphasis being placed on the following:

(a) Instruction of wrecking crew concerning the hazard of handling hazardous material roughly.

(b) Removal of broken containers and loose explosives, ammunition, or other hazardous material, that can be accomplished before handling of wrecked railroad cars.

(c) Appraisal of condition of railroad car and contents to allow safe rerailing of car without reloading.

(d) Furnish advice as to which containers can be recovered or repaired for reshipment.

(e) Furnish advice as to which containers and ammunition should not be shipped and as to their disposal, either by transfer to an AMC installation for disposition or by destruction at the scene of the incident. If need for destruction of explosives or ammunition at the scene of the incident is determined, the Ordnance Officer of the appropriate Army Area should be contacted and the services of an Explosives Ordnance Disposal Officer requested. (See AR 75-15, Responsibilities and Procedures for Explosive Ordnance Disposal.)

(f) Furnish other advice relative to handling the particular types of explosives, ammunition or other hazardous material involved.

(g) Inspect area to ensure that all ammunition, explosives or other hazardous material has been cleaned up or disposed of.

c. In order to permit accomplishment of necessary supply and surveillance functions, whenever the commander of the AMC installation has rendered assistance due to an incident as outlined above, the commander shall immediately contact--

(1) Commander, U.S. Army Industrial Operations Command (IOC), Rock Island, IL, ATTN: AMSMC-TM, when ammunition items other than guided missiles and heavy rockets are involved.

(2) Commander, U.S. Army Missile Command, Redstone Arsenal, AL, when guided missile ammunition items or rockets are involved. Such report will be made by the most rapid means of communication available, starting all pertinent facts concerning the incident.

(3) Commander of the Zone of the Interior Army in whose area the incident occurred when nuclear weapons are involved.

d. Any action required, other than that outlined above, will be directed by the Commander, U.S. Army Industrial Operations Command, for ammunition items other than guided missiles and rockets.

e. Incidents resulting in explosions of ammunition or explosives shall be reported by the installation rendering assistance per AR 385-14, Transportation Accident Prevention and Emergency Response Involving Conventional Munitions and Explosives.

17-12. Motor Vehicle Transportation Motor Vehicle Safety Program.

a. The operation of motor vehicles within an AMC installation shall be per this and other applicable current regulations.

b. Current regulations, particularly AR 385-10, Army Safety Program, require the institution of a motor vehicle safety program as part of the overall safety program of an AMC installation. AR 385-55, Prevention of Army Motor Vehicle Accidents, contains detailed information for inclusion in such a program. This paragraph and paragraph 17-14 outline a recommended motor vehicle safety program.

c. An appropriate countermeasures program will developed to assist in reducing Army Motor Vehicle accidents. Additional assistance will be provided by the Provost Marshall's Office as required.

17-13. Administration of Program. a. General. An effective traffic accident prevention program shall be included in the overall safety program and administered by the installation Safety Director. He must cooperate with the various supervisors whose functions are pertinent to traffic activities and whose active cooperation is essential to the successful accomplishment of the program. These include, but are not limited to the following:

(1) Supervisor responsible for spot control of traffic when necessary.

(2) Motor vehicle maintenance supervisor when accidents indicate maintenance deficiencies.

(3) Facilities engineer where accident indicate physical hazards and nonexistence or improper function of traffic signals, etc.

(4) Transportation supervisor when high accident locations, driver deficiencies, and traffic congestion are pertinent.

(5) Training supervisor.

(6) Traffic Control Committee or Inquiry Board.

(7) Provost Marshall.

b. Accident reporting and follow-up.

(1) Each motor vehicle accident which occurs on the installation and each occurring off the installation involving Government-owned vehicles assigned to the establishment shall be investigated by competent personnel and reported as required by current regulations.

(2) Each traffic accident and investigation report shall be transmitted to the Safety Director for complete analysis of the accident and dissemination of resultant information.

(3) Incomplete reports of accidents submitted by drivers should be returned through their immediate supervisor for complete information.

c. Accident records. The motor vehicle safety program should require the following records:

(1) Accident spot map of the installation should show the specific location of each accident, and the identifying number which designates the particular accident report from which the information was obtained. As an adjunct to the map, a similarly numbered list should indicate the identifying numbers, location, hour of the accident, and the specific unsafe acts or conditions involved.

(2) A monthly and cumulative tabulation sheet containing a complete breakdown of all reported accidents.

(3) A simple card record of drivers showing the name, badge, or payroll number, and such data as the time and place of

accident or violation, and the unsafe act involved. This file should be maintained to assure prompt identification of accident repeaters.

d. Periodic summaries. Periodic summaries of motor vehicle accident and traffic violation information shall be compiled and disseminated to interested supervisors designated in subparagraph a above for appropriate action as determined by the local safety official.

e. Warning signs. Stop, railroad crossing, curve, speed zone, and no-passing signs or signals should be used as local conditions dictate. Standard highway regulatory, warning and guide signs as require by current ANSI Standard D6.1, "Manual on Uniform Traffic Control Devices for Streets and Highways," shall be used exclusively throughout the establishment. All signs that are intended to convey the message during periods of darkness or poor visibility shall be reflectorized or illuminated. Specific hazards should be identified by posting appropriate warning signs.

(1) The use of an excessive number of warning signs should be avoided to prevent unreasonable impediment of traffic flow and the breeding of disregard for all traffic controls.

(2) Warning signs in the speed zones specified shall be placed at the following minimum distances from hazards to assure drivers sufficient time to adjust driving to cope with the hazard.

Speed Zone (MPH)	Distance (Feet)
15	36
25	55
35	101
Others	200

(3) Heavily traveled gate entrances and exits, particularly at shift change, should be channelized so that two or more traffic lanes can be formed to expedite traffic flow. Channelizing should be accomplished by road striping and instructional signs.

(4) Hazardous curves should be posted and the road should be striped if the road surface permits. At sharp turns crash fences should be erected and striped in contrasting colors for visibility.

(5) Blind intersections shall be appropriately posted. At blind intersections in congested areas, reduced speed limits should be enforced, and, if necessary, stop signs installed for the lesser flow of traffic. At dead end streets, crash fences should be erected and striped in contrasting colors for visibility.

(6) All regulatory signs or signals must be located within the confines of the installation boundary, except where prior approval of state or local authorities has been obtained.

f. Road, parking and pedestrian traffic layouts.

(1) Pedestrian lanes designated by strips or portable standards should be used where large numbers of pedestrians cross heavily traveled roads at recurring intervals such as shift change times. Conflicts between pedestrian and vehicular traffic should be reduced to a minimum number of controllable points. Vehicular traffic must stop for posted pedestrian signs unless personnel are stationed at such locations to control vehicular and pedestrian traffic.

(2) Adequate clear passage lanes should be provided in parking lots for through traffic. No parked vehicle should be permitted to encroach upon clear passage lanes. One-way entrances and exits for parking lots should be designated where necessary to facilitate traffic movement with a minimum of conflict. Parking lots should have safety aisles for pedestrians.

(3) Parking of vehicles, other than those necessary for efficient operation, shall not be permitted in close proximity to operating buildings or other structures where there is considerable traffic congestion. Parking of vehicles should be prohibited on shoulders of roads in congested areas during heavy traffic periods.

g. Driver training (AR 385-55, AR 600-55).

(1) Each driver shall be trained in the operation of the specific type of vehicle to which he will be assigned before being permitted to operate the vehicle. Additional training should be given if necessary when assignments are changed.

(2) Drivers who have been involved in violations or an accident should be given specific training in the particular unsafe act which caused or contributed to the violation or accident. This training should be simple, brief, and focused upon the phase of operation in which the driver is considered deficient. Actual operation of the vehicle under realistically simulated conditions in the immediate presence of a competent instructor should be included.

(3) A simple set of traffic rules and regulations appropriate to the installations should be prepared and given the widest practicable distribution to personnel engaged in the operation of vehicles on the installation. Accident violation trends disclosed through accident reports should also be highlighted and disseminated to personnel through supervisors' meetings, safety meetings, installation publications, and similar media.

h. Educational enforcement. Proper driving practices of motor vehicle operators should be developed and controlled by educational enforcement. Educational enforcement should consist of the assignment of personnel, preferably guards, to control traffic at intersections or locations which are high in accident frequency or traffic congestion. Prior to each assignment, the designated person should be fully informed of the specific problem or unsafe act which has caused trouble at that point in the past.

i. Preventive enforcement. After educational enforcement has been applied and safe driving practices develop in the majority of vehicle operators, recalcitrant operators may be controlled by preventive enforcement. In the event that an authorized person observes a military driver action which is contrary to existing regulations, a written warning should be issued to the offending driver, with a copy routed to the individual in charge of the program and another copy to the driver's supervisor. After a second warning has been issued to the same driver, the driver should be given specific training to remedy the violating practices reported. If three warnings are issued to the same driver within 12 months, punitive action should be taken as deemed necessary upon the facts involved in all three violations. However, punitive action is wholly permissible and in many cases desirable, on either the first or second warning, depending upon the gravity of the violation. In cases involving civilian drivers, action should be taken per the Table of Standard Penalties prescribed by Civilian Personnel Regulations.

j. Punitive enforcement. Punitive enforcement measures should be applied to employees who have received three warnings within 12 months, employees involved in outstanding flagrant traffic violations, and employees whose actions have caused motor vehicle accidents on the installation or accidents involving a Government vehicle off the installation. A point system may be established per AR 190-5.

k. Traffic control personnel. When circumstances dictate that personnel of the Department of the Army be assigned traffic direction and control duties, appropriate reflectorized or illuminated clothing and equipment will be provided and worn for their protection at night and other periods of poor visibility (except where such duties are performed in well lighted areas).

l. Seat belts. Motor vehicle seat belts will be used as prescribed by AR 385-55.

17-14. Motor Vehicle Shipment Regulations. Motor vehicle shipments on public highways are governed by the Department of Transportation regulations. All motor vehicle shipments from an AMC installation shall comply in full with the applicable portions of DOT, State and municipal regulations except as provided for in these regulations. Before any motor vehicle designated for movement over public highways may be loaded with ammunition or explosives and other dangerous articles, as specified in Chapter 33, Section II, AR 55-355, the vehicle must be inspected and approved by a qualified inspector for compliance with AR 55-355, DD Form 626 (Motor Vehicle Inspection). After loading, lading must be inspected and approved. Driver selection, training, etc., for interplant shipping and for operation of Government-owned trucks on public highways shall be per pertinent requirements of 49 CFR. Parts 390-397, Federal Motor Carrier Safety Regulations, FM 55-30, Army Motor Transport Units and Operations; and FM 21-305, Manual for the Wheeled Vehicle Driver.

17-15. Motor Vehicle for Explosives Shipment. Cargo-type trucks and truck-tractor drawn semitrailer vans are the preferred means for transporting ammunition, explosives, and other hazardous material. Other types of trailers should not be used by AMC installations for this purpose except where the material is sufficiently large to make handling by vans impractical (this restriction need not apply to licensed common carriers and contract equipment). Red lights are not permitted on the front of vehicles transporting explosives and ammunition.

17-16. Inspection of Vehicles. Government-owned motor vehicles used for transportation of hazardous materials shall be inspected quarterly using DD Form 626 or local equivalent by a competent person, other than the driver, to see that mechanical condition and safety devices are in good working order. Daily inspections shall be made per Chapter 7 of DA PAM 385-64.

17-17. Operating Requirements. The following requirements shall be observed in the operation of Government-owned/leased motor vehicles transporting explosives, ammunition, and other hazardous material:

a. The brakes of conveyance must be set when parked and materials handling equipment (MHE) is operating in and out of conveyance. When parked on a grade, at least one wheel must be chocked. Safety jacks may be necessary to support a semitrailer during the loading and unloading when the trailer is not coupled to a trailer.

b. When a motor vehicle approaches within 25 feet of the doors of a structure through which a shipment is to be moved, the doors must be kept closed until the motor has been switched off unless the exhaust system is equipped with a spark arresting device or no exposed explosives are present. Exposed explosives exclude finished ammunition and explosives packaged for shipment per DOT regulations.

c. When it is necessary to transport explosives on routes where ferry-boats, tunnels, or toll bridges will be encountered, local State officials should be contacted to determine what procedures must be followed to comply with their regulations.

d. Trucks containing ammunition or explosives should not be refueled within magazine or explosives areas of AMC installations including refueling from mobile units. A central refueling station located outside the restricted area should be used.

e. No explosives shall be loaded into or unloaded from motor vehicles while their motors are running except when required to provide power to vehicle accessories such as mechanical handling equipment used in the loading and unloading of the vehicle, provided--

(1) The accessory is an integral part of the vehicle.

(2) The exhaust gases from the motor are emitted at least 6 feet from the point at which the loading operations are conducted and are directed away from this point.

(3) The exhaust pipe is equipped with a spark arrester.

(4) Materials being loaded or unloaded which may evolve flammable vapors are enclosed in tightly fitting containers.

17-18. Inspection and Movement of Incoming Shipments. Incoming or outgoing ammunition and explosives loaded trailers that cannot be exchanged directly between the carrier and the AMC installation may be moved into the interchange yard. Quantity-distance provisions do not

apply provided the trailers are moved expeditiously from the interchange yard. At least 10 feet separation should be maintained between trailers in an interchange yard.

17-19. Intraplant Movement. Loading and bracing of ammunition and components for intraplant (on-post) movement will be per AMC Loading and Bracing Drawing number 19-48-4306-5-11Q1000.

17-20. Air Transportation. The transportation of ammunition, explosives and other hazardous materials by civil aircraft is regulated by the DOT. See 49 CFR.

17-21. Permissible Air Shipments. Hazardous materials that may be shipped by civil air are identified in 49 CFR 172.101 along with the maximum net quantities per package, and in chapter 4 of TM 38-250 for shipments by military aircraft. External or internal transportation of electrically initiated explosive loaded items or components by helicopter will not be permitted without prior approval from the Commander, AMC. Packages must conform to the requirements of DOT regulations. Dangerous articles and other cargo must be firmly lashed to the aircraft structure or otherwise secured to prevent shifting in flight. Signaling devices, equipment necessary to promote safety in operations, small arms equipment in moderate quantities for personal use and other items as permitted in Title 49 CFR part 175.10 may be carried without complying with the above requirements. Dangerous articles must be placed in a baggage compartment inaccessible to passengers during flight.

17-22. Military Aircraft Operating Regulations. a. Operation of military aircraft shall be per requirements outlined in the applicable flight envelope, Army and/or Air Force regulations, and as further required by locally established regulations.

b. Prior to take-off or landing, the pilot must contact the tower for taxi, take-off, or landing and parking instructions. The pilot shall, when requesting instructions, make known the contents of the cargo and shall request priority for his aircraft.

17-23. Damaged Shipments. Air shipments of explosives or ammunition received at an AMC establishment in a damaged condition or not loaded per applicable requirements shall be reported on SF 361 per AR 55-38, Reporting of Transportation Discrepancies in Shipments. If damage was due to improper preservation, packaging, or packing, SF 364 will be prepared per AR 735-11-2.

CHAPTER 18

MATERIALS HANDLING EQUIPMENT

18-1. General. Specification, operation, and maintenance of materials handling equipment shall be per this regulation, TM 5-725, Rigging, DA PAM 738-750, The Army Maintenance Management System, DOD 4145.19-R-1, Storage and Material Handling; and OSHA and NFPA regulations. Materials handling equipment contaminated with hazardous materials/hazardous wastes such as polychlorinated biphenyl (PCB) may not be removed from the area in which they are used unless decontaminated or cleaned by approved procedures.

18-2. Power Trucks and Tractor Specifications. Trucks with end-operating platforms or pedals shall be equipped with platform guards of heavy channel iron and heavy steel plate or materials of equal strength. The guards should be at least 18 inches high on the sides and should extend a sufficient distance beyond the platform or pedal to protect the operator. Overhead guards meeting the requirements of DOD 4145.19-R-1 and ANSI/ASME B 56.1 are required for fork lift trucks of all types. Exceptions may be granted in writing by installation commanders only when the height of the overhead guard would deny entry of fork lift truck into work locations or the overhead guard would be lower than the top of the operator's head. Modifications must have the approval of the manufacture per OSHA standards. In such cases, the forklift truck must be equipped with a standard load back rest (vertical package guard) designed according to specifications in MIL-T 21870 and MIL-T 21869. Back rests may be modified in design to facilitate operation in proximity to curved roofs of igloo type storage magazines. Lift trucks shall be designed to prevent the sudden dropping of the load in the event of a power failure.

18-3. Battery Powered Equipment for Handling Explosive Material. Battery powered equipment and its use in hazardous locations shall comply with OSHA and NFPA standards. All equipment will be appropriately labeled for ready identification.

18-4. Refueling Procedures. a. Gasoline and diesel powered equipment refueling must conform with the requirements of chapter 3 of DA PAM 385-64.

b. Refueling of permanently mounted LP gas fuel tanks shall be done outdoors at least 50 feet from buildings critical to the mission of the installation and at least 15 feet from LP storage tanks at the end furthest from the relief valve. The filling plant shall conform to NFPA Standard No. 58.

c. Replaceable fuel tanks may be exchanged indoors at least 25 feet from open flames or other ignition sources provided that prior to disconnecting the empty fuel tanks the fuel supply is shut off at the tank and the engine is operated until all fuel in the system is consumed.

18-5. Equipment for Refueling. In addition to the requirements given in the preceding paragraph, refueling equipment is subject to the following:

a. Refueling truck construction should comply with requirements outlined in NFPA Standard No. 385, "Flammable Liquid Tank Vehicles." An approved discharge hose with self-closing nozzle should be provided. Refueling trucks shall be provided with a portable bonding wire to be clamped to the equipment before refueling. If a conductive hose is used, the resistance shall be checked at frequent and regular intervals.

b. If portable wheeled tanks are used (50 to 60 gallons capacity), they shall be of a type approved by Underwriter's Laboratories or other recognized testing agency.

c. The refueling truck or portable wheeled tank should be equipped with a 10-20 pound carbon dioxide or 4-6´ pound dry chemical extinguisher (5-BC minimum) or this equipment should be available nearby. Employees who refuel or operate materials handling equipment shall be trained in the proper use of the extinguishers and in reporting fires.

d. If portable containers are used for refueling they shall be approved safety cans, with flame arrester screen, not exceeding 5-gallon capacity.

18-6. Storage of Gasoline, Diesel-Powered or LP-Gas-Powered Equipment. a. Gasoline, diesel-powered or LP-gas-powered equipment shall not be stored in buildings containing explosives or ammunition or on explosives loading docks or piers when explosives or ammunition is present.

b. A central storage location for gasoline, diesel-powered or LP-gas-powered equipment is preferred. Such a building should be located at least 50 feet from other buildings so as not to constitute a fire hazard. Storage areas for LP-gas-powered equipment should have continuous positive mechanical ventilation from the floor level.

c. If gasoline-powered equipment is stored outdoors or in unheated buildings, care should be taken to prevent cracking the

sediment bowl as a result of moisture collecting and freezing in the bowl.

d. If on a grade, the wheels of the vehicle should be blocked to prevent movement of the truck in event of brake failure.

18-7. Storage of Battery-Powered Equipment. When necessary for efficient operation, battery-powered MHE permitted for use in buildings or magazines containing explosives or other hazardous materials may be temporarily stored in magazines containing packaged ammunition and explosives and inert warehouses provided the following conditions (designed to prevent fires or other trouble from occurring during unattended periods) are met:

a. Periods of idle storage shall not exceed 4 days.

b. After each workday, MHE will be inspected for hot brakes, leaking oil, or fluid. If found, the MHE will be removed from the building.

c. MHE will be made inoperative by removing ignition keys, activating shut-off switches, or seat control disconnects, etc. Battery cables will not be disconnected in explosives storage locations due to the possible arcing when terminals separate.

d. MHE will be parked and secured at the maximum distance from the explosives or ammunition.

18-8. Maintenance. Inspection and maintenance of MHE shall be accomplished per applicable regulations. A daily inspection check made by the operator shall include items listed in an authorized checklist. The hoisting and tilting mechanism and water-type mufflers, if installed, shall be checked before and after each day's operations. Records of inspections, repairs and service shall be kept up to date. Neither maintenance nor repair of equipment shall be accomplished in explosives storage or operating buildings. Battery charging stations and maintenance shops for battery-powered equipment preferably should be located in an inert area. When these facilities serve a single explosives operating line, they may be located at intraline distance from the operating buildings; locations having exposures to minimum quantities of explosives in the line (inert end of line) are preferred. Battery charging stations for MHE used in magazine areas only may be located at magazine distance from magazines. Operator preventive maintenance may be performed on noncombustible docks of explosives operating buildings provided the docks are clear of ammunition and explosives.

18-9. Operator Selection and Training. Operators shall be carefully selected, thoroughly trained, and required to pass an operating test

before they are permitted to operate powered materials handling equipment. The selection and training of operating personnel shall be per the program described in DOD 4145.19-R-1. All operators should undergo an examination to eliminate those physically unfit for this type of work.

18-10. Operating Requirements. a. A distance of at least three truck lengths shall be maintained between trucks in operation.

b. Transportation and/or moving fuzed ammunition, including bombs, directly or indirectly on the forks of lift trucks without skids or pallets is prohibited unless such containers are so designed to be safely carried in this manner. Loaded unfuzed bombs may be carried directly on the forks of lift trucks. Boxes of finished ammunition when of sufficient length so as to be firmly supported on both forks may be carried directly on the forks.

c. Riders, lunch boxes, newspapers, extra clothing (not being worn), etc., shall not be permitted on lift trucks at anytime. When the equipment is used as a personnel lift, approved safety pallets must be used (DOD 4145.19-R-1).

d. Forklift trucks used outside after dark shall have red reflectors on the rear and be equipped with headlights (front and rear).

e. Operators shall not make any repairs on their machines nor tamper with any mechanical devices. A report shall be made to the foreman indicating repairs necessary so that the trucks may be kept in safe operating condition at all times.

f. Gasoline-powered equipment shall be started and the motors thoroughly warmed up before entering any building.

g. Loads on tines of forklifts must not extend more than one-third of the height of the top tier of containers above the load back rest. When handling two low profile unitized (or similar) loads together because of low overhead clearance the package guard must extend to at least one-third the height of the top unit of the load.

18-11. Handtrucks. a. Handtrucks may be two-, three-, or four-wheeled. Each type is constructed for special purposes and a careful survey shall be made to assure that the proper equipment is being used on the various jobs since special hazards are inherent in each type of truck.

b. Handtrucks with broken or damaged wheels shall be removed from service immediately and repaired. Nails, pieces of wire, or other substitutes shall not be used in place of cotter pins to hold wheels

in place on axles. Trucks should not be stored in passageways. Each truck should be numbered for identification to facilitate inspection and maintenance.

c. Flooring over which trucks must travel shall be kept free from holes and depressions. Aisles and passageways should be marked and kept free of materials and obstructions. When trucks must be wheeled up and down ramps, the surface of the ramp should have a rough finish to prevent people from slipping or falling. Walkways should have devices to prevent wheels from running off walks, particularly where inclines may be steep. Loading plates or gangplanks used between platforms, freight cars, motortrucks, and trailers shall be fastened securely to prevent movement while in use. When trucks are placed on elevators, the wheels should be chocked.

d. Handtrucks and buggies with more than two wheels should have the following features: low center of gravity; design that will permit easy washing and cleaning, and when pulled by power units and used on plant roads at night, handtrucks, trailers and buggies should have reflectors. The power units must be equipped with headlights. In addition, those units used for transporting explosives material out of DOT packaging shall be addressed in the hazard analysis and have appropriate safety devices when required.

e. The method and sequence of unloading should be considered before loading a truck, particularly if hoisting equipment is used. Blocks should be used to separate sections of the load to permit easy fastening of slings at the unloading point. If selective stacking is required at the unloading end, the material should be loaded on the truck in proper sequence. Trucks should not be loaded to a height that will obstruct visibility in both directions unless at least two men are assigned to move the truck. Loads shall be placed to prevent tipping, shifting, or falling.

f. Handtrucks/pallet jacks, not containing an energy source, may be stored in operational magazines when it can reasonably be expected that they will be required for use to relocate items or load/unload the magazine. Permanent storage of handtrucks/pallet jacks in the magazine is prohibited. Good housekeeping and safe practices will be followed.

CHAPTER 19

AMMUNITION PRESERVATION AND PACKING, MODIFICATION, RENOVATION, AND DEMILITARIZATION

19-1. Standing Operating Procedures. SOPs shall be established, approved and posted as required by DA PAM 385-64 and AMC-R 700-107.

19-2. Layout of Operations. a. Ammunition normal maintenance, modification, renovation, and demilitarization operations should be performed in operating buildings within the ammunition workshop area. These buildings must be separated from each other by a minimum of intraline distance and from magazines, other operating buildings, inert areas, etc., by a minimum of inhabited building distance. Concurrent renovation, modification, normal maintenance, or demilitarization is permitted within a workshop area except as follows:

(1) The repacking of bulk black powder shall not be accomplished concurrently with operations on items having a missile producing hazard.

(2) Bulk initiating explosives shall not be processed, loaded, or otherwise handled while other operations are in progress.

b. Unless a building is specifically designed for concurrent operations, permissible concurrent operations (para a, above) should be accomplished in separate buildings located at the appropriate intraline distance from other operating buildings in the workshop area. When necessary to conduct concurrent operations in the same building, they must be arranged in a manner to segregate the items so that dissimilar hazards are separated by a reinforced concrete dividing wall. The quantities of explosives and number of personnel exposed at each concurrent operation shall be held to the minimum consistent with safe and efficient operating procedures.

c. Where the facilities described above are not available and when approved by Commander, AMC, normal maintenance, and in some cases modification and renovation operations may be performed in an empty magazine or in the open at intraline distance from the nearest explosives storage location, based on the maximum quantity of explosives at the operations, but in no case less than 90 feet. These operations must be separated from other operating locations (including loading docks) in the magazine area by intraline distance based on the larger quantity of explosives involved. The site chosen must be devoted

exclusively to the work and all necessary safeguards, such as operational shields, must be provided. Since personnel performing such operations will be exposed to large quantities of stored explosives, the hazards are inherently greater than would be present if the operation were performed outside the magazine area, therefore, plans and procedures for all such operations shall be carefully scrutinized.

d. The performance of minor normal maintenance operations in the magazine area per paragraph c above, may be approved by the installation commander. Such operations will be limited to hand de-rusting and brush painting of bombs and separate loading projectiles, opening and repairing boxes and metal containers of ammunition, repacking of ammunition into serviceable boxes and fiber containers, spot painting projectiles, maintenance, and other relatively safe operations of the same general type. Any operations requiring the removal or replacement of explosives components will require approval from the Commander, AMC, ATTN: AMCSF before being performed in the magazine area.

e. The quantity of explosives or ammunition at an operating location shall be the minimum necessary to carry out the operation. This quantity shall be subdivided to the maximum extent possible into smaller amounts, adequately separated to prevent propagation if detonation occurs. Personnel exposure shall be the minimum consistent with safe, efficient, and continuous operation. Eating in operating buildings containing explosives and toxic items will be prohibited except where separate lunchrooms have been provided for this purpose.

19-3. Requirement for Shielding Disassembly Operations. a. Adequate operational shields shall be provided for operations such as disassembly of foreign ammunition or other ammunition of uncertain design and condition.

b. The following and similar operations may not require operational shields for the protection of operators if the assembly has been normal and the normal equipment, tools, and methods used in the assembly are sufficient to accomplish the disassembly without the application of undue force. Removal of fuzes from hand grenades provided--

(1) A baffled tank of sufficient size is available to dispose of fuzes that may accidentally function. When incendiary or smoke grenade fuzes are handled, the tank should contain water.

(2) Shielded trays are available to receive fuzes and not more than 50 fuzes are permitted at each disassembly station.

(3) Grenade is such that a fuze well liner is provided in the design. (Note: Whenever the grenade is not designed with a fuze well liner, the fuze removal must be by remote control. In addition, a mirror arrangement will be provided to observe whether the detonator body has separated from the fuze head during disassembly operations. When separation occurs, the operational shield door will not be opened before a 30-second waiting period has elapsed.)

c. Each disassembly operation shall be separated from adjacent similar or dissimilar operations by operational shields designed to protect the operator at any operation from the blast and missiles arising from a possible explosion at any other adjacent operation. Items awaiting disassembly or resulting from disassembly operations must be placed or shielded so that propagation of an incident from the disassembly station will not occur.

d. When the disassembly of material not generally included in the preceding paragraphs is contemplated, specific approval of the proposed methods and locations of the operations must be obtained by submitting a request through command channels to the Commander, AMC, ATTN: AMCSF, before starting the work.

e. The operator and all other personnel must be provided complete protection from disassembly operations involving conditions that are known or expected to require use of undue force.

f. When disassembly is required to be performed with the operator protected by an operational shield (disassembly means complete separation (threads or other connections) of component parts), it is not permissible to loosen the components with the operator protected and then permit the operator to complete the disassembly without protection.

g. When an operator is protected from an operation by an operational shield, no other operator may be exposed to that operation in such a way as to expose him/her to a greater risk than that presented to the operator for whom the operational shield was intended.

19-4. Operational Shields for Disassembly. a. Existing reinforced concrete walls which were built to resist the effects of accidental explosions and were designed and built per regulations applicable at the time of construction may be used as operational shields employing the following guidance as a minimum requirement.

(1) A 12-inch reinforced concrete wall may provide adequate protection from disassembly operations involving an item containing 15 pounds TNT equivalent or less of high explosives when the nearest part of the item is at least 3 feet from the wall and the item is at least 2 feet from the floor. Care must be taken to use appropriate equivalence data for close in effects. Explosives characterized by greater brisance than that of TNT may have very high equivalencies at small distances from the explosives. When equivalence data is not available, existing 12-inch reinforced concrete walls may be used for operational shields for protection from items containing not more than 6 pounds of high explosives.

(2) A 30-inch reinforced concrete wall may provide adequate protection from the effects of an item containing not more than 50 pounds TNT equivalent of high explosives. The same separation distance as stated in subparagraph (1) above applies. When equivalence data is not available, a 30-inch wall may be used for an operational shield for protection from items containing not more than 20 pounds of high explosives.

(3) A 36-inch reinforced concrete wall may provide adequate protection from the effects of an item containing not more than 70 pounds TNT equivalent of high explosives. The same separation distance as stated in subparagraph (1) above applies. When equivalence data is not available, a 36-inch wall may be used for an operational shield for protection from items containing not more than 28 pounds of high explosives.

(4) Operational shields previously approved by the Commander, AMC (AMCSF), may continue to be used for the specific operations approved.

b. During disassembly, ammunition items other than those with shaped charges should be placed with their longitudinal axes perpendicular to the wall, at least 3 feet from the wall and 2 feet from the floor. Greater distances should be used whenever possible. Cones of shaped charges should not be pointed toward protective shields or walls. Personnel should not be closer than 2 feet from the opposite side of the wall. Disassembly equipment that penetrates a protective wall must be so designed that personnel will not be injured by movement of the tool in event of a detonation.

c. Laced reinforced concrete walls designed for personnel protection per TM-5-1300 need not be tested. The design of the wall shall be verified by individuals knowledgeable with the design principles in the TM.

19-5. Soldering Containers. Containers to be soldered shall be free from explosives, explosives dust, and flammable vapors. This does not prohibit soldering covers to metal liners containing completely closed ammunition. Examples of such operations are covers on metal liners for small arms ammunition and tear strips on metal can containing fuzes.

19-6. Inert Scrap Components and Packaging Materials. a. All scrap components and packaging materials, other than fired small arms cartridge cases, derived from ammunition and hazardous chemical renovation, preservation and packing (P & P), modification and demilitarization operations shall be inspected by the activity performing the operation, opened to ensure that no hazardous chemicals or ammunition items are present. Qualified responsible personnel shall certify such material to be inert and free of hazardous chemicals and explosives prior to reuse or transfer to the Defense Reutilization and Marketing Office (DRMO) or to an inert storage area.

b. For those items transferred to DRMO, the qualified responsible personnel conducting the inspection of material shall submit a certificate of inertness as part of the turn-in document per the provision of DOD 4160.21-M-1, Chapter II, paragraph D2. Materials generated from ammunition or other hazardous items, even though properly inspected and certified inert, shall not be mingled with other types of material, including scrap. The separation of inert projectiles, dummy ammunition rounds, and other inert ammunition items from other types of material shall be maintained.

19-7. Demilitarization of Fuzes and Other Loaded Components. Fuzes, primers, boosters, and other items containing explosives should be disassembled into their separate components for destruction, to assure elimination of the contamination hazard and provide ready means of inspection after burning or detonation. Where the methods used for demilitarization are such that the residue can be certified as being free of explosives contamination, disassembly prior to burning or detonation is not required.

19-8. Sand and Shot Blast Cleaning. a. Blast cleaning of solid propellant rocket motors may be accomplished only with prior approval from the Commander, AMC, ATTN: AMCSF.

b. Blast cleaning of fragmentation bombs introduces certain inherent hazards because of the possibility of explosives being present between the body and tube, as well as between the helix of the body and other component parts. Before blast cleaning loaded fragmentation bombs, all explosives in cracks or crevices that may cause difficulty when exposed to the abrasive cleaning medium shall be removed with a nonferrous wire brush or by other satisfactory methods.

c. Blast cleaning rooms, cabinets, duct work, dust collection chambers, and abrasive separation chambers shall be maintained in a manner and cleaned at sufficiently frequent intervals to preclude the accumulation of excessive dusts containing hazardous explosive residue.

d. All metal processing equipment used at the sand or shot blasting operations shall be electrically grounded and tested per the requirements of DA PAM 385-64.

e. All operators directly engaged in sand or shot blasting operations shall be required to wear the necessary personal protective equipment.

f. Approved type automatic or semiautomatic sand or shot blasting equipment should be installed where practicable. Remote control of equipment, from behind an adequate barrier, is preferred.

g. The quantity of loaded items being sand or shot blasted at one time should be maintained at the minimum consistent with safety and efficiency. The sand or shot blasting equipment location shall be separated from the remainder of the operations and personnel by an adequate barrier, dividing wall, or appropriate quantity-distance in a manner to effectively limit the forces of an explosion during the process to the immediate area.

h. The use of steel wool is prohibited for cleaning purposes where possible contact with exposed explosives exists. Non-ferrous wool may be used in these instances.

i. Operations involving the processing of related inert components should not be performed in close proximity to the sand or shot blasting operation involving explosives-filled items but should be accomplished at a location where safety from an explosion can be reasonably assured. Wherever practicable, the independent processing of inert components such as cleaning metal grommets and the like should be accomplished at not less than the appropriate intraline quantity-distance separation from the explosive hazards.

19-9. Sand or Shot Blasting Operations within a Building in an Operating Line. The following safety measures are required in addition to the applicable precautions listed in paragraphs 19-9 above and DA PAM 385-64, when sand and shot blasting operations are carried on within a building in an operating line:

a. Unless otherwise approved by HQ AMC, ATTN: AMCSF, the actual sand or shot blasting operation must be separated from all other operations in the building by means of walls or barriers that are

designed to protect all other personnel in the event of an unusual incident occurring at this location. Openings in these walls or barriers should be limited to the minimum sizes required to facilitate the handling of items to and from the operation. These openings should be arranged in a manner to effectively baffle fragments and prevent projection into adjoining rooms. Openings of the size to allow entry and exit of MHE, such as fork lift trucks or tow motors shall not be permitted within the protective walls or barriers unless specially designed to provide resistance to potential explosions equivalent to that provided by the wall. A door opening of sufficient size for use of personnel only may be provided in the protective wall, if required. If existing buildings where protection is provided by 12-inch reinforced concrete dividing walls, the walls must extend to the exterior walls of the building. In no event will the height of the concrete wall be lower than the bottom chord of the roof truss. Any opening remaining between the top of the concrete wall and the underside of the roof will be closed on both faces with rigid fire-resistance material securely fastened to the wall and the underside of the roof.

b. Equipment for sand or shot blasting operations should be of the type not requiring the presence of operators in the immediate vicinity of the machine for its control. It should be automatically controlled and provided with interlocking switches that will stop the machine if any of its parts fail. Manually controlled STOP switches also should be provided at proper intervals to permit prompt stopping of the equipment in event of accident. When manually operated abrasive equipment is used, "dead man" controls shall be provided on the blast nozzle.

19-10. Rotational Speeds for Equipment Used in Ammunition Operations. Requirements are found in DA PAM 385-64, chapter 18.

19-11. Cleaning Ammunition. Power tools with nonferrous brushes may be used on ammunition or ammunition components only when there are no exposed explosives or thin walled casings where brushing would create heat or friction sufficient to initiate the item involved.

19-12. Army Equipment Data Sheets. The Army Equipment Data Sheets, Ammunition Peculiar Equipment, TM 43-0001-47 should be used as a guide in selecting equipment for specific operations.

CHAPTER 20

SAFETY IN MUNITIONS LOADING

20-1. Scope. This section outlines safety requirements for certain explosives operations and is supplementary to other pertinent regulations.

20-2. Screening and Blending High Explosives. a. Bulk high explosives, in granular or small flake form, intended for processing shall be passed through a screen to remove extraneous material prior to use. Dry explosives in large flake or lump form need not be screened but must be visually inspected and passed over a magnetic separator. Wet explosives that cannot be screened shall be visually inspected. Screen openings may be circular, square, or rectangular. If circular or square, the size of the opening shall not exceed one-fourth inch in diameter or on each side. If rectangular, the screen dimensions should not exceed one-fourth inch by four-tenths inch. Screen sizes may be selected to classify the material according to particle size if required for the work. Screening equipment shall be constructed to prevent explosives form becoming subjected to pinching, friction, and impact. Screen shall be electrically interconnected and grounded. Screening of all high explosives should be supplemented by a permanent type magnetic separator. In general, hand-screening is not recommended because of health, fire, and explosion hazards to personnel. When necessary, a maximum of one-half pound of explosives may be hand-screened provided precautions are taken to preclude hazards to personnel other than the operator. The necessity for hand-screening a maximum of one-half pound of explosives is restricted to one lot or one mix and is not a justification for dividing larger quantities into one-half pound increments. The availability of one or more remote control facilities should preclude the necessity for hand screening.

b. Operational shields, suitable for the quantity of explosives involved should be provided to protect personnel from screening (except hand-screening per paragraph a above) and blending operations involving black powder, tetryl, pentolite, explosives of similar sensitivity and metal powders. When suitable operations shields are not provided as required, all personnel and controls for the operation equipment shall be located at a minimum of intraline distance from these screening and blending operations. When personnel are required to remain at remote control stations for periods longer than needed to start or stop the screening and blending equipment, suitable protection against potential missiles shall be provided. Operational shields and remote controls are not required for the screening of TNT, Explosives D and explosives of similar sensitivity.

c. Exhaust ventilation must be provided for explosives screening units if operational procedures and equipment design do not preclude the development of concentration of explosives dusts in excess of the threshold limit values (TB MED 265). Even when exhaust ventilation is not required, screening rooms must be thoroughly cleaned at the end of each shift or more frequently if necessary, to prevent hazardous accumulations of explosives dusts. Generally, wet-type dust collection systems are preferred.

d. The same piece of screening equipment shall not be used for two or more materials unless it is definitely established that a mixture of the two will not present an increased hazard. Complete decontamination of screens is difficult.

e. In tritonol loading, aluminum is usually fed into the melt-mix kettles in the melt-pour building. When adding aluminum, there should be provided at the juncture of the drum and drumhead, a screen having 0.25-inch openings as a maximum. A second screen of 0.50-inch maximum should be placed near the top of the chute leading to the melt-mix kettles. A magnetic separator of permanent magnet type should be installed at the chute to remove ferrous metal from the aluminum. To prevent dangerous dust dispersing, aluminum powders should be introduced in a manner to permit immediate immersion in the melted ingredients.

f. TNT used for feathering must have first been screened in the screening building. A second screen, of the dimensions specified below, shall be installed between the tip of feathering chutes and melt-mix kettles, that will prevent sliding or moving to create friction with the sides of the chute. Slide valves shall not be used.

(1) For circular opening screens, the diameter of the opening shall not exceed three-eighths of an inch.

(2) For square opening screens, the side dimensions of the opening shall not exceed three-eighths of an inch.

(3) For rectangular opening screens, the dimensions of the opening shall not exceed five-sixteenths by seven-sixteenths of an inch.

(4) Where difficulty is encountered in maintaining flow of TNT through screen openings mentioned above, air-operated vibrating devices may be installed on feathering chutes.

20-3. Inspection of High Explosives. In addition to being screened, bulk explosives in granular or flake form shall be visually inspected to detect extraneous material. Explosive material in the form of large pellets or slabs need not be screened but it shall be visually inspected and passed over a magnetic separator between box opening and charging of the melting equipment to assure removal of foreign material.

20-4. Explosives Melting. a. Temperatures used for melting explosives and keeping explosives molten shall not exceed 228 degrees Fahrenheit (109 degrees Celsius) which corresponds to 5 psi saturated steam, except in the following cases:

(1) Saturated steam pressures up to 15 psi (250 degrees Fahrenheit, 121 degrees Celsius) may be used to melt Composition B and similar binary explosives and maintain them in a molten state, if required by the established process.

(2) Steam at pressures not in excess of 10 psi (240 degrees Fahrenheit) may be used for TNT core melting equipment.

b. Water legs shall be installed in steam lines, where pressure does not exceed 5 psi to prevent a build-up in pressure. Where steam line pressures exceed 5 psi, a counterbalance, sealed to prevent tampering, or a rupture disc should be used in addition to installed pressure relief valves if water legs are impracticable. The overall height of the water leg should be 2.3 feet for each pound of steam pressure.

c. Steam heated fingers may be used in melt-mix kettles handling tritonol and Composition B and are preferred for TNT handling to prevent build-up of solidified explosives. Stationary steam fingers must be fastened to the kettle frame in a positive manner (welding is preferred) and cracks and crevices must be eliminated. The fixed part of the lid should be jacketed for tritonol operations. Steam heated splash guards should be installed where needed in to prevent build-up of explosives. Steam heated "fingers" shall not be used in kettles used for remelting risers or other forms of explosives which are of such size that the explosives would be subjected to a crushing or pinching action between the stationary steam "fingers" and the agitator of the kettle.

20-5. Screens for Molten High Explosives. a. At least two screens shall be interposed between the melt unit grids and the melt-mix kettles for the handling of any explosives. One of these should extend the full width of the melt unit reservoir and be of wire mesh with maximum openings of by ¨ inch. For TNT and similar explosives, the second screen should be an effective conical screen over the

opening into the melt unit draw-off pipe. The bucket type screen shall be of a strong non-sparking material such as brass with holes 3/32 inch diameter on 1/8 inch centers, and shall be free from burrs. The ledge in the draw-off pipe upon which the bucket screen rests shall be sloped to allow drainage of explosives. The screen shall be securely fastened in place and shall not be removed for cleaning while melt unit reservoirs contain molten explosives. Screens shall be examined frequently and replaced promptly as needed. Spare screens shall be available to allow ready replacement. Melt units shall not be operated without the screens described.

b. A heavy wire screen or a metal grid must be installed at the outlet of the melt-mix kettle. A grid with openings one by three inches is satisfactory. The grid must be welded or brazed in place or so designed that it will not become dislodged during agitation or when extraneous matter is removed from it. A steam jacket is not recommended for the screen or grid frame in the case of tritonol because of the possibility of water leakage. The melt-mix kettles shall not be operated without the screen described and spare screens or grids shall be kept handy for immediate replacement when necessary. When wooden or other non-sparking rods are used to dislodge lumps from the grids, the force used shall be strictly limited so that the deformation of grids will not result. Grids or screens shall not be removed from melt-mix kettles for any reason until the bulk of the explosives material is first removed from the screens and equipment.

20-6. Valves for Molten Explosives. a. Melt unit valves should be of the plug type made form neoprene or equivalent; steam-jacketed Saunders, or Hills-McCanna rubber diaphragm-type valves may be used. Plug valves should be designed to provide line contact, rather than surface contact, with the valve seat. Springs shall not be used on valves. Sash cord or nonferrous chain should be used on valve controls to prevent application of undue force when closing the valve. The length of travel of the plug should be limited to inch.

b. Valves used in melt-mix kettle draw-off pipes and in all other lines carrying slurry and/or molten explosives should be of rubber diaphragm (Saunders, Hill-McCanna or equal) or rubber tube (nut cracker) types. Teflon-type valves also are acceptable, except with aluminized explosives. The weir and compressor spider in diaphragm valves should be machined smooth or surfaces effecting closure of the valve. To assure complete closure while preventing metal contact between the diaphragm stud and the weir, the valve stem should be adjusted so that the compressor spider is separated from the weir by two-thirds the thickness of the diaphragm when the valve is in the closed position. The weir side of the valve should be steam-jacketed. It is essential to assure that diaphragm-type valves do not have cracked diaphragms, permitting metal-to-metal contact. It is

recommended that valves be procured or modified to provide an open bonnet, permitting visual inspection. Weep holes of a minimum one-fourth inch diameter will be provided in closed bonnet designs, with the weep hole positioned to drain by gravity, giving evidence of leaking diaphragm.

c. Modified open bonnet diaphragm valves which permit inspection of the diaphragm, diaphragm seating arrangement and threaded area of the valve stem may be used in melt-mix kettle drain-off pipes and in other lines carrying slurry and/or molten explosives with the following inspection requirements:

(1) Manual valves opened or closed one or more times per shift - disassemble and inspect quarterly.

(2) Manual valves opened or closed once per month - disassemble and inspect semiannually.

(3) Manual valves opened or closed less frequently than once per month - disassemble and inspect annually.

(4) Automatic valves - disassemble and inspect quarterly.

d. All modified valves shall be usually inspected at least once a week. All wrinkled, cracked, or malfunctioning diaphragms shall be replaced immediately and such actions should be recorded and filed.

20-7. Draw-off Pipes. a. The melt unit draw-off pipe must be steam or hot water jacketed. It should be attached to the melt unit reservoir in such a manner that no threads on the fastening screw or bolts are exposed either outside or between the flanges. A sealing compound should be used to prevent TNT seepage or vapor condensation on contracting surfaces of the bolts, flanges, screws, and nuts. A copper-covered fiber gasket or equivalent high temperature gasket should be used in joints of pipes carrying molten explosives.

b. Melt-mix kettle draw-off pipes should be electrically connected to bombs or shells during draw-off operations. Each bomb or shell should be individually grounded unless tests show that grounding through mutual contact surfaces is adequate in spite of intervening paint films.

20-8. Melt-Mix Exhausting System. a. A wet-type collector, effective in removing dust and vapors from the exhausted air, is recommended. The explosives in the collector must be maintained wet. Tritonol accumulations must be kept submerged. The equipment must

function so that any flammable gas generated is promptly removed from the equipment and building. Water in the wet collector should not be recirculated unless the system removes hazardous suspensions. If explosives are retained in the water, it should be discharged to a sump constructed to maintain retained explosives wet. Fan blades within exhaust ducts should be of nonferrous material and should be adequately sprayed with water when in operation. A drain should be provided in the fan scroll. Provision must be made for frequent inspection and cleaning out of explosives accumulations in the exhaust and collecting equipment. Where the propagation of a detonation between melt kettles is prevented by distance separation or protective construction, each kettle shall be equipped with a complete dust and vapor collection system so that no part of system services more than one kettle. Where prevention of propagation between kettles is not furnished, multiple melt kettles in a single building may be connected to a single wet collector. However, multiple exhaust ducts may not be manifolded to exhaust headers upstream from the collection chamber and the deluge system protecting all the kettles must be connected so that if one actuates water will flow into all the kettles.

b. To reduce dust to a minimum, the equipment used for charging solid material into a melt-mix kettle should be constructed so that the solids will be incorporated as they are added into the molten explosives. Melt-mix kettle covers should be designed high enough to minimize the amount of finely divided solid exhausted. This is particularly important when aluminum is being added.

20-9. Agitators. Motor-driven, metal-mix kettle agitators should be provided with overload relays having a rating not greater than 15 hp. Shear pins are not recommended. The speed of agitators shall be limited to prevent spilling explosives outside the kettle.

20-10. Pour and Probe Machines. All multiple pour and probe machines shall be equipped with an effective vapor-venting system arranged to draw vapors away from the moving parts of the machines and to protect health of personnel. Care should be taken to prevent the creation of "cold air" areas adjacent to these machines as a result of excessive air intake to the venting system. Sublimed explosives shall be prevented from collecting on the machines or overhead structures. The quick-acting valves on multiple pour machines shall be designed to prevent appreciable impact on molten explosives when the valves are closing.

20-11. Hoppers. In locations where aluminum, tritonol, or other hazardous dusts may be on the floor or in the air, the legs of skids,

hoppers, and similar equipment should be covered with nonsparking material where they may contact the floor or other objects capable of striking a spark from them. The section of floor where ferrous metal drums of aluminum powder are handled should have a spark-resisting surface.

20-12. Inert Sealing. Inert wax sealing or other inert operations requiring more personnel than the minimum needed to conduct explosives melt-pour operations efficiently, should be removed to a room or cubicle not containing explosives where practicable.

20-13. Forming Tools. Booster cavity forming tools should be maintained in a polished condition and shall be handled carefully to prevent marring of surfaces. For removing forming tools, implements which exert thrust in the direction of the longitudinal axis of the item involved are recommended rather than those affording a sideward motion. The forming tool should be rotated on its own axis prior to removal.

20-14. Pressing Explosives. a. Each pelleting operation involving black powder, tetryl, TNT, pyrotechnic mixtures, and other explosives of similar sensitivity and operations involving pressing or reconsolidating of explosives in medium and major caliber rounds shall be conducted in a separate room or cubicle having walls of sufficient strength to withstand an explosion of the total quantity of explosives at the operation. Operators must be protected by the room or cubicle walls during such operations.

b. Pressing or reconsolidating of explosives in small caliber rounds, tracer bodies, tetryl lead-ins, detonators, and in similar items shall be performed on machines having consolidated stations designed to eliminate propagation between stations and provide adequate operator protection. Operators must be behind protective barriers when such operations are conducted.

c. Punches and dies must be in matched sets which have been inspected and approved for use by the control laboratory or the unit. Sets of tools as approved for use must be matched for acceptable dimensional and finish characteristics, but they need not be the original tools comprising the set. All punches and dies used in explosives pressing operations must be subjected to a rigid test such as a magnaflux or X-ray prior to use and at regular intervals after such tools have been used in pressing operations.

d. Replacement of punches and dies in a pelleting press must be by matched sets known to have ben checked and calibrated by the

control laboratory. Replacement of single components by the operating staff to complete a set of punches and dies is prohibited.

e. Tetryl, TNT, and RDX pelleting presses should be cleaned with acetone or acetone dampened rags.

f. Black powder pelleting presses should be cleaned with water-dampened rags.

g. Tracer and incendiary pelleting presses should be cleaned with a petroleum solvent similar to Stanisol, Varsol, or other equivalent.

h. Polishing pastes or other media containing grit or alkali are prohibited.

i. Pelleting machines (Jones loaders) should be provided with an operational shield for the reject side of the receiving tray.

j. Explosive dusts shall be eliminated between pressing or consolidation stations where operators are protected by operational shields at individual machine stations. This is to preclude propagation between machine stations where the operators may be exposed.

20-15. Concurrent Operations in Loading Plants. a. If production schedules make necessary concurrent loading of ammunition of different item designations, or the concurrent loading of different components in the same line simultaneously, the grouping of work shall be so arranged that mutual exposure of items presenting dissimilar hazards is avoided. The following separation by groups is preferred, if concurrent loading is necessary so that exposure of items of one group to items of other groups is avoided:

(1) Rockets, long-range.

(2) Artillery primers and delays.

(3) Detonators and relays.

(4) Fuzes.

(5) Boosters.

(6) Projectiles, separate loading.

(7) Propelling charges, separate loading.

(8) Complete rounds and mortar ammunition.

(9) Bombs.

(10) Spotting, saluting, and practice charges.

(11) Pyrotechnics.

(12) Chemical ammunition and chemical agents. Ammunition in the different groups shown above. (Different groups should be separated from each other and different chemical agents must be separated from each other.)

(13) Small arms ammunition.

(14) Rockets, short-range, and rifle grenades.

(15) Hand grenades.

(16) Mines. (Classes (08)1.2 and (12)1.2 mines should be separated from Class 1.1 mines.)

(17) Selected ammunition.

b. When more than one explosive material is handled on a line or within a building or room, mutual contamination must be avoided. Particular attention should be given to both portable and stationary vacuum systems in this respect. This also applies to explosives scrap collection. Inadvertent mixing of explosive material can be hazardous not only to loading plant facilities and personnel, but also to the user if such material is loaded into ammunition.

c. When an item of ammunition is designed to contain more than one explosive material, the appropriate rules regarding inadvertent contamination will apply.

d. When two or more explosives are used in a line or within a building, and mixing is not intended, it is recommended that they be placed at separate locations. It is also recommended that where differentiation of the explosives cannot be made readily by color or crystalline form, the boxes be plainly marked to identify contents.

e. Some explosives operations are inherently more hazardous than others. The personnel exposure in locations where concurrent operations must be performed should be controlled by installation of dividing walls so that the number exposed is not greater than if a single type of ammunition were worked on.

f. Those operations requiring the presence of a relatively large quantity of explosives material, and usually carried on with small personnel exposure, should not be performed on the same line with operations requiring a large number of people and perhaps a relatively small amount of explosives material.

g. Care should be exercised to properly segregate material in service magazines as well as in operating buildings.

h. If concurrent loading is done, undue congestion should be avoided by rearrangement of working areas.

i. When loading of a new item of ammunition is contemplated, on a given line or in a building, the current job should be completed and the excess material removed promptly so that the hazards of mixed materials will be eliminated.

20-16. Evacuation of Buildings (See paragraph 16-13). a. Evacuation plans shall be developed and coordinated with storm prediction systems. When an electrical storm is anticipated a first warning should be given whereupon the quantity of explosives in process should be reduced to a minimum until danger of the storm has passed.

b. If a melt-pour building is equipped with an effective lightning protection system, melt loading may continue after the second warning (indicating the storm is imminent) until all molten explosives in the building can be run into the item or receptacle involved. All persons not required for these operations shall be evacuated to a safe place. As soon as equipment is drained, all remaining personnel shall be evacuated.

c. In operating lines or buildings where serious explosive incidents are possible, suitable means for warning personnel to evacuate the building, line, or area should be installed. A visual or audible warning system or combination of both is considered satisfactory. The warning alarm system should be interlocked or connected to the deluge system in a manner that actuation of the deluge system will also actuate the alarm system.

20-17. Explosives Washout and Flaking Facilities. a. Explosives washout operations are considered line operations and therefore are subject to quantity distance separation. Where washout operations are to be placed in operating buildings, they must be placed in separate bays or cubicles or be separated from other operations in the building by suitable operational shields.

b. Ammunition items subjected to washout operations must be certified as being free of explosives after washout. When examination

or tests reveal the presence of explosives contamination of ammunition items after washout, they will be decontaminated by an approved method prior to disposition. Decontamination of ammunition items by flashing will be performed at the explosives destruction (burning) area or in approved destruction incinerators.

20-18. Rebowling Operations. Rebowling operations involving lead azide and primer mixes shall be performed by remote control, with the operator protected by operational shields.

20-19. Thread Cleaning. Projectile loading techniques should preclude the deposition of explosives in threaded openings in the projectiles. See DA PAM 385-64 for additional information on thread cleaning.

CHAPTER 21

COLLECTION AND DESTRUCTION EXPLOSIVES, AMMUNITION, AND CHEMICAL AGENTS AND MUNITIONS

21-1. Compliance with Environmental Laws and Regulations. Notwithstanding any other provision of this chapter, compliance with applicable Federal, State, and local environmental laws, regulations, and permits is mandatory. Review of all SOPs for explosives and ammunition operations by the installation or supporting activity Environmental Coordinator is mandatory.

21-2. Collection of Contaminated Industrial Wastes. Industrial wastes which may contain explosive materials and chemical agents shall be collected only in holding, storage, or disposal facilities specifically designed and permitted (i.e., having environmental operating permits) for that purpose. Disposal into sanitary sewers, septic tanks, sanitary filter tanks and unlined sumps, settling basins, or leaching pits is prohibited except as specifically authorized by permit. Sumps should be desensitized and cleaned at regular intervals. Cracks and crevices may contain explosives residue. Such residue must not be subjected to impact or friction from such sources as high pressure water streams, scraping tools or devices, etc., which may initiate the sensitive explosives. Quantities of initiating explosives in excess of 28 grams shall be destroyed by burning or detonation (see para 21-14). Explosive materials to be removed from a settling basin should be maintained wet until removed. The more sensitive explosives should be maintained wet until destroyed. Materials containing powdered metals should be kept under water to prevent any dangerous rise in temperature which might otherwise be developed in the reaction between the metals and a small quantity of water. Requirements applicable to destruction of chemical agents and munitions are contained in DA PAM 385-61 and chapter 10 of this regulation.

21-3. Deposition from Waste Liquids. When sumps or basins are properly designed, the wash water which passes beyond filters and basins should be free from significant amounts of explosive materials. If the effluent is discharged into a public stream, river, etc., it must not contain more explosives than permitted by Federal, State, and local state regulations. Consideration should be given to the possibility of deposition of explosive materials on the banks of streams or marshes during periods of drought, as well as to any possible subsequent precipitation of explosives with change of temperature, acidity or concentration of the waste water. Where uncertainty exists regarding the composition of waste waters, competent technical advice and assistance should be obtained.

21-4. Handling Water-Soluble Materials. Where ammonium picrate (Explosive D), black powder or other materials which are appreciably soluble in water are handled, the amount of dissolved material should be kept as low as practicable. Floors should be swept before washing down to reduce the quantity of dissolved material in the wash water.

21-5. Destruction of Collected Solid Wastes. Contaminated solid waste material should be taken in closed containers, as soon as practicable, to buildings set apart for its treatment or to the burning ground to be destroyed in an appropriate manner. Collected explosive and chemical wastes must not be disposed of by being buried, or thrown in any streams or tidewater unless they are decomposed by water. Disposal of decomposed wastes in streams or tidewater will be allowed only if permitted by Federal, State, and local laws and regulations.

21-6. Requirements for Destruction of Explosives Materials. a. General. Explosives and ammunition which are dangerously deteriorated or cannot be definitely identified shall be destroyed by an approved method. Burying explosives or ammunition or dumping them into waste places, pits, wells, marshes, shallow streams or inland waterways is prohibited. Destruction shall not be undertaken without prior approval of the installation's major subordinate command (headquarters) safety office chief unless the local commander decides that immediate destruction of deteriorated explosives or ammunition is necessary for the protection of life and property. When destruction is authorized, the provisions of all current Army directives involving lost, destroyed, damaged, or unserviceable property must be observed. Prior approval for destruction of routine waste is not required.

b. Chemical destruction of explosives. The chemical destruction of loose explosives or ammunition except as provided below shall not be permitted unless approval is given by the Commander, AMC. Chemical methods must be supervised by qualified personnel having knowledge of chemistry. Chemical methods shall not be used in an attempt to destroy explosives which are enclosed or pressed into components such as detonators. Explosives generated as waste by production processes in quantities of less than 1 pound may be chemically destroyed provided adequate facilities and procedures exist for safe destruction. The following procedures may be used under adequate supervision for 28 grams or less of the explosives named.

(1) Mercury fulminate. Place a quantity of aqueous sodium thiosulfate (hypo) solution (20 percent by weight of sodium thiosulfate) equal to 10 times the weight of mercury fulminate to be destroyed in a wood or earthenware container. While agitating the hypo solution, add water-wet mercury fulminate. The mixture

shall be agitated by air or mechanical means but not by hand. Agitation must be continued until all fulminate has been dissolved, usually within 2 hours. Operators shall keep to the windward of the container or wear appropriate respiratory protection to avoid inhaling any cyanogen gas evolved.

(2) Nitroglycerin. Small quantities of nitroglycerin may be neutralized or destroyed with a mixture of the following solutions:

Solution A. Sodium sulfide (pulverized) -- 9 parts by weight and water -- 30 parts by weight.

Solution B. Denatured ethyl alcohol -- 70 parts by weight and acetone-- 20 parts by weight. Do not combine the two solutions until immediately before use since potency of the mixed solutions diminishes on storage. This mixture should be only for very small quantities of nitroglycerin (e.g., the oily film that adheres to surfaces after the nitroglycerin has been removed with sponges or absorbed in wood pulp or sawdust). Operators using this solution should wear rubber gloves.

(3) Black powder. Black powder may be completely destroyed by leaching or washing with large quantities of water and disposing of the washings separately from the residue.

(4) Lead azide.

(a) Lead azide accumulated on surfaces should be taken up with water wet cloths. The cloths should then be washed out in one of the solutions named below after which the complete desensitizing treatment is carried out in the solution. The cloths should be thoroughly washed with water before reuse. Empty shipping bags while still water-wet should be turned inside out and treated. Approved chemical methods for destroying lead azide include those described below.

(b) Sodium nitrate-acetic acid method. For destruction of a quantity of 1 ounce of lead azide, the ounce of lead azide should be placed in one-half gallon of a 10 percent solution of ammonium acetate to which is added a solution of 2´ ounces of sodium nitrate in 1 pint of water. The mixture is stirred and while stirring, 7 ounces of glacial acetic acid or its equivalent of weaker acid is added. The entire solution should be allowed to stand in a warm place for 1 hour more before disposal.

(c) Another method is to use sodium nitrate and nitric acid. The lead azide should be destroyed in small quantities at a time by successive treatment with a 25 percent solution of sodium

nitrite and a 36 percent solution of nitric acid. Place water, then lead azide to be destroyed in a ceramic crock or other suitable container of ample size (at least 500 cc of pure water per gram of azide). Add sodium-nitrate solution and agitate carefully but thoroughly; and add the nitric acid solution slowly with continual agitation. Heat is generated during the decomposition so all additions must be made slowly. Decomposition is rapid and complete if sufficient quantities of the killing solution are employed. The resultant solution is clear. Ferric chloride solution is used to test for incomplete decomposition of the azide. A red color appears if azide is still present. Toxic fumes may be evolved during the killing reaction.

(d) The third method is to dissolve lead azide in 10 percent ammonium acetate solution, from which the lead is precipitated with 10 percent aqueous potassium bichromate. This is followed by a thorough washing with water. However, this procedure may leave a sludge containing sensitive explosive material and appropriate precautions must be taken. All wash cloths or brushes used to apply ammonium acetate solution should be treated with a sodium bichromate solution.

(e) A fourth method (preferred) is to use a 20-25 percent aqueous solution of ceric ammonium nitrate for the chemical destruction of lead azide. When small quantities of lead azide are destroyed in this manner the reaction is not violent. Since one of the products of the reaction is a gas, the ending of the gas evolution indicates completion of destruction. This method offers the following advantages over preceding ones:

1. Safer to use because the chemical reaction is less violent than those involving acid.

2. Residue formed is more readily disposed of than lead chromate.

3. Evolved gas acts as indicator to assure completion of the reaction.

21-7. Decontamination and Dismantling Explosives Establishments. A permanent report of the type and quantities of ammunition and explosives handled in a facility shall be maintained for use when decontamination, disposal, or layaway is undertaken. The decontamination and dismantling procedures to be followed for explosives establishments upon cessation of activity or upon conversion to other uses shall be outlined in detail. (Ref: TB 700-4.)

21-8. Destruction Sites. a. When trials required by paragraph b below prove that fragments and debris are limited to lesser ranges the appropriate inhabited building distances may be used. Sites must also be located in relation to the direction of prevailing winds, so that sparks will not be blown toward explosives location. Where possible, natural barricades shall be used between the site and operating buildings or magazines. When destroying explosives by burning, the possibility that the mass may detonate must be recognized and appropriate protective barriers or distance separation should be used for the protection of personnel and property. Open air burning and detonation of munitions, explosives, and pyrotechnics for purposes of demilitarization between sunset and dawn is prohibited.

b. In all disposal and destruction activities, the number of units or quantity of explosives that may be destroyed safely at one time shall be determined carefully by starting with a limited number of quantity and then gradually increasing that quantity until the optimum amount consistent with safe and efficient operations is determined.

c. Dry grass, leaves, and other extraneous combustible material in amounts sufficient to spread fire shall be removed within a radius of 200 feet from the point of destruction. The grounds should be of well packed earth and shall be free from large stones and deep cracks in which explosives might lodge. Explosive materials shall not be burned or detonated on concrete mats.

d. Fire-fighting facilities shall be readily available to extinguish brush or grass fires and, if necessary, to wet down the ground between burnings and at the close of each day's operation.

e. Ordinary combustible rubbish shall be destroyed at a location removed from places where explosives and explosives contaminated material are destroyed. Where limited space does not permit separate burning areas, a part of the explosives destruction ground may be reserved for burning rubbish provided the two areas are not operated simultaneously, and the area where rubbish has been burned is wetted down and inspected before explosives burning is resumed. Combustible material should be burned in an incinerator complying with National Fire Protection Association Standard No. 82 or in a substantial wire-mesh enclosure (not over inch openings).

f. The demolition area or burning ground shall be serviced with telephones or two-way radio communication. A change house serviced with electricity is desirable.

21-9. Explosives Material Awaiting Destruction. Explosives material awaiting destruction shall be stored at not less than intraline distance, based on the largest quantity involved, from the explosives being destroyed. The material shall be protected against accidental ignition or explosion from fragments, grass fires, burning embers, or detonating impulse originating in the materials being destroyed.

21-10. Personnel Protection. a. Adequate protect for personnel shall be provided in the form of operational shields with overhead and frontal protection as a minimum. Where circumstances warrant their use, complete personnel protection shall be provided. Such structures should preferably be located at the appropriate inhabited building distance for the quantity and type of materials being detonated but in no case will this distance be less than 300 feet. Employees must use such protection when explosive materials are destroyed by detonation or when explosive materials which may detonate are being burned. When class 1.3 material is being destroyed by burning, personnel must remain at the greatest practicable distance from the burning site but in no case shall personnel be permitted closer than the applicable public traffic route distances.

b. During disposal and destruction operations, the number of people in the area exposed to the hazard must be kept to a minimum. Warning signs or road blocks shall be posted to restrict the area and to ensure proper segregation of activities. The number of personnel engaged in the disposal and destruction operations shall be no fewer than two and operations shall be arranged so that not all of the personnel are exposed to an incident. Personnel engaged in burning explosives should be provided with flame resistant type clothing.

21-11. Supervision and Training. a. The disposal area and its operations shall be under the direct control and supervision of an experienced and trained individual charged with supervisory responsibility for the activities within the area. He shall be present during all burning and demolition ground operations. He shall also be charged personally with the sole custody of all ignition devices. Prior to actual burning or detonation of explosives, all personnel including the demolition ground supervisor will be evacuated to a safe distance or protective structure affording adequate protection but consistent with the need to monitor the total operation until it is complete.

b. Personnel employed at the destruction area shall be thoroughly trained regarding the nature of the materials handled, the hazards involved, and the precautions necessary. The danger of using unapproved improvised methods and other deviations must be thoroughly instilled in the minds of the employees. It is essential that thorough training and vigilant supervision be provided. All burning

and demolition grounds operations must be carried out in strict conformance with approved SOPs.

c. In the absence of specific regulations covering any phase of the destruction of explosives material, complete information will be forwarded through command channels to the Commander, AMC, ATTN: AMCSF, requesting instructions and guidance.

21-12. Containers for Waste Explosives. Explosives destined for the burning ground shall be in original closed packages or in containers of fire-retardant materials which will not contribute to the existing hazard by readily producing sparks when contacting rocks, steel, or other containers. Bags or containers made from easily ignited material shall not be used. Containers shall have closures that will prevent spilling or leakage of contents when handled or if overturned. Closures shall be of a type that will not pinch or rub explosives during closing and opening. The closures and surfaces of containers openings shall be thoroughly cleaned of explosive contamination to minimize the hazard during closing or opening.

21-13. Servicing of Destruction Site. a. Trucks transporting explosive material to burning or demolition grounds shall meet the requirements of chapter 17. No more than two persons shall ride in the cab.

b. Upon arriving at a burning or demolition ground, vehicle(s) may distribute the explosives containers or explosives items to be destroyed at the sites where actual destruction is to take place. As soon as all explosives items have been removed from the vehicle(s), the vehicle(s) shall be withdrawn from the burning or demolition area to a safe location until destruction is completed. Containers of explosives shall not be opened until the vehicle(s) have been withdrawn.

c. Containers of explosives or ammunition items to be destroyed at the destruction site shall be spotted and opened at least 10 feet from each other and from explosives material previously laid for destruction to prevent rapid transmission of fire in event of premature ignition. Containers of propellant awaiting destruction will be spotted and opened a safe distance from the burning pans (beds) and limited in quantity to no more than the rated capacity of the pan or bed.

d. Empty containers shall be closed and moved a sufficient distance away to prevent charring or damage during burning of the explosives. Empty containers may be picked up by truck on the return trip after delivery of the next quantity to be destroyed.

e. When materials being processed at destruction sites are to be handled by gasoline or diesel-powered forklift truck, the requirements of paragraph 18-2 will be observed. All such material handled will be properly packaged and must not be contaminated with explosives. All powered equipment used at destruction sites will be withdrawn to a safe location prior to opening containers of explosives.

21-14. General Burning Requirements. a. Burning trays shall be used for all open burning of ammunition, explosives, and PEP contaminated waste operations except in emergency situations approved by the installation commander.

b. Except in specific cases, such as Explosive D loaded projectiles, ammunition and explosives shall not be burned in containers.

c. Bulk initiating explosives and other used predominantly in detonators and photoflash compositions shall be destroyed by detonation except that small quantities (not exceeding 28 grams) may be decomposed chemically.

d. When burning trays are used, the following must be complied with:

(1) When burning loose explosives other than initiating explosives, depth of explosives in tray will be 3 inches or less.

(2) Burning tray ignition train will be arranged and lit so both it and the explosives burn in the direction from which the wind is blowing.

(3) Installations must establish written procedures to prevent auto-ignition of materials to be burned from heat or residue remaining in pans/trays or on pads.

(4) Burning tray (bed) limits, and separation distance requirements shall be established on the basis of hazard analysis and confirmed by test for each explosives material to be destroyed. In the absence of analysis and test, trays (beds) must be parallel to each other and separated by 150 feet, and limited to 1,000 pounds NEW.

(5) When burning wet explosives, the tray should be lined with nonexplosive combustible material upon which the explosives are placed to ensure complete burning of the explosive material. It is usually necessary to burn Cyclonite (RDX) wet to prevent detonation.

(6) Burning trays should be designed without cracks or angular corners to help prevent build-up of residue.

(7) Open burning/detonation shall comply with applicable Federal, State, and local air pollution regulations and permits (see AR 200-1).

e. Pyrotechnic materials collected may be burned, except as noted below, by emptying the containers or buckets containing the oil and pyrotechnic mixture into a shallow metal pan and igniting as described above. The opened containers may be burned with the explosives.

f. Some types of explosives and tracer or igniter composition give off toxic fumes when being destroyed by burning. Proper respiratory protective equipment shall be worn where such fumes are likely to be encountered.

21-15. Materials for Detonating Ammunition. a. Detonation of explosives or ammunition should, where practicable, be initiated by electric blasting caps using blasting machines or permanently installed electric circuits energized by storage batteries or conventional power line. Improvised methods for exploding electric blasting caps shall not be used. When items to be detonated are covered with earth, as specified in paragraph 21-16, blasting caps shall not be buried beneath the ground level with the initiating charge. The initiating explosives should be primed with detonating cord of sufficient length to reach up through the covering to a point where the blasting cap may be connected above the ground level. The advantages and disadvantages of double priming should be considered during hazard analysis and SOP development.

b. Special requirements for using electric blasting caps and electric blasting circuits.

(1) Electric blasting caps, other electric initiators, electric blasting circuits, and the like may be energized to dangerous levels of extraneous electricity of types and sources such as: static electricity, galvanic action, induced electric currents, high tension wires, and radio frequency energy from radio, radar, and television transmitters. Safety precautions shall be taken to reduce the probability of a premature initiation of electric blasting caps and explosives charges of which they form a part.

(2) The shunt shall not be removed from the lead wires of the blasting cap until the moment of connecting them to the blasting circuit, except during electrical continuity testing of the blasting cap and lead wires. The individual who removed the shunt should ground his/her self by grasping the firing wire prior to performing the operation in order to prevent accumulated static electricity from firing the blasting cap. Note: After

electrical continuity testing of the blasting cap the lead wires must be short-circuited by twisting the bare ends of the wires together immediately after testing. The wires shall remain short circuited until the time to connect them to the blasting circuit. The Blaster's Galvanometer or Blaster's Multimeter may be used for continuity testing of blasting caps and lead wires.

(3) When uncoiling the lead wires of blasting caps, the explosives end of the cap should not be held directly in the hand. The lead wires should be straightened out as far as necessary by hand and shall not be thrown, waved through the air, or snapped as a whip to unloosen the wire coils. Avoid loops by running lead wires parallel to each other and close together. If loops are unavoidable, keep them small. Keep wires on the ground in blasting layouts.

(4) Firing wires shall be twisted pairs. Blasting circuit firing wires shall at all times be twisted together and connected to ground at the power source and the ends of the circuit wires where blasting cap wires are connected except when actually firing the charge or testing circuit continuity. The connection between blasting caps and the circuit firing wires must not be made unless the power end of the circuit lead (firing wires) are shorted and grounded. The following methods should be followed when connecting electric type blasting cap lead wires to the firing circuit wires:

(a) Check wires leading to the blasting machine for continuity and stray currents.

(b) Test electric blasting cap wires for electrical continuity, and after the test, connect to wires leading to the blasting machines.

(c) Evacuate all but two personnel from the area. Place cap into charge to be detonated. After cap(s) are placed into the charge the two personnel will evacuate to the personnel shelter.

(d) Un-short firing lead wire circuit and check for continuity.

(e) Connect firing lead wire to blasting machine and fire charges.

(f) After firing remove lead wires from blasting machine and twist the end to short them.

(5) Electric blasting or demolition operations and unshielded electric blasting caps should be separated from radio frequency energy transmitters by the minimum distances specified for electroexplosive devices in Chapter 6 of DA PAM 385-64. These distances apply to all parts of the operation, including the lead wires of the cap and the firing wires circuit. Before connecting electric blasting caps to the firing wires, the blasting circuit must be tested for the presence of extraneous electricity by the following test:

(a) Arrange a dummy test circuit, essentially the same as the actual blasting circuit except that a No. 47 radio pilot lamp (or equivalent device) of known good quality inserted in place of the blasting cap shall be used without applying electric current to the circuit. Any glow is evidence of the presence of possible dangerous amounts of RF energy, and blasting operations in such areas must be performed with nonelectric blasting caps and safety fuse.

(b) The Blaster's Multimeter may be substituted for the No. 47 radio pilot lamp when testing for extraneous electricity, but will not detect RF energy. Distances prescribed for electro-explosive devices in chapter 6 of DA PAM 385-64 be used as a guide in the selection of sites for electric blasting operation in the vicinity of RF energy transmitters.

(6) Blasting or demolition operations shall not be conducted during an electrical storm or when a storm is approaching. All operations shall be suspended, cap wires and lead wires shall be short-circuited and all personnel must be removed from the demolition area to a safe location (IHBD) when an electrical storm approaches.

(7) Prior to making connections to the blasting machine, the firing circuit shall be tested with a galvanometer or Blaster's Multimeter for electrical continuity. The individual assigned to make the connections shall not complete the circuit at the blasting machine or at the panel, nor shall he give the signal for detonation until he is satisfied that all persons in the vicinity are in a safe place. When used, the blasting machine or its actuating device shall be in this individual's possession at all times. When the individual uses a panel, the switch must be locked in the open position until ready to fire and the single key or plug must be in his possession.

(8) Electric blasting caps must be in closed metal boxes when being transported by vehicles equipped with two-way radios and also when in area where extraneous electricity is known to be present or is suspected of being present.

c. Although electrical blasting caps are the preferred method of initiation, safety fuses may be used in the detonation of explosives and ammunition when enhanced safety and efficiency will result.

Safety fuse, when used, must be tested for burning rate at the beginning of each day's operation and whenever a new coil is used. Sufficient length of fuse shall be used to allow personnel to retire to a safe distance, but under no circumstances will the length be less than 3 feet or have less than a 120 second burning time. Crimping of the fuse to blasting caps must be accomplished with approved crimpers. Safety fuse which is too large in diameter to enter the blasting cap without forcing shall not be used. Before igniting the safety fuse, all personnel, except the supervisor and one assistant, shall retire to the personnel shelter or be evacuated from the demolition area.

d. When using blasting caps involving the electric or nonelectric system of destruction, the explosives end of the blasting cap shall always be pointed away from the body.

21-16. Detonation of Ammunition. a. Ammunition or explosives to be destroyed by detonation should be detonated in a pit not less than 4 feet deep and covered with not less than 2 feet of earth. The components should be placed on their sides or in the position to expose the largest area to the influence of the initiating explosives with an adequate number of demolition blocks placed in intimate contact on top of the item to be detonated and held in place by earth packed over the demolition blocks. Where space permits, and the demolition area is remotely located from inhabited buildings, boundaries, work areas, and storage areas, detonation of shells and explosives may be accomplished without the aid of a pit. In either event, however, the total quantity to be destroyed at one time, dependent on local conditions, should be established by trial methods to assure that adjacent and nearby structures and personnel are safe from the blast effect or missiles resulting from the explosion. This procedure should be used for the destruction of fragmentation grenades, HE projectiles, mines, photoflash munitions, mortar shells, bombs, and HE rocket heads which have been separated from motors. Rocket motors containing solid propellants should not be destroyed by detonation (para 21-25).

b. After each detonation a search shall be made of the surrounding area for unexploded material and items. Items or material such as lumps of explosives or unfuzed ammunition may be picked up and prepared for the next detonation. Fuzed ammunition or items which may have internally damaged components should be detonated in place unless the item can be safely handled by using mechanical retrievers providing protection to personnel.

c. In case of misfires, personnel shall not return to the point of detonation for at least 30 minutes after which not more than two qualified personnel shall be permitted to examine the misfire.

d. AR 95-2 outlines the organization and functions of Regional Airspace Subcommittees and establishes uniform procedures for the handling of airspace problems. AMC installations will request, through channels, airspace clearance for demolition ground activities per these regulations.

21-17. Dynamite. Unopened boxes of exuding dynamite to be destroyed should be burned on a bed of combustible material without being opened. Precautions must be taken to protect personnel and property from possible detonation. Individual cartridges may be burned in a single layer not greater in width than the length of one cartridge, on a bed of combustible material. Dynamite awaiting destruction shall be shielded from the sun. Frozen dynamite is more likely to detonate during burning than normal cartridges. Destruction of dynamite by detonation may be accomplished where the location will permit this method of destruction. Care in priming to assure complete detonation of the quantity must be taken.

21-18. Initiating Explosives. When relatively large quantities of initiating explosives such as lead azide or mercury fulminate are to be destroyed, detonation is the best method. The bags containing the explosives should be kept wet while being transported to the demolition area. A predetermined number of bags should be removed from the containers, carried to the destruction pit, placed in intimate contact with each other, and blasting caps used to initiate the explosives. The remaining explosives shall be kept behind a barricade with overhead protection during the destruction operations and located at a distance that will assure safety.

21-19. RDX and PETN. RDX and PETN may be burned as described in paragraph 21-14.

21-20. Propelling Charges. Propelling charges with igniters may be burned without slitting but in all cases igniter protector caps shall be removed from the charges to be burned. Protection must also be provided against possible projection of the charges and explosion. Propelling charges must not be piled one on the other but shall be burned in a single layer of charges laid side by side. Core igniter type charges in the single layer should be separated one from the other by a distance equal to one caliber.

21-21. Black Powder. Black powder is best disposed of by dissolving out the potassium nitrate in a closed system and disposing of the solid wastes separately. It may also be burned as previously described. Wet black powder on drying out may retain some of its explosive properties since the nitrate may not have been removed completely.

21-22. Parachute Flares. Parachute flares with pressed charges such as the M26 type may be burned. Individual flares should be 4 feet apart and be placed upon a layer of combustible material. When burning flares and similar materials occasional explosions may occur; therefore, adequate protection from such hazards must be provided.

21-23. Small Arms Ammunition and Items with Mixed Hazards. Small arms ammunition and items having two or more explosive hazards, such as spotting charges M1A1, where the black powder charge may be destroyed in burning pits, but the initiating device (primed cartridge) may be intact after being projected from the burning area, shall be destroyed in such a manner that projected units will be restricted in flight and returned automatically (gravity) to the burning pit to eliminate the hazard of manually retrieving unexploded items.

21-24. Burning out Loaded HE Projectiles. a. TNT, Explosive D, Composition B, pentolite, and other explosives filler in open projectiles may be burned out when destruction by detonation or washing out and burning the explosive filler separately is impracticable. The area selected for the operation should be based on the same principles as outlined in paragraph 21-8.

b. Projectiles to be burned out should be placed on their sides and arranged in groups of not more than six projectiles, with all open ends facing in one direction. Opened ends of projectiles should not be pointed into the wind. Each group of six projectiles should be separated from adjacent groups by not less than 12 inches in order to reduce the possibility of mass detonation in the event of incident in any one group. Where it has been determined, by trial, that adequate safety is provided from a detonation of an established quantity of explosives in projectiles, this established quantity may be used as the criterion of consolidation when burning out items. Class 1.3 solid propellant (smokeless powder) may be used for ignition of the projectile filler.

c. Combustible material such as excelsior or scrap lumber should be used to ignite the explosive filler. Oil-soaked waste may also be used; however, it shall not be placed in the interior of the fuze cavities. Use of oil-soaked waste which may be contaminated with polychlorinated biphenyls (PCB) or wood treated with pentachlorophenol (PCP) is prohibited, unless specifically authorized by the Commander, AMC, ATTN: AMCSF.

d. Personnel shall not be permitted to return to the scene of the operation until a competent observer has determined that all explosives have been burned.

e. Burned out projectiles shall be reprocessed to assure that explosives residue does not remain. The projectile shall be thoroughly inspected to assure that all explosives have been destroyed prior to releasing the components for salvage (para 25-6).

21-25. Destruction of Rockets and Solid Propellant Motors. a. Infantry and aircraft type HE and practice rockets shall be destroyed as follows:

(1) Wherever practicable, separate the rocket motor from the HE head and dispose of the head as specified for HE artillery ammunition. If separation of the motor and head is impracticable, short range rockets may be destroyed in pits in the manner prescribed by paragraph 21-23. Sufficient charge must be used to assure destruction, in place, of the motor and head.

(2) Remove the nozzle plate from the rocket motor and take out the igniter and solid propellant charge. The igniter and solid propellant charge shall then be destroyed or salvaged per preceding instructions.

(3) In certain rocket motors the propellant cannot be removed from the motor. In this case, the nozzle shall be removed and the motors placed in a vertical position, firmly held, with the open end up, and the propellant burned. Rocket motors greater than 6 inches in diameter shall be disposed of according to paragraph c below.

(4) Propellant in 3.5 inch (and smaller) practice rockets and rocket motors (without heads) may be destroyed by static firing with the nozzle in place.

b. Wherever practicable, propellant must be removed from rocket motors and destroyed by burning. In the event removal of the propellant is not practicable, the rocket motor should be positioned or restricted to prevent movement and propellant in the units shall be destroyed by static firing. When units are to be destroyed by static firing, complete details of the procedures must be submitted to the Commander, AMC, ATTN: AMCSF for approval.

c. Rocket or missile propellants (solid) may weigh as much as several thousand pounds per grain, and the polymer-oxidizer type may be extremely difficult to ignite at atmospheric pressures. Large size rocket motors for specific systems may be destroyed per instructions contained in TMs or TBs applicable to such systems.

21-26. Existing Land Burial Locations. Known locations of buried ammunition and explosives, including chemical warfare agents/munitions, shall be appropriately marked with permanent-type signs, and measures shall be taken to prohibit unauthorized personnel from entering the area. Existing records identifying the type and quantity of items buried shall be maintained and the burial area shall be noted on installation drawings.

CHAPTER 22

WEAPONS AND AMMUNITION TESTING

22-1. General. a. The requirements of this section apply primarily to AMC establishments whose principal mission is the testing of materiel, including AMC depots who perform function and trace tests of small arms ammunition per SB 742-1, but pertinent requirements are applicable to materiel test activities at any AMC establishment. The development of restricted air space or a controlled firing area shall be obtained per AR 95-2 and applicable Federal Aviation Regulations (FAR). The development of Surface Danger Zones (SDZ) shall be per AR 385-63 and other applicable documents.

b. Hazard analysis (HA) techniques as previously addressed in this regulation and in AMC-R 700-107 shall be utilized to identify and reduce hazards to an acceptable risk. The HA will be utilized in developing SOPs and will be approved by the servicing Safety Office.

22-2. Layout of Explosives Buildings. a. In all future construction, the layout of explosive buildings necessary for materiel or proof testing activities shall be per the principles shown on figure 22-1. In separating one facility from another as shown in figure 22-1, the distance must be based on the quantity and/or class of materiel requiring the greater separation. Distance is not intended to afford protection against premature or weapon failure. Such protection must be obtained from increased distances or appropriately designed firing barricades.

b. Insulated containers or conveyances may be needed to avoid significant temperature changes in the propellants or items during transportation. The containers shall be of noncombustible materials and constructed to provide safe transportation.

c. Cartridge case resizing operations and other operations on inert materials or components may be located at intraline distance from explosives buildings in a line if the inert operations serve only one line. If the inert operations serve more than one line, they shall be located at inhabited building distance from the line building. A line is considered to be the operations incident to one loading and assembly building.

d. Quantities of explosives may be detonated in cubicles of an operating building, provided the cubicle is capable of withstanding and confining the effects of the explosion and

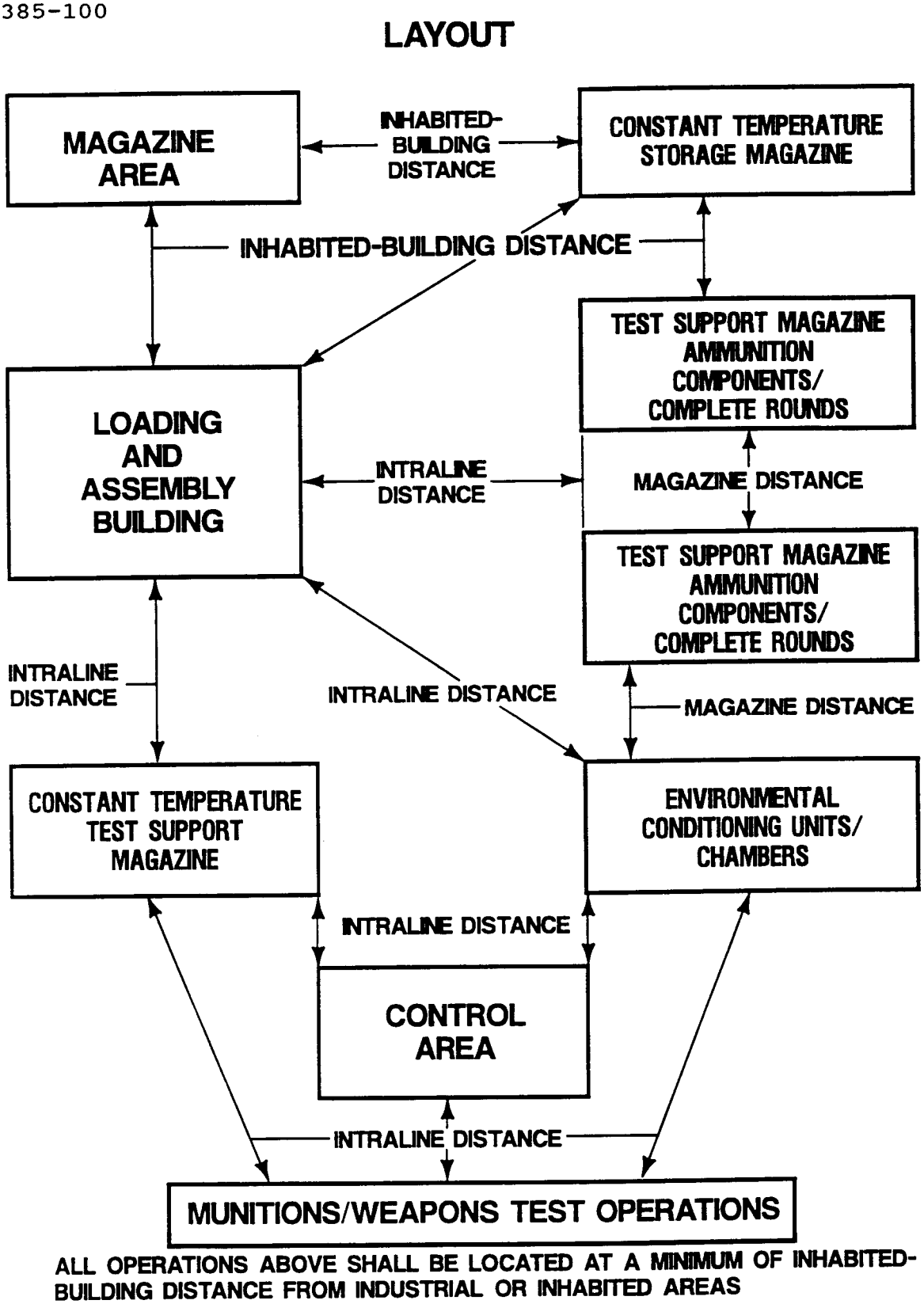


Figure 22-1. Layout - Munitions/weapons test operations.

personnel are properly safeguarded. Certification by qualified engineering personnel shall be made periodically to ensure structural integrity is maintained after repeated detonations.

e. Laboratory supplies of explosives, not to exceed 15 pounds per cubicle, may be stored without regard to the compatibility required by chapter 19, provided walls meet requirements for operational shields; however, the principle of separating high explosives, primary explosives, and chemicals shall be observed.

22-3. Loading and Assembly Building. a. The building or buildings used for the assembly and loading of ammunition shall be designed and constructed per established explosives safety principles. Numbers of personnel and quantities of explosives or ammunition shall be kept at a minimum consistent with safe and efficient operations. Substantial dividing walls shall be used to limit exposures and to separate operations involving dissimilar hazards. Explosives and personnel limits shall be posted for each operation.

b. Long-term storage of assembled rounds or explosive components shall not be permitted within the building. When a test support magazine is necessary, it shall be provided at intraline distance.

22-4. Responsibility for Materiel Test Programs. Test officers shall be responsible for the safe conduct of tests assigned to them. This responsibility includes, but is not restricted to, ensuring adequate protection is provided and used by personnel who may be exposed to hazards associated with test programs, such as high noise levels, blast overpressure, fragmenting missiles, toxic gases, smoke, and flash.

22-5. Preliminary Hazard Analysis. a. Every proposed program for testing shall be examined by the test officer and designated responsible officials for all foreseeable hazards involved in the test; all significant failure modes in equipment and operations shall be analyzed to determine possible hazards. This must be done with a knowledge of the construction and operation of all items (standard and nonstandard) to be used. When a specific hazard can be foreseen, it must be eliminated or reduced to an acceptable risk level before pursuing the objectives of the test. If this is not possible, personnel and equipment must be afforded adequate protection.

b. Inert loaded or minimum charge ammunition instead of HE shall be used in all cases where the substitution will still yield the objectives of the test. For safety and environmental purposes, particular efforts shall be made to use minimum hazard ammunition in these instances:

(1) When protection cannot be provided for assigned personnel firing ground or aircraft guns.

(2) When testing fuzes for fuze action only.

(3) When conducting firing test of fire-control equipment of tanks and combat vehicles.

(4) When testing propelling charges only.

(5) When firing expenditure rounds as part of weapon fatigue or wear test, or when proofing a tube.

(6) When conducting environmental tests of ammunition.

(7) When firing metal parts tests (projectile).

(8) When firing any warmer, conditioning, or spotter projectile.

(9) When conducting launcher characteristic tests on small missile systems.

(10) When testing missile flight characteristics.

22-6. Environmental Conditioning Operations/Testing. The following rules apply where tests are to be conducted on environmentally conditioned and hazardous material:

a. Adequate information shall be furnished by the test officer (prior to scheduling the test) to the servicing Safety Office/Range Control Office to ensure:

(1) SOP for testing operations (test officer responsibility) has been prepared.

(2) Required danger zone for each type of test.

(3) Explosives limits for environmental conditioning rooms.

(4) Recovery or disposal procedures in case of malfunction.

(5) Hazards of each test and required safety procedures (hazard analysis) have been prepared in conjunction with the SOP(s).

b. During tests, one member of the crew shall serve as observer and shall be stationed outside the lookout window at all times when personnel are within the temperature-controlled room. The observer shall be on the alert for personnel affected by the temperature and for the various firing signals.

c. Working time in temperatures of 0 degrees Fahrenheit (-18 degrees Celsius) or lower, or above 125 degrees Fahrenheit (52 degrees Celsius) will be restricted to the shortest time possible to meet test objectives and will not exceed 30 minutes in any consecutive period. A close check on the time shall be maintained by the observer. Breathing aids approved for the range of temperature involved may be required by employees working in abnormal temperatures. When working in atmospheres containing concentrations of toxic dusts or vapors at 50 percent of threshold limit values (TLV), approved respiratory protection must be worn. No person shall work alone in temperatures below -40 degrees Fahrenheit (-40 degrees Celsius) or above 130 degrees Fahrenheit (55 degrees Celsius). Emergency, plunger-activated hardware shall be provided on the interior sides of doors of conditioning rooms or facilities.

d. Local procedures shall be developed for entry into areas utilizing CO2, nitrogen or other cooling agents.

e. All firings conducted from environmentally controlled facilities shall be on an approved azimuth. No weapon shall be fired in any room unless the muzzle, even in recoil, is located outside the port opening, or a tube extension sleeve is used to carry the blast and gases out the chamber. Destruction tests, excess pressure tests, and tests of known unsafe classes of ammunition or weapons where the possibility of ammunition or weapon failure exists shall be conducted when maximum safety is afforded by the structure. This shall be accomplished by an approved plate shield over the weapon and an approved plate shield to the rear. These portable structures shall be placed so as to form an effective operational shield.

f. All equipment employed in environmental conditioning of explosives shall be submitted for review and approval by the Safety Office. The location of all such equipment shall be sited per quantity-distance requirements.

g. Environmental conditioning units (ECU) will not be moved when containing ammunition/ explosives. ECUs are intended to condition ammunition and explosives for testing, they are not intended as long term storage. Items in ECUs will not remain longer than 10 working days without approval from the supporting Safety Office.

h. Exhausts shall be piped to the outside of the buildings.

i. Protective clothing and equipment shall be provided and used by all personnel who are required to enter the environmentally-controlled room.

j. Environmental conditioning operations shall have two independently operating, automatic, hot and cold temperature control devices to regulate temperatures and to shut off the heat source.

k. At elevated temperatures, make-up air will be provided for recirculation in conditioning facilities. For temperature range +70 degrees Fahrenheit (21 degrees Celsius) to +180 degrees Fahrenheit (82 degrees Celsius), the change rate should be 15 air changes per hour within the facility with 10 to 20 percent fresh air makeup. Through temperature range +70 degrees Fahrenheit (21 degrees Celsius) to -80 degrees Fahrenheit (-62 degrees Celsius), 5 air changes per hour will be provided. If a hazard analysis determines that there is no hazard associated with a buildup of gases that may evolve during conditioning of explosives, up to 100 percent recirculation (without make-up air) may be used. Nonferrous (sparkproof) material shall be used for fan blades and ducting.

l. Heating blankets for environmental conditioning of ammunition items shall be fabricated from fire retardant material as prescribed by MIL-C-20696 with positive type overheat protection; circuit protection shall be provided by current limiting devices. Thermostat protection shall be provided over the surface of blanket to prevent "hot spots."

m. Laboratory ovens (electrical energy source), if purchased from a commercial private vendor, shall comply with AMC-R 385-100, chapter 6, and also have the required designation of the Occupational Safety and Health Administration (OSHA) Standard, 29 CFR 1910.307, Hazardous (Classified) Locations. The (electrical energy source) laboratory oven must satisfy either the "Class II, Division I, Group G" or "Intrinsically safe" design specifications.

(1) Design requirements. All ovens shall be provided with dual automatic heat controls, one of which shall override the other. In ovens heated by steam only, the requirements for dual automatic heat controls shall be satisfied if the steam pressure is controlled by a reducing value (max of 5 psi unless otherwise authorized) on the main building steam supply and a thermostat on the oven. In ovens heated by electricity, the overriding control shall be of a manual reset type which shall shut off all current to the oven in the event of failure of the first operating temperature control. The operator may manually reset the thermostat after cause of failure has been

determined and corrected by qualified personnel. Ovens shall be equipped with blow-out type panels or the door must be provided with self-release latches (mechanical or magnetic). Ovens shall be effectively vented to permit the escape of dangerous gases that may evolve during heating or drying of material. Steam shall be used as the heating media wherever practicable. Whenever electric heating elements must be used, the elements shall be located where there is no possibility of contact with explosives or flammable materials. (This may mean using forced air non-recirculation systems.) Any surfaces exposed to explosives shall not exceed 228 degrees Fahrenheit (109 degrees Celsius). If the oven uses a fan for circulation of air, the blades shall be of nonsparking material and where possible, the electric motor shall be installed on the exterior of the oven. Air used for heating shall not be recirculated if the heating surface is above 228 degrees Fahrenheit (109 degrees Celsius) or contains material which may collect on the heating coils.

(2) Installation requirements. All noncurrent carrying metal parts of the oven shall be electrically bonded and grounded.

(3) Usage requirement. Other hazardous materials shall not be located in the room or cubicle near an oven. The quantity of explosive material in an oven shall be limited to the type and quantity authorized for the specific oven. The explosives limits shall be conspicuously posted on the oven door as determined by the operation being conducted. If the explosive is wet with a flammable solvent, it shall be air-dried to remove as much of the solvent as practicable prior to being placed in the oven. Ovens shall not be used for explosives storage. Explosive materials shall not be placed directly on the floor of the oven. The drying temperature of compositions shall be known before drying operations commence. Oven temperatures shall be checked during operation at specified intervals especially after recent adjustment or during extended drying periods. All ovens shall be cleaned after each composition (including vacuum lines, circulation ducts, etc.) is dried. A record of the cleaning will be noted on a card attached to the oven. An additional record of cleaning will be maintained by the supervisor of the operation.

(4) Ovens shall be calibrated at least semiannually or whenever maintenance is performed.

22-7. Range Clearances. a. General. A clearance shall be granted only by the range control/range safety person having jurisdiction of the danger area in which the operation is to be conducted. If a test encompasses two or more danger areas, the range control/range safety person of the area in which the weapon is located shall obtain the necessary coordination and clearance from the other range control/range safety persons involved.

b. Entrance/exit clearances. The person in charge of any work crew entering a danger area shall obtain a clearance from the range control/range safety person or test director in charge of the test immediately prior to entering. The clearance shall include the nature and location of the work to be done, the name of the person in charge of the crew, and the number in the work crew in the danger area. The person in charge shall be responsible for accounting for each person assigned to the work crew when entering, traveling within, or leaving the danger area. Each work crew must confine its activities to the areas for which the clearance is granted and to the prescribed routes to and from that area. The person in charge of the work crew shall be responsible for maintaining communication with the range control/range safety person as directed and for canceling the clearance when the work crew leaves the danger area.

c. Test/firing clearances. Each test officer shall obtain a testing/ firing clearance from the range control/range safety person prior to conducting the test. Testing of ammunition items, rockets, or guided missiles often creates hazardous conditions for aircraft operating in the restricted airspace near the planned trajectory (i.e., installation airfield). If this airspace is periodically subjected to air traffic, precautions will be taken by the range control/range safety person and the test officer to assure that the restricted airspace will be clear of traffic at the time of testing. Coordination with local air traffic control tower shall be maintained during the period of testing. Having obtained a testing clearance from the range control/range safety person, the test officer shall not be authorized to transfer the clearance to any other person. In the event the test is to be assumed by another test officer, the original clearance shall be canceled and the new test officer will obtain a new clearance prior to resumption of testing. At the completion of any testing, the test officer shall notify the range control/range safety person who shall cancel the clearance.

d. Establishing danger zone. The range control/range safety person shall plot and determine the danger zone of each test per the danger zone prescribed for that class of fire, using the information concerning location of the weapon, azimuth of fire, type of ammunition to be tested, range to impact or burst, and any other pertinent data. To determine the range for a given program, the range-elevation curve applicable to the data submitted shall be used. When a curve is not available for a prescribed velocity of projectile, the curve for the next higher velocity and the projectile giving the longest range shall be used. The danger zone will extend to the side and rear of the weapon and adequate precautionary measures shall be taken to protect personnel/equipment.

Signs or flags other than those displayed by the range control/range safety person shall be posted or displayed at various locations throughout the installation to further define the danger zone. The test officer shall be responsible for ensuring these warning signs, flags, or road barriers are placed under the instructions of the range control/range safety person. The signs, flags, or road barriers when posted or displayed shall not be passed unless authority to do so has been given by the range control/range safety person. Danger zone data shall be kept on file in the range control office.

e. Firing over water. Where necessary, patrol boats shall be utilized when tests involve impacts and bursts over water areas to assist in assuring safety. Clearance must be obtained from the range control/range safety person before conducting any test which will endanger water areas. Before granting a clearance, the range control/range safety person shall check with all other range control/range safety personnel and with other patrol boats assisting in monitoring the safety of the restricted water areas as specified by local SOP. Firing shall not be permitted over restricted water unless the danger zone has been determined to be clear of personnel and watercraft.

22-8. Ammunition and Equipment at Firing Fronts and Firing Positions. a. The quantity of ammunition or explosives delivered to a firing position shall not exceed that required to conduct the test safely, efficiently and without delay. All ammunition at the firing position must be so located as to make its ignition, explosion, or detonation improbable. The ammunition should be piled on a clean tarpaulin or nonflammable dunnage in a dry location, free of combustible material or excess vegetation, protected from the rays of the sun by a tarpaulin or other cover, with air space between the top cover and the items to provide ventilation. It must be stored in a manner to prevent ignition from a grass fire. White phosphorus shells must be securely positioned vertically and well away from personnel (refer to chapter 11, paragraphs 11-23 through 11-29).

b. No firing shall be conducted which will endanger, either by fragments or blast, any equipment such as cranes, shovels, locomotives, trucks, etc., which might be parked in the vicinity of firing fronts.

c. It shall be the responsibility of the test officer to protect equipment and personnel that might be endangered by test firing under his control.

22-9. Safety Signals. Standardized signals shall be used to warn personnel of firing in the area. For the sake of uniformity, the following signals should be used. All test officers/directors must be thoroughly familiar with the various signals.

a. Firing signal. The signal to fire shall be given by the test officer immediately prior to firing. The signal may be given via radio or other audible signal such as a whistle, horn, siren or bell. Local procedures will be established to ensure all personnel are aware of the intent to fire.

b. Warning signals. During daylight (unless other means such as lights have been provided) red warning flags shall be displayed to indicate testing/operations in progress. A flashing red light shall be used to indicate that firing is being conducted or is planned in that danger area.

22-10. Testing Facility. a. No test shall be conducted unless safe testing facilities are provided. The test officer shall determine the adequacy of facilities and the need for additional safeguards prior to beginning tests.

b. Maximum use shall be made of mechanical/electrical devices to replace manual operations.

c. Weapons operated by remote control shall be equipped with devices by which operations can be halted when noticing a hazardous condition. These devices shall be independent of those regularly used for controls so the operation can be stopped if the regular control should fail.

d. Firing from a protected location is preferred for all firing and is required where chamber pressures of the order of 115 percent or greater of rated maximum pressure are expected.

22-11. Range Crews. A range crew shall consist of at least two persons, and no testing shall be performed on any recovery field or impact areas with less than two persons present at the location. The person in charge of the crew shall be responsible for their safety, and assure personnel remain inside a closed bombproof during firing. He shall maintain constant communication with the firing point and the range control/range safety person during the firing program and he shall not give approval to fire until all safety precautions have been fulfilled.

22-12. Halting Hazardous Programs. All personnel shall be alert to detect any evidence of unsafe conditions. An individual must

stop a test when an unsafe condition exists. Operations will not continue until the condition has been corrected. Examples of the points to be checked are:

a. Filling of recoil mechanisms.

b. Safe function of the firing mechanism.

c. Absence of foreign obstructions in the bore.

d. Correct selection and installation of fuzes.

e. Correct charges for separate loaded ammunition and mortars.

22-13. Test Firing Recoilless Weapon and Ammunition. a. General. All personnel shall be adequately protected from both breech blast and possible premature or malfunction of the round. To protect against flying missiles as a result of the blast, breech-blast danger areas shall extend to the rear of the weapon, 100 yards for all calibers up to and including 75mm, and 150 yards for larger calibers or as specified by range control/range safety. When effective barricades are used to confine the blast effect, the danger zone may be reduced. The protection of personnel and equipment shall be provided. Weapons mounted for vehicular firing shall be analyzed to ensure protection of the loader and other members of the work crew.

b. Safety switches. The safety switch on the weapon shall be in the safe position while the weapon is being loaded. The weapon shall not be advanced to the firing position until the breechblock is closed and all preparations for firing are completed.

c. Multiple firing. Special precautions must be taken for programs requiring multiple firing due to the rear blast possibly obscuring a misfire. When salvo firing must be done, at least 2 minutes shall be allowed to pass after a one-volley salvo before opening any breechblock. When several salvos are to be fired, a designated crewman shall be responsible for observing whether or not his piece has fired. If a rifle has not fired or if there is doubt as to whether it has fired, the breechblock shall not be opened unless the provisions covering misfires are followed. The rifle should be eliminated from the salvo program.

d. Special precautions. Unburned propellant from test firing weapons shall not be allowed to accumulate in the surrounding area. Decontamination by means of controlled flashing is permissible

if other explosives and flammable or combustible material are at least 100 feet away from the outermost edge of the contaminated area. An approved SOP must be in effect and readily available to the clean-up crew.

22-14. Vertical Firing. a. Vertical firing or firing in the immediate vicinity of 90 degrees elevation shall be conducted only in an isolated area that will safely accommodate the maximum dispersion expected under the conditions. For calibers up to and including the 57mm gun, this area shall have at least 1,000 yards radius from the gun. Such firing must not be conducted on days when excessive wind velocities prevail. No weapon above 57mm shall be fired without current wind data, and a corresponding increase in the danger zone. Where the impact cannot be determined (for under 57mm) when firing with an elevation that would ordinarily give safe impacts, the firing shall be suspended until wind data are obtained.

b. The weapon shall be located based on the prevailing winds for the particular ordinate and particular season with respect to the selected impact area, and shall have been previously set with minimum cant. The gun shall be sighted on the center of the impact area and elevated in the vicinity of 90 degrees.

c. Vertical firing of high explosive filled projectiles may be performed only if initiating components of the projectiles are inert and provided the danger zone is increased to accommodate fragmentation and/or blast overpressure in the event of detonation of the projectile. Projectiles containing small charges of black powder that will not produce fragmentation of the shell and live initiating components may be fired vertically.

d. Test support personnel at test sites shall be located in bombproofs which are adequate to withstand penetration of the particular caliber to be fired.

22-15. Firing Over Personnel. No firing over personnel shall be permitted unless the personnel are under adequate cover as determined by a hazard analysis. Ammunition used for this purpose will be researched to ensure no overhead fire suspension notices are in effect.

22-16. Test for Specific Items. a. Hand grenades. Live hand grenades shall be tested only with a mechanical grenade thrower or specially designed and approved apparatus or facilities for static testing.

b. Rifle grenades. Live rifle grenades shall be tested only with the rifle secured in a rest and with all personnel in an approved bombproof.

c. Smoke/obscurants/riot control ammunition. Test officers must take into consideration the direction and velocity of the wind to prevent the liberated smoke and obscurant from endangering nearby localities. Consult with appropriate Environmental Quality Office to ensure compliance with EPA regulations. A waiting period of 15 minutes will be observed before examining or recovering smoke (not WP) and riot control agent filled hand grenades and canisters from 105mm and 155mm projectiles (with ignition device installed but without HE components) that fail to function during surveillance testing. If, for any reason, the items cannot be refuzed and retested, collect in a safe location for subsequent disposal.

d. Anti-tank mines. Tanks or other vehicles shall not be driven across fuzed live full-load high explosive mines. Vehicles can be driven over unfuzed or down-loaded mines if a hazard analysis is conducted to determine the protection requirements and such protection is installed. In cases where the tank or vehicle is towed over mines by another vehicle, personnel shall not be permitted in the towed tank or vehicle. A specific distance based on hazard analysis shall be provided between the towed vehicle to prevent injury to personnel in the towing vehicle. If the towing device is to be disconnected, this must be accomplished remotely without exposure of personnel.

e. Anti-personnel mines. This ammunition shall be functioned by means of wires, sash cords, or some other type of lanyard having negligible stretch. The wires or cords shall be encased in a permanent or semipermanent conduit from the mine to a remote, protected firing location. Mines shall be secured in fixtures so that mine bodies cannot be tipped from the vertical position either by pulling the wires or cords or by the recoil of the mine base. The wires or cords shall not be attached to the mine until the latter is in the fixture. Properly identified activation cord(s) or cable(s) will be used to function the mines by remote control. In event of misfire, a waiting period of 30 minutes or more will be observed (based on conditions). Mines that do not function will be removed from the firing fixture by remote control without exposure of personnel. Provisions shall be made for "pre-rigging" explosive items for safe remote control removal of malfunctions without the need for handling.

f. Family of scatterable mines (FASCAM).

(1) The ammunition shall be tested remotely providing adequate protection to personnel while the mines are in the initiating arming phase. Protection shall be provided while simulating any deployment characteristics after activating the arming process of the mine, or operating within the potential hazardous fragmentation

distance of previously activated mines. All sequence test evaluations associated with activated mines must be accomplished remotely without exposure to personnel. Tanks or other vehicles shall not be driven across an activated high explosive mine.

(2) Duds can be remotely disposed of by disassembly or explosive destruction, or by other mechanical means after waiting the elapsed period of self-destruct time (T-setting), plus a minimum waiting period of 24 hours. The required waiting period can be reduced to T-setting, plus 4 hours if a remote attempt is made to function the dud or malfunction. This attempt shall be made by prime fuze sensor stimulus prior to conducting any disposal operation.

g. Small anti-armor missiles. If the safety fan of a missile exceeds the boundaries of the test range, a flight termination system shall be incorporated into the missile. This system shall be capable of terminating an erratic flight prior to violation of range boundaries.

h. Rocket motors.

(1) Mobile cranes will normally be used to handle large rocket motors at the firing pad.

(2) Approved type slings of reinforced rubber or nylon web are recommended and shall be used in handling thin walled motor cases in lieu of woven metal or wire rope slings. All slings, regardless of type, will be inspected before use.

(3) The installation of missiles and rocket motors into test positions will not be undertaken until all equipment has been given thorough inspections and approval by the supervisor of the operation. All operations personnel shall be thoroughly briefed on each phase of the movement and the overall objective. The test officer shall exercise complete control over the operation at all times.

(4) When possible, motors will be installed in a manner to prevent the motor from backing out of the test fixture. These tie down methods shall have a safety factor of 5 to 1.

(5) The rocket motor will be grounded during all test operations (off loading, loading in test fixtures, and firing). The ground will first be attached to the rocket motor and then attached to the facility ground.

22-17. Unplanned Cook-Off. a. In tests involving a high rate of fire, particularly with machine guns and antiaircraft guns, automatic

function or "cook-off" of a round left in the hot gun for a period of time is possible. The possibility of cook-off depends largely upon the rate of heat dissipation of the weapon, and factors such as high air temperature, low wind velocity, and low elevation of the weapon. Confinement of the weapon will increase the possibility of cook-off. To prevent cook-off, the weapon will be periodically cooled with water during the test; or if the use of water is prevented for some reason, the empty and opened weapon will be air cooled. In case a round is retained or remains in a hot weapon with the breech closed, all personnel in the vicinity shall remain within a bombproof (shelter) until sufficient time has elapsed to assure that a cook-off will not occur or unless some means of water cooling the weapon by remote control is available. If a round jams and the breech fails to close, personnel in the danger zone shall be placed within a bombproof (shelter) immediately and the weapon cooled remotely. The following shall be followed to assure adequate cooling of the weapon:

(1) Water cooling - 5 minutes

(2) Air cooling, machine guns - 15 minutes

(3) Air cooling, other guns - 30 minutes

b. When the possibility of a cook-off exists, the danger zone for personnel in the vicinity of the weapon when firing explosive ammunition shall be:

(1) Machine guns - 200 yards (180 meters) radius.

(2) Weapons up to and including 75mm - 400 yards (360 meters) radius.

(3) Weapons over 75mm up to and including 105mm - 600 yards (550 meters) radius.

(4) Weapons over 105mm - 800 yards (730 meters) radius.

c. When inert ammunition is used, radii given above may be halved. When effective barricades are used to confine blast effect, the danger zone may be reduced. The distance and type of protection shall be such that safety of personnel is assured. In all cases of possible cook-off, the danger zone down range shall be maintained as for actual firing until the danger has passed.

22-18. Premature Bursts. The test officer shall notify the range control/range safety person immediately of a premature burst. The range control/range safety person shall either suspend the test or increase the lateral limits of the danger zone per prescribed safety

distance prior to allowing the test to continue. The increased lateral limits shall be maintained until the particular test is completed. All personnel in the increased lateral limits area will be evacuated or placed in an approved personnel bombproof (shelter) prior to continuation of testing.

22-19. Misfires. General precautions. A waiting time of 30 minutes from time of predicted firing will be observed before downloading. This time will be used as a safety period due to an abnormal situation. The misfired round will be marked as such and placed in a predesignated safe holding area. The safe holding area will be determined according to quantity-distance (Q-D) requirements and will not present a personnel fragmentation hazard. While waiting after a misfire, all persons shall remain within approved personnel bombproofs (shelters) in case the system functions. At the same time, all electrical connections which can cause firing of the weapon shall be deenergized. The appropriate danger zone for the actual firing shall be maintained during the waiting period when a cook-off is expected. After the round has been removed, it shall be immediately placed where subsequent detonation will not cause injury or damage. Before resuming fire after a misfire, the firing pin and mechanism shall be checked for proper functioning and the barrel of the weapon shall be examined to assure it is clear. Additional misfire procedures may appear in Technical and Field manuals for specific weapons and ammunition items.

22-20. Cover. a. General. During tests involving explosives, all energetic material shall be located in a substantial barricade or in an isolated area with adequate cover for all operating personnel and equipment within the danger zone. On tests where there is a possibility of fragmentation, the test officer shall require all personnel within the danger zone to move to an approved personnel bombproof(s) (shelter). Only the minimum number of personnel required to conduct the test will be involved in the firing operations. The person assigned to attach the lanyard, however, shall be the last to leave the emplacement or stockade, and no firing shall be attempted until he has informed the test officer that all personnel are clear of the weapon and in an approved personnel bombproof (shelter).

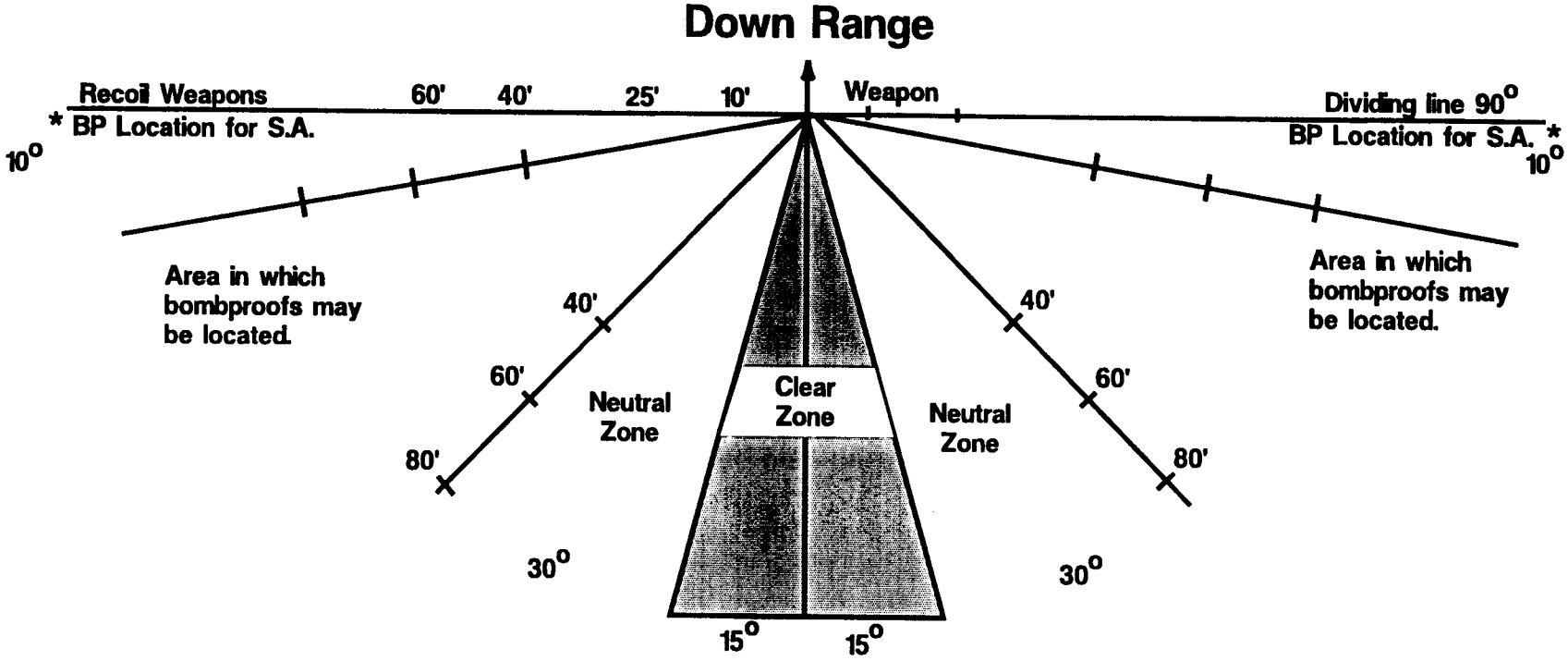
b. Portable bombproofs. Portable bombproof types and uses are set forth in table 22-1. Design of bombproofs (shelters) must be approved by the Safety Office. Emplacement of bombproofs (shelters) must be approved by range control/range safety. Portable bombproofs will be marked as to number of personnel permitted, type of bombproof and weight of bombproof.

CLASS	TYPE OF ARMOR	TYPE OF VISION	TYPE OF PORTS	NUMBER OF PERSONNEL	TO BE USED ON LOCATIONS	CALIBER OF WEAPON
A	3" Homogenous	Indirect	Safety Glasses with Periscope	*	Firing Front & Impact Area	All
B	+2" Green	Indirect	Safety Glasses with Periscope	*	Firing Fronts	All
C	+3/4" Boiler Plate or Mild Steel	Direct	+1" Safety Glass	*	Firing Fronts Trajectory Line	Up to and Incl 30MM
X	1/4" to 3" Homogenous	Direct or None	Open or None	No	Cameras, X-Ray, Ammo Shields	All

* Each bombproof will be marked as to the number of personnel permitted.

Table 22-1. Portable Bombproof Types and Uses

c. Locating portable bombproofs (shelters). Portable bombproofs (shelters) shall be emplaced at firing points as shown in figure 22-2 with the distances to the firing points being as indicated in table 22-2. Portable class A bombproofs (shelters) only shall be used in the impact area for observation of artillery projectiles. These shall be emplaced per figure 22-3. Portable bombproofs (shelters) shall be adequately secured and supported to prevent overturning. When the impacts result in fragmentation, the bombproof (shelter) shall be located in the weapon side area on either side of the line of fire located more than 10 degrees from impact on the dividing line results and more than 45 degrees from impact on the line of fire (figure 22-3). After being properly located as described in figure 22-3, the bombproof (shelter) shall be oriented with respect to the impact so that no wall surface is presented to fragmentation at an angle greater than 60 degrees. This can usually be done by centering one intersection of the walls of the bombproof (shelter) in the case of a square or U-type, or pointing the apex of the bombproof (shelter) in the case of a pointed V-type toward the impact. Under no circumstances shall the bombproof (shelter) be oriented to expose the rear to gunfire and fragmentation. Observations from bombproofs (shelters) shall be indirect -- by mirrors, periscopes, or other devices approved by the official responsible for range safety.



Note: Emplacing of bombproofs in the neutral zone requires prior approval from the responsible agency.
No bombproofs permitted in the clear zone.
The dividing line is center line of trunnions.

* Locating BP in 10° small arms area requires approval of the Range Safety Office.

Figure 22-2. Emplacement of bombproofs at firing points.

	Firing Point to Bombproof Distances (in feet)			
Category of Firing	Class A	Class B	Class C	Class X
Small Arms up to 30MM Inclusive, Shoulder Fired Rockets up to 3.5" Inclusive	5'	5'	5'	*
Artillery Items, Incl Rockets, up to & Including 175MM Gun. All Howitzer Incl 8" Howitzer (Propellant Charges up to 54 lbs.)	40'	40'	Not Permitted	*
Artillery Items, 8" Gun and Over (Propellant Charges 55 to 160 lbs.)	80'	80'	Not Permitted	*
Recoilless Rifles up to 120MM	At 10' or beyond 40'	At 10' or beyond 40'	Not Permitted	*
Recoilless Rifles Above 120MM	At 25' or beyond 60'	At 10' or beyond 60'	Not Permitted	*
Propellant Charges Above 160 lbs.	**	**	Not Permitted	*
* Class X to be used only for cameras, X-Ray equipment, ammo (no personnel). ** Distance of bombproofs to be established by the official responsible for range safety.				

Table 22-2. Separation of Firing Points and Bombproofs

d. Portable shields. Portable shields for the protection of equipment; i.e., camera, instrumentation, etc., will be utilized for that purpose. Design criteria will be based on the protection required for the item being tested, distance from the test site and the item(s) being protected. Approval of the type and design will be the responsibility of the Safety Office. The official responsible for range safety will approve the location of the items being protected, the shield positioning, and type shield required.

22-21. Deflection and Elevation. a. Deflection. Firing shall not be permitted unless the weapon has been laid in previously by a qualified gunner or other knowledgeable person to ensure the first impact will be at least 200 meters from the observer's bombproof (shelter) for small caliber weapons. Tests involving larger caliber weapons, i.e., 105mm, 4.2 inch mortar, etc., will require 250 meters or more distance from the bombproof (shelter). The test officer is responsible for assigning a qualified person to check the deflection prior to firing. In rapid fire, the person responsible for deflection shall ensure the weapon will not drift in traverse. This individual is also responsible for correcting any errors in the sighting system.

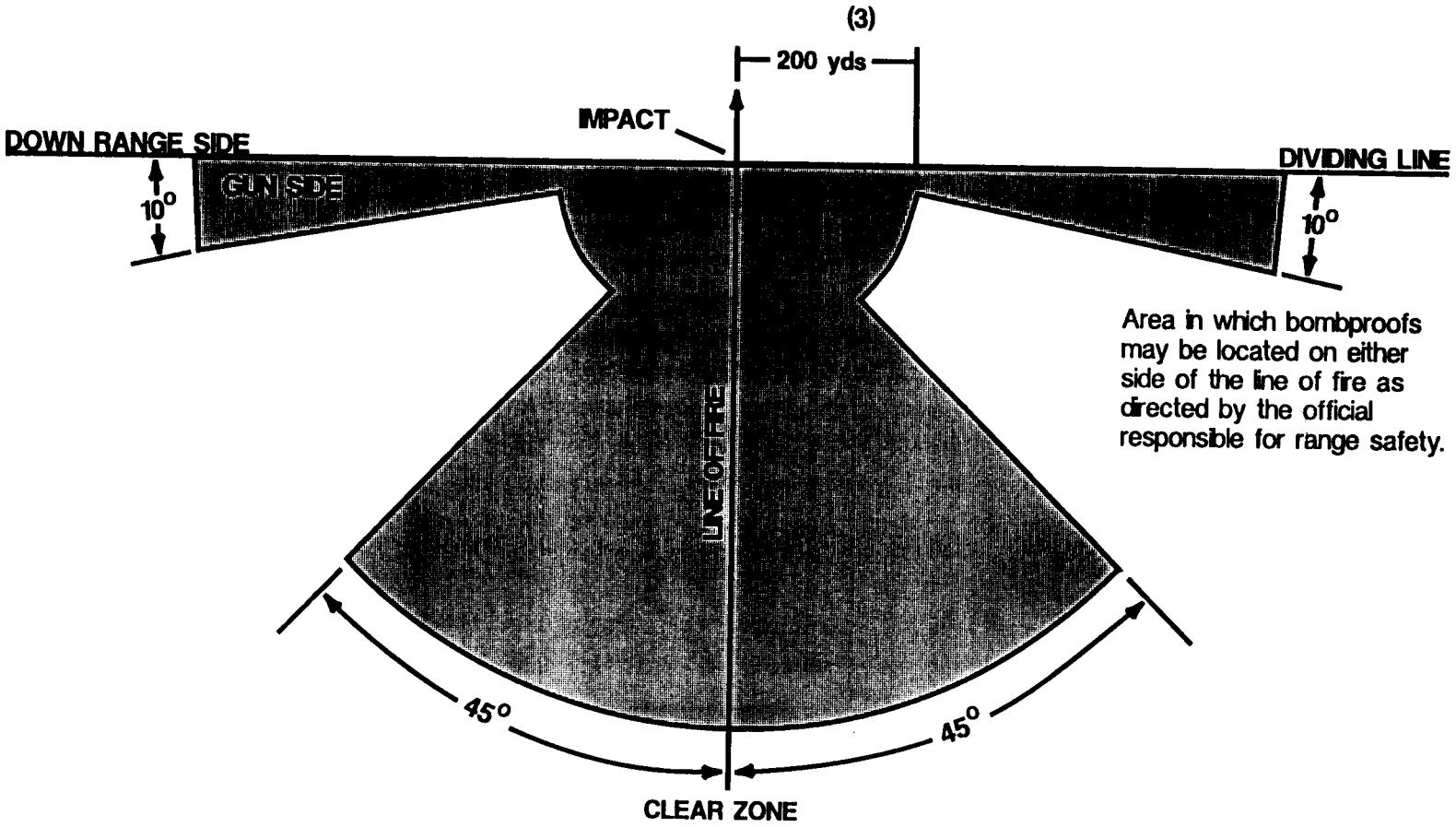


Figure 22-3. Emplacement of portable class A bombproofs for impact observation (Para 28-21)

NOTE:
1. **No bombproof will be emplaced in the hatched area.**
2. **No personnel shall be stationed in portable bombproofs until after impacts are known and then only with approval of the official responsible for range safety.**
3. **Bombproofs shall not be positioned within 200 yards of known impacts for small caliber weapons and 250 yards for large caliber weapons.**

Figure 22-3. Emplacement of portable class A bombproofs for impact observation (para 28-21).

b. Elevation. The elevation shall be obtained from past firings, records, firing tables or range-elevation curves. The test officer is responsible for assigning a qualified person to check the elevation prior to firing. Frequent elevation checks must be conducted based upon the requirement of the test.

22-22. Test Firing Involving Aircraft. a. Flight paths. Each installation at which bombs are dropped in tests shall establish safe flight paths to be used in flying to, over, and from the bombing areas. These flight paths will be followed as closely as possible. Deviations will be reported to the controlling agency. Aircraft shall not egress the restricted airspace without approval of the FAA or appropriate controlling agency.

b. Clearance. Prior to scheduling any flight entering special use airspace or danger areas, the test officer shall obtain the proper test clearances from the appropriate range control/range safety person. When requesting the clearance, the test officer shall comply with local procedures which will completely describe the item to be tested, speed, altitude, type of aircraft, expected point of impact, and the expected flight path to be followed. When ground observers are used, bombs shall not be dropped until an additional clearance is obtained for the aircraft through the use of a prearranged signal. Clearance will not be granted until it can be assured the ammunition will fall within the designated impact field. No clearance will be given to drop bombs if any doubt exists concerning location, identification and visibility of the target.

c. Bombing. Aircraft loaded with bombs shall not fly over private property, buildings, or assemblages of persons unless bomb racks are locked, bomb bay doors closed, and all release mechanisms are in the "off" position. The dropping of bombs must be carefully controlled to assure bombs will fall within the designated impact field and without injury to personnel or equipment in the area. The use of a bomb sight or an equally positive signaling device controlled from the ground is recommended for all bombings.

(1) VT-Fuzed bombs. For tests in which VT-fuzed bombs are dropped from aircraft, an arming delay or similar device shall be used as an extra safety device when the objectives of the test permit. The altitude from which the bombing is conducted shall be increased sufficiently to permit proper functioning of the arming delay.

(2) Hung bomb. In case of a hung bomb, the pilot shall immediately notify the range control/range safety person and attempt to release the bomb in a safe place designated by the range

control/range safety person who shall give the necessary warnings. If the bomb cannot be released and, if in the opinion of the pilot, it is necessary to land at the installation airfield, the pilot shall obtain the necessary clearance to land. Prior to permitting the landing, the field shall be cleared and all emergency units shall be alerted.

d. Rocket firing. All rocket firing conducted from aircraft shall be with practice loaded nonfragmenting heads, inert loaded or high-explosive loaded rockets of accepted type and caliber, fitted with inert fuzes or inert boosters. Firing of HE ammunition with live fuzes and live boosters shall be done only when accepted components are used, and then only with the approval of proper authority. Aircraft, mounted with rockets, shall not approach a firing range by passing over inhabited buildings or populated areas outside of the danger zone. Arming of the rocket firing circuit shall be withheld until the aircraft pilot is making his approach to the target area. An electrical interlocking feature shall be incorporated into the firing circuit to preclude firing of rockets if the aircraft drifts off target. A designated drop area shall be available for disposal of rockets in case of misfire.

e. Aircraft commanders. Only fully qualified personnel who are thoroughly familiar with established range regulations shall be permitted to drop bombs or fire projectiles from aircraft. The aircraft commander or pilot shall be responsible for instructing all personnel assigned to, engaged in, or observing bombing mission test from aircraft concerning the standard procedures regarding emergency exit and rescue procedures from the aircraft. Effective two-way communications will be established and maintained between the aircraft and ground operations at all times during ammunition testing.

22-23. Marking Duds and Recoverable Ammunition. When a test program requiring the use of projectiles or bombs containing high explosives, or armed with live fuzes or live boosters, is fired for impact on, or burst over a recovery field, observers shall be located in an approved personnel bombproof (shelter) to note and locate the impacts and duds, and to observe the functioning of each round. Stakes bearing flags shall be used to designate the location of ammunition duds or ammunition fired for recovery. The flags used to designate the location of ammunition to be recovered should be:

a. Red flag for inert projectiles.

b. Yellow flag for HE projectile, bomb, or live fuze or combination of these.

c. White flag for undetermined loading which shall be designated hazardous until determined otherwise.

d. Black flag for DU projectiles.

22-24. Cleaning of Ranges. Ranges shall be "policed" for live ammunition as soon as practicable after each test (not to exceed 30 calendar days). The disposition/disposal of unexploded (dud) ammunition fired on test ranges is the direct responsibility of the organization firing the item. Ammunition collected as a result of these policing operations shall be disposed of as follows:

a. Slugs and ammunition with inert filler and inert fuzes shall be collected in a separate stack in a designated safe location and the stack identified for future disposition, following Army and local environmental/disposition guidance.

b. Ammunition containing high explosives with live fuzes and all duds shall be detonated in place by personnel certified per AMC-R 350-4.

c. Dud ammunition shall not be left on the range after testing has ceased for the day unless at least one of the following situations exists:

(1) The range has a security fence totally surrounding it.

(2) The range has a 24-hour physical security coverage.

(3) Trespassing on the range is not evident or access is not easily gained from public traffic routes (i.e., land, water).

d. Live fuzes in projectiles containing inert filler shall be destroyed in place or recovered for disassembly by personnel certified per AMC-R 350-4.

e. Projectiles containing high explosives with dummy fuzes shall be disposed of per local requirements under direction of the servicing Safety Office.

f. All persons, except those certified per AMC-R 350-4, and other authorized individuals, shall be prohibited at all times from touching or disturbing in any manner, dud ammunition. Unfuzed or inert fuzed live ammunition or ammunition components which have failed to function will not be recovered unless it has been determined that recovery will be necessary for the purposes of examination. Except when using approved armored vehicles and/or remote control recovery and disassembly equipment so that adequate protection is provided the operator and all other personnel, live ammunition with live fuzes which have failed to function will not be recovered. Recovery of dud

or malfunctioned items must be accomplished only by personnel certified per AMC-R 350-4. Test programs must be planned to use inert components when practicable to ensure safe recovery.

g. Marking and recovery of depleted uranium (DU) ammunition may be conducted only by certified ammunition handling personnel who have received a health physics radiation safety orientation within the past year. An approved radiac meter, G-M, or gamma scintillation, will be used to identify DU items. Personnel will wear TYVEK coveralls, rubber gloves, and a whole body thermo-luminescent dosimeter (TLD) if determined appropriate. Eating, smoking, and drinking in DU areas is prohibited. DU material will not be handled with bare hands. Storage and disposal of DU material will be per AR 385-11. Personnel will be monitored by health physics personnel for radioactive contamination after completing DU recovery operations.

22-25. Test Range Firing Circuit Criteria. The following criteria are guidelines for the design of electrical circuits which are used to arm and initiate squibs, igniters and similar electroexplosive devices (EED) at test range activities.

a. Every electrical ARM and FIRE circuit on a test range shall include an interlock device, consisting of a safety plug or a key-operated switch, to prevent inadvertent energization.

b. The safety plug design and configuration shall be unique for its application and use to prevent unauthorized or accidental activation of a firing circuit. Key-operated switches for ARM and FIRE circuits shall be designed to lock in the safe (off) position when the control key is removed. Duplicate keys or safety plugs shall not be permitted in any test area.

c. All fire control circuits in test operation areas shall be properly documented for operational control purposes. Documentation shall include complete wiring diagrams or running sheets, electrical schematics, and cable functions lists. All changes or modifications to FIRE control circuits must be approved by the Safety Office before being incorporated into the FIRE control circuits.

d. Whenever feasible, each FIRE control circuit shall be balanced to ground and isolated from all other circuits. A shielded, twisted pair of wires with an outer insulating jacket is preferred for each circuit. The FIRE conductors shall be physically isolated and shall not be run in the same cable with any other circuits. The system shall as a minimum be single-point grounded with no common return wires. The safety plug or key-operated switch shall not break

(interrupt) the cable shield. Shields shall be earth-grounded at one end and shall not be used as a current-carrying element.

e. When the firing leads exceed 100 feet in length, at least two interlocks shall be used. One shall be located as near the squib as possible, and the other on the fire control panel. The two plugs or locks must not be identical.

f. All programmers (sequential timers) used in firing circuits shall be "fail safe"; i.e., failure of a component or circuit must not energize the firing circuit.

g. The fire control network shall include both an ARM switch and a FIRE switch. It is desirable that the safe mode of the arming circuit not only interrupt the firing circuit, but also short-circuit and earth-ground the squib terminals. A relay with heavy-current contacts (three amperes or greater) is appropriate for this function if located close enough to the squib to ensure a low-resistance, noninductive (RF-impervious) short circuit.

h. Procedures must assure that personnel are adequately protected (in case of initiation) before testing circuit continuity with EEDS installed. When circuit continuity tests are necessary, the test current shall not exceed 10 percent of no-firing rating of EED in the circuit.

i. Firing circuits shall be clearly marked or otherwise identified in a distinctive manner and installed so as to prevent them from becoming inadvertently energized from other circuits. Testing for stray voltage on the firing line shall be done per chapter 21.

j. Local review boards or safety officers may specify alternate shorting and grounding techniques of either or both requirements. In general, however, squib circuits shall include some type of leak to ground to prevent static potentials from building up. Deviations from this criteria are left to the discretion of local review boards and safety officers.

k. A locally developed SOP will be prepared to establish necessary control over test operations and to ensure security of ARM and FIRE circuit protective devices.

22-26. Function and Trace Test of Ammunition. a. General.

(1) This paragraph prescribes the safety precautions necessary in conducting tests required by SB 742-1. This includes information relative to establishing surface danger zone data required

for the safe firing of the weapons, munitions, and explosive devices involved in these tests. Surface danger zone diagrams (safety fans) indicating specific danger areas are based on the latest available information. The danger areas established are minimum requirements and are adequate only when employed with properly functioning safety equipment and/or devices which are operated by thoroughly trained and certified personnel. Local SOPs and/or regulations designed to minimize the potential for personal injury and property damage shall be established to supplement this regulation. These procedures should prescribe or refer to additional precautions contained in applicable TMs and FMs for the particular weapon, munition, explosive device and classes of fire being conducted.

(2) The commanders of all installations and activities performing function and trace of small arms ammunition will establish a test range safety program as an addendum to the installation safety program. This program will include consideration of the following: maintenance and policing of ranges; selection of qualified test personnel; preparation of detailed maps; notification of firing; stationing of ambulances, range personnel; wearing of hearing protection devices per AR 40-5; taking suitable precautions to prevent unauthorized trespass or presence on ranges; and other duties and activities associated with the safe operation of ranges. In addition, the range safety planning for the firing of any ammunition or explosives must include the available terrain, purpose of the firing, atmospheric conditions, and the adequacy and accuracy of safety equipment required to ensure that the ammunition and explosives or debris resulting therefrom will not violate the boundaries of the surface danger zone.

(3) Suitable precautions will be taken to assure that all unauthorized persons are excluded from the surface danger zone as set forth in this regulation prior to firing. Livestock will also be excluded unless an agreement in writing has been completed with the owner or owners thereof. After firing is completed, precautions will be taken to prevent entry into the impact area by all unauthorized personnel until a thorough search of the impact area has been made and any unexploded or contaminated items found are destroyed by personnel certified per AMC-R 350-4.

(4) Range guards properly instructed concerning their duties and/or appropriate barriers with signs will be posted to cover all normal approaches to the danger area.

(5) Ranges will be located so that firing activities will not be nearer than inhabited building distance to ammunition storage areas. Where available land areas are inadequate, the separation distance from personnel on the firing range to ammunition storage

areas may be reduced to not less than public highway distance. These distances may be determined by referring to the tables of quantity-distance published in DA PAM 385-64 and will be computed based on the quantity and class of ammunition in the limiting magazine or storage point within the ammunition area. The limiting magazine or storage point is defined as the one requiring the greater distance based on the quantity and class of ammunition contained therein. The red flag or flashing red lights will be displayed from a prominent point on all ranges and at all times during firing. Red flashing lights will be used during nighttime hours. No firing will take place unless these conditions are met. Signs warning persons of the danger from unexploded or contaminated items will be posted in the vicinity of the firing area at all times. All entry points into danger areas shall be posted. Maps of the areas shall show the location of the safety control points for each area. In addition to the warning signal and signs employed to prevent entry to the range during firing, the boundaries of all range areas adjacent to roadways and points of entry, or along the outside limits or ricochet areas, will be placarded with permanent signs, at 200 meter intervals or less, which emphasize the danger connected with the range area and the handling of unexploded ammunition. The signs will prohibit trespassing on the ranges or the removal of items under penalties provided by law.

b. Small arms tracer test.

(1) Firing small arms and machine guns against land targets will comply with the following instructions:

(a) Figure 22-4 describes the surface danger zone that will be applied when firing from a single firing position on a single line-of-fire.

(b) The impact area is established by projecting an angle corresponding to 5 degrees in deflection on both sides of the line-of-fire.

(c) The described ricochet area is an angle in deflection of 5 degrees beyond both sides of the impact area. This area will provide adequate distances to contain ricochets under soft, dry, loamy soil conditions. Soil conditions containing rocks and firing on hard targets will require larger distances.

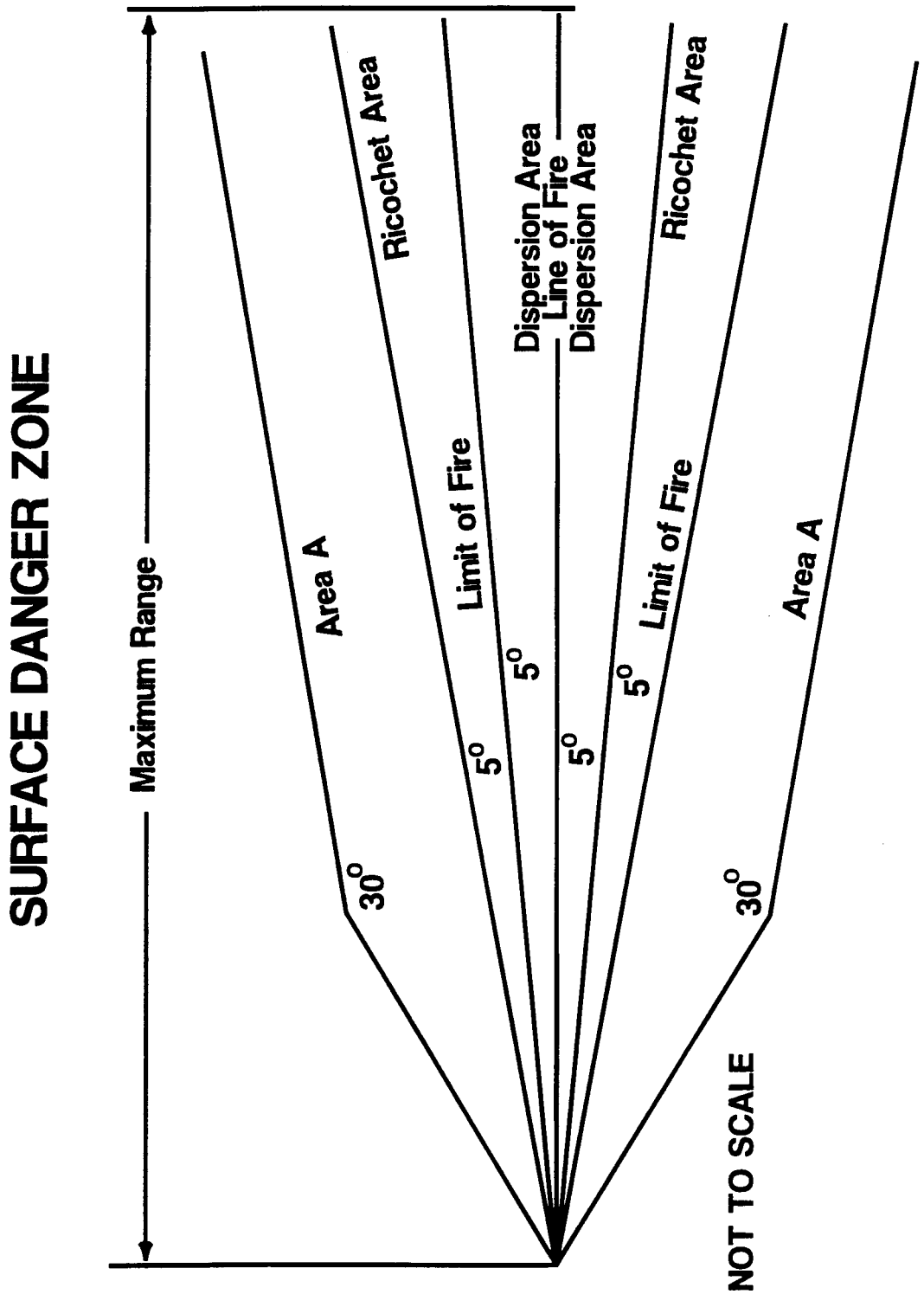


Figure 22-4. Surface danger zone for small arms weapons firing at fixed terrestrial targets.

(d) Area A is the area (secondary danger area) which parallels the impact area laterally and is provided to contain fragments from items exploding, or ricocheting on the right or left edge of the impact area. For dimension, see table 22-3. Area A may be omitted for nonexploding ammunition.

	Dimensions of Areas and Range (Meters)	
Caliber	A	Maximum Range
Cal. .22 Long Rifle	100	1400
5.56MM Ball, M193	100	3100
7.62MM Rifle and MG Ball, M80	100	4100
7.62MM Rifle and MG Match, M118	100	4800
Cal. .30 Rifle and MG Ball, M2	100	3100
9MM	100	1700
Cal. .30 Carbine	100	2300
Cal. .45 Open Range (no backstop): Pistol Submachinegun	 100 100	 1300 1400
Cal. .50 Machinegun, Ball, M33	100	6500
Cal. .50 Machinegun, AP, M2	100	6100
Shotgun, 12 GA. Skeet & Trap (No. 7 Shot or Smaller)	100	275
Shotgun, 12 GA. Riot (00 Buckshot)	100	600
Cal. .38 Revolver, Ball, M41	100	1600
Cal. .38 Revolver, Ball, PGU-1218	100	1900

Table 22-3. Small Arms and Machineguns

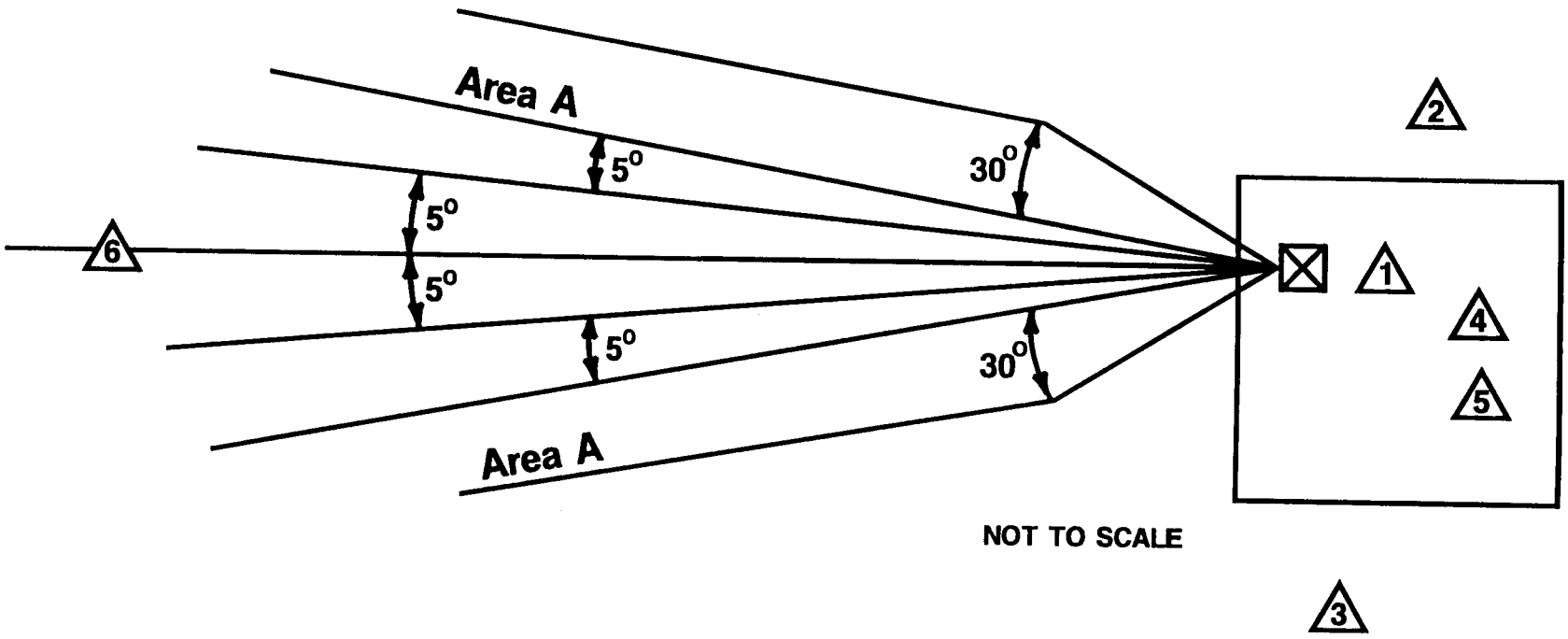
(e) Table 22-4 shows the thickness of various materials required for positive protection against individual bullet impact. The material thickness will not provide positive protection against continued burst firing.

Nature of Cover	Thickness in Inches		
	5.56MM	7.62MM & Cal. .30	Cal. .50
Concrete (500 psi)	5	7	12
Broken Stone	14	20	30
Dry Sand	16	24	32
Wet Sand	25	36	48
Logs, Wired Together (Oak)	28	40	56
Earth, Pakced or Tamped	32	48	60
Earth, Undisturbed, Compact	35	52	66
Earth, Freshly Turned	38	56	72
Plastic Clay	44	65	100

Table 22-4. Thickness of Material for Positive Protection Against Caliber of Ammunition Listed

(2) Figure 22-5 describes a typical small arms trace test range and may be used as a guide in the location of supporting facilities.

c. Ammunition function test. Figure 22-6 depicts the layout of a typical function test range. Distances used will be per those prescribed in the manual for ammunition peculiar equipment being used and the technical manual for the specific item to be tested.



1 CHIEF OBSERVER'S TOWER - UPPER STORY
GUNNER'S POSITION & SAMPLE STORAGE - LOWER STORY

2 OBSERVATION TOWER

3 OBSERVATION TOWER

4 OFFICE & LUNCHROOM

5 EQUIPMENT STORAGE

6 BULLET STOP

APE 1923
COMBINATION GUN MOUNT

Figure 22-5. Typical small arms trace test range

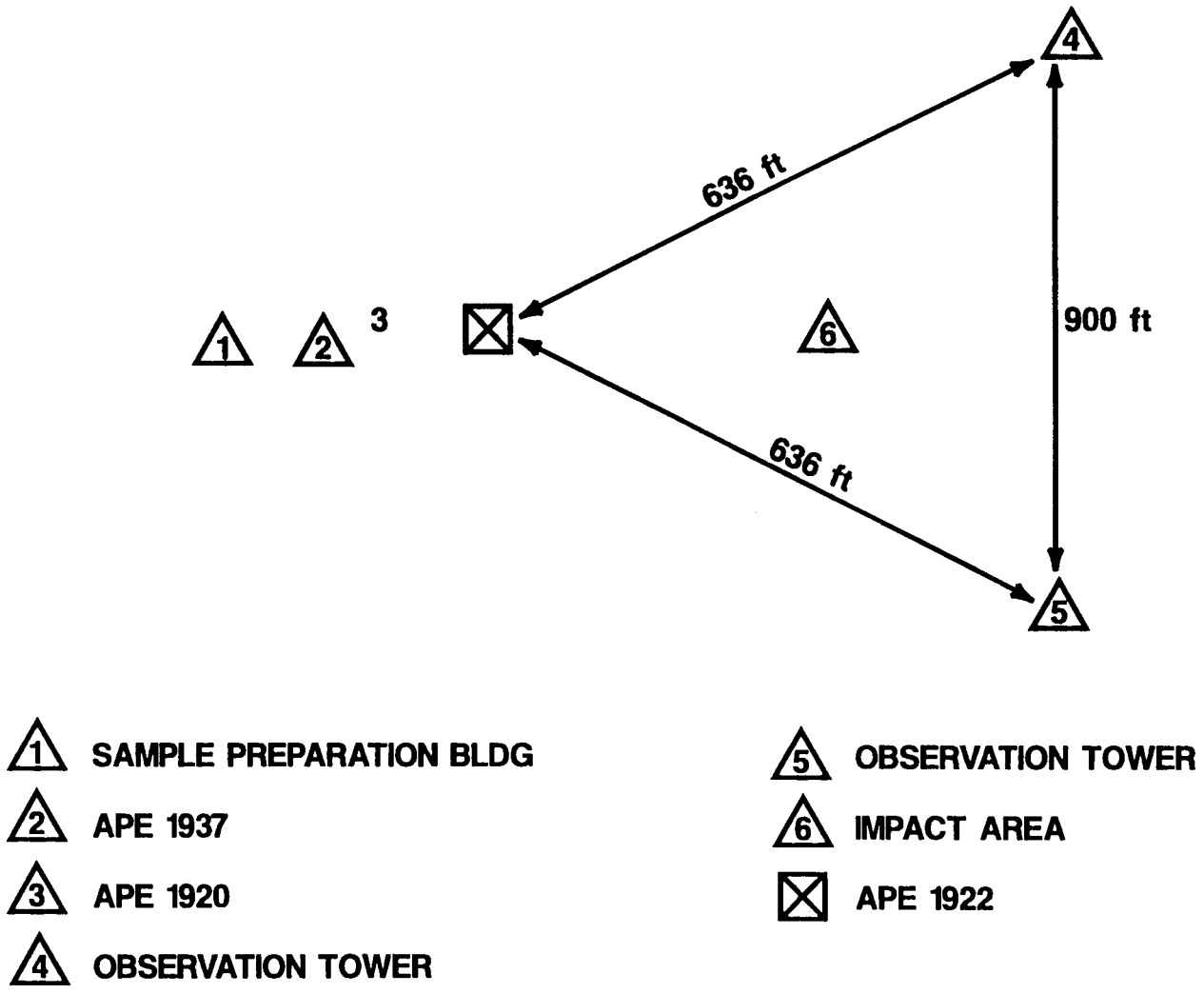


Figure 22-6. Typical ammunition function test area

CHAPTER 23

MANUFACTURING AND PROCESSING PYROTECHNICS

23-1. General. The safety precautions for manufacturing and processing pyrotechnics parallel those of many types of explosives and other energetic materials. Pyrotechnics, as a group, display many different characteristics because they are formulated for different purposes. Pyrotechnics can be divided into several general categories including: Initiators (igniters), illuminants, smokes, gas generators, sound generators, heat producers, and timing compositions. Each of these categories has its own characteristics and attendant processing requirements. Knowledge of these characteristics is necessary to assure safety in processing. The range of characteristics associated with pyrotechnics includes compositions that are easily initiated, including compositions that burn in seconds at temperatures exceeding 2760 degrees Celsius (5000 degrees Fahrenheit) through compositions that require substantial energy for initiation and have relatively low output temperatures. As examples, the auto-ignition temperature for smoke compositions is typically about 180 degrees Celsius while for illuminants it is about 500 degrees Celsius; illuminants burn approximately 2.7 times faster than smokes and the heat of reaction is 1.5 times as great; Infrared (IR) flare compositions are both hotter and faster burning than illuminants. Many of the compositions in the igniter or initiator class are as sensitive to static electricity, friction, or impact as are initiating explosives such as lead azide and lead styphnate. Initiation thresholds to such stimuli as impact, friction, and electrostatic discharge must be known for safety in specific processes. The response of the material in terms of energy release, must be considered in assuring personnel safety. In addition to the safety precautions generally required for the handling of explosives and other energetic materials, the following paragraphs provide specific guidance pertinent to pyrotechnic operations.

23-2. Machinery, Equipment, and Facilities. Except as provided for specifically in this chapter, the design, layout, and operation of facilities and equipment will be per the mandatory provisions contained in other chapters of this manual for the processing of explosives and other energetic materials. Where specific guidance is not provided, operations should be governed by the results of hazard analyses performed and documented to address specific operations. As the majority of pyrotechnic compositions are sensitive to initiation by static electricity, bonding and grounding together with other means of static elimination and control is considered to be of paramount importance.

23-3. Weighing of Raw Materials. Separate weight or measurement rooms, cubicles or areas, (dependent upon the quantity and sensitivity of the materials handled), will be provided--one for oxidizers and one for combustible materials and metallic powders. It is important to assure that containers, equipment, handtools, scale pans, etc., used for weighing processes are not intermixed between the weighing or measurement of oxidizers and fuels, particularly where distance rather than physical barriers are used to separate these areas. Positive measures will be adopted to assure the complete separation of equipment and tools for these purposes. Personnel weighing or handling exposed oxidizers or fuels shall wear flame retardant uniforms, cotton undergarments, cotton socks, and conductive shoes as a minimum.

23-4. Drying of Materials. The minimum temperature necessary to meet processing requirements will be used to dry components and pyrotechnic materials.

23-5. Mixing and Blending. a. Mixing and blending of pyrotechnic compositions is an area of serious concern as the majority of injury producing accidents have occurred during the mixing or blending process or the clean up operations that follow. Due to the variety of different compositions classified as pyrotechnics, there is a large variety of mixer types, each suitable to one or more groupings of pyrotechnic compositions. Each of these mixer designs has its own unique characteristics that include greater or lesser opportunities for initiation due to friction or impact, greater or lesser degrees of confinement, and greater or lesser degrees of personal exposure during the operations in which the ingredients are added to or removed from the mixer. Due to the variety of composition types and characteristics, no single mixer or blender type can be established as the exclusively approved equipment for pyrotechnic mixing and blending operations. In order to preclude undue impact on research and development operations small quantities of pyrotechnic compositions in the range of 10-21 grams may be exempted from these requirements where full operator protection can be provided and the operation is approved by the installation commander.

b. Each individual mixing device must be considered separately with respect to the composition to be processed. Where a history of safe operation has not been established, the type of mixer or blender and batch size should be evaluated by appropriate hazard analysis or tests. In general, every effort will be made to use devices that use a tumbling action as opposed to those that use rotating blades, in order to minimize points where frictional heat may develop or where accidentally introduced foreign material can create hot spots through friction or crushing of composition. Mixers and blenders will be

provided with an adequate means of assuring pressure relief to preclude the transition from burning to detonation. Every effort will be made to minimize the personal exposures during charging and emptying of mixers. Where the energetic characteristics and quantities of composition involved so dictate, mixers and blenders will be remotely charged, operated, and emptied. In the instance where personal safety has been demonstrated by hazard analysis or tests, mixers or blenders may be manually charged or emptied with personnel exposed to contents of the mixer or blender. Appropriate interlocks, clutch brakes, and similar devices will be used to preclude personnel exposure during mixer or blender operation, and to preclude the movement of mixer or blender parts during periods when operators are present at the mixer or blender.

c. Mixing and blending operations will be conducted in buildings or cubicles designed for such purposes. Multiple mixing or blending operations may be conducted in the same building provided that each blender or mixer is located in a separate room, bay, or cell and separated from other operations by substantial dividing walls. Two or more mixers or blenders may be located in the same cubicle provided that the hazard to personnel or production capability is not increased by such installation. Normally this would require that the materials in process be of significantly low energy content or slow energy release and the mixers be charged and emptied simultaneously. At least one wall or equivalent panel area in each bay shall be frangible so as to provide pressure relief in the event of an incident. Cell arrangement and pressure relief areas shall be so located that personnel are not required to, and are prohibited to pass in front of these areas while mixers or blenders are in operation.

d. Exhaust ventilation equipment will be installed on mixers or in bays where flammable solvents are used and interlocked with the mixers. The interlock shall be designed to preclude mixer operation without ventilation although operation of the ventilation system without the mixer is permitted. Vapor sensors should be used to give automatic warning of a build-up of flammable vapors to a level approaching that of the lower explosive limit or in such configuration that an ignition of the flammable vapors could occur. Such sensors should be interlocked to personnel access control devices. Ventilation system designs must not permit translation of an incident in one bay to others served by the same system.

e. The operation of mixers or blenders may be observed by remote means such as closed circuit television, mirrors, or transparent shields providing operator protection. Direct viewing of blender or mixer operation without intervening barriers is prohibited.

f. Manual scraping in the mixing or blending process is prohibited. Manual mixing or blending of fuels and oxidizers into a mixture is prohibited.

23-6. Pressing, Extruding, and Pelleting. a. Pressing operations will be conducted with personnel protected by either substantial dividing walls, barricades, or operational shields or be located at intraline distance from the operator and other operations. When it is necessary to repair, adjust, or otherwise clear a jam on a press or extruder, the pyrotechnic material will be removed from the hopper and the bay or press room before such repairs or adjustments are made. Only those adjustments of ram speed or conveyor speed normally intended to be under the control of the operator may be conducted with material in the bay. Under no circumstances shall repair or adjustment requiring the use of tools be permitted with pyrotechnic material in the bay.

b. The quantity of composition at the pressing location (behind the barricade) shall not exceed that required for the components undergoing the pressing operation. The quantity of composition in the remainder of the building at any one time shall not exceed the minimum required for a safe, efficient operation.

c. Each individual press, extruder, or loading device shall be located in a separate building, room, or cubicle, and be designed to limit an incident to that area and protect operators. Multiple installations may be permitted within a bay or cubicle provided that tests or hazard analysis demonstrate that production and personnel safety are not thereby jeopardized. Adequate means of pressure relief will be designed into each bay or cubicle.

23-7. Assembly Operations. Individual assembly operations shall be adequately separated from each other and shall be located in a separate cubicle or building from mixing, blending, and consolidation operations. Pyrotechnic composition will be kept in closed or covered containers at all times when not actually being processed. Surge, storage, and in-process transit between operations will also be accomplished with closed containers whenever not absolutely prohibited by the operational configuration. The quantity of components in any assembly room, bay, or building will be limited to the least quantity necessary for safe and efficient operations.

23-8. Granulation, Grinding, and Screening. a. Material to be reduced in particle size will be processed over a mechanical or magnetic separator to remove foreign materials prior to grinding. Following grinding, the material should again be screened and/or passed over a magnetic separator.

b. In the operation of ball mills, hammer mills, granulators, or screeners, the operator shall be protected from the effects of a potential incident by substantial dividing walls or operational shields. Every effort will be made to remotely fill and discharge grinding, granulating, and screening equipment. Cleaning of such devices will also be performed so as to provide the maximum degree of operator protection.

c. Working surfaces, containers, and handtools will be appropriately bonded and grounded.

23-9. Transportation. Transportation of pyrotechnic composition will be accomplished in closed containers only. Individual containers and the transport vehicle (handcart, handtruck, etc.) should be fabricated of the lightest materials compatible with the composition and having the requisite strength. The intent is to minimize fragment generation in the event of an incident by virtue of light construction and/or pressure relief. Transport vehicles should be equipped with "deadman" brakes when if the terrain requires it. On- and off-loading of transport vehicles should be conducted only in weather protected areas designed for this purpose. As necessitated by the size or shape of the composition containers, racks, or other support should be provided to secure containers against the possibility of falling.

23-10. Rebowling. Rebowling operations consist of the transfer of materials from one container to another, typically small quantities of sensitive materials. It may be done to recover the remains of small quantities of materials, or to subdivide large masses of materials into smaller masses for processing. An operational shield will be provided to shield operators from the potential effects of rebowling of pyrotechnic mixes.

23-11. Machining of Pyrotechnic Material. Machining of pyrotechnic materials will be accomplished remotely, except where specifically permitted in this chapter.

a. General requirements.

(1) Where machining with coolant is required, the coolant must be compatible with the pyrotechnic composition, and positive automatic interlocking devices will be provided to ensure that

the machine cannot be started until the coolant is flowing. These controls must also be capable of stopping the machine if the flow of coolant is interrupted. When it is essential to cut off the flow of coolant in order to adjust machine tools, positive means must be used to assure that once adjusted, the flow of coolant is restored and all automatic control devices are in operation, before resumption of machining. If a cutting edge inadvertently attains an excessive temperature during machining, it poses the maximum hazard when the machine is stopped and continuous contact with the pyrotechnic material is maintained. It is, therefore, essential that coolant flow be continued to the cutter until the cutter is removed from contact with the pyrotechnic material.

(2) Sensors are recommended to detect tooling malfunctions or other potentially hazardous conditions. Machine tool power consumption monitors, tool force gages, sound or noise detectors, and temperature indicating devices or IR can be used in this regard.

(3) Cutting tools must be chemically compatible with the pyrotechnic material to be machined and be capable of maintaining a sharp cutting edge throughout the machine cycle.

(4) Only positive control limits on tool adjustment will be used to ensure proper depth, diameter, and/or contour of the cut. Such control measures include guides, bushings, stops, and other physical alignment aids. The lineal and rotational speed of tools for the machining of pyrotechnic material will be maintained at the minimum necessary for safe and efficient operation. There should be no latitude for unintended operator adjustment of these features.

(5) Drilling operations must not impede the flow of chips and coolant in the bore. The drilling of small holes (one-quarter inch or less) and any size of multiple drilling operation will be performed by remote control, with operator protection provided, unless documented hazard analysis or tests demonstrate that operators will not be subjected to hazard by such operations.

(6) Contoured cutting tools must be completely free of contact with the pyrotechnic material being machined before personnel are permitted to enter the machining area. Machine tools should be cleaned as often as necessary during operating hours to prevent an accumulation of material residues and will be thoroughly cleaned from the machine operation by vacuum accumulator systems or by immersion in a stream of liquid coolant or similar automatic means. When using compressed air as a coolant, only low pressure (10 psig) may be used, and then only

when a vacuum collection system is used to reduce the scattering of pyrotechnic particles. The coolant delivery tube shall have a metallic tip or nozzle that is grounded to the machine to assist in the elimination of static charges.

b. Specific guidance for machining.

(1) Drilling and facing operations for colored smoke compositions containing organic dyes, potassium chlorates, and sugars should be conducted at not more than 2475 lineal inches per minute, with the feed rate adjusted to enhance the machinability of the composition. For red phosphorous compositions, drilling and facing operations should be conducted at not more than 1100 lineal inches per minute with the feed adjusted to minimize friction and heat build-up. For extruded candles composed of magnesium, tetrafluoroethylene polymers, and fluoroelastomer binders, drilling and machining operations shall be conducted at not more than 530 lineal inches per minute.

(2) Hand trimming and cutting of pyrotechnic candles may be permitted when supported by results of a hazard analysis specific to the particular composition and candle configuration.

(3) Particular attention must be given to the sawing operations to prevent the work from plunging into the saw blade and to ensure that chips are removed from saw teeth prior to their next cutting pass. Plunging can occur when thin sections are force fed into coarse-pitch saw blades. To prevent this, either a minimum of two saw teeth must remain in contact with the work while sawing, or the work-feed must be positively controlled. Chip accumulation ion saw teeth is a function of the material being sawed, rate of feed, blade speed, tooth design, and flushing arrangement. Additional chip removal equipment such as blade wiping brushes may be required.

23-12. Spill Control. Spills of pyrotechnic composition and energetic ingredient are potentially hazardous. In the event of an accidental spill the responsible supervisor should be notified prior to taking any action to clean or contain the spill. SOP for pyrotechnic operations will include specific provisions for spill clean-up. Such provisions may be incorporated into the various operations covered by the SOP or may be addressed as a separate procedure. The procedures should detail what actions are to be taken by whom and in what order. The recovery of the spilled material and decontamination of the area must also be addressed in the procedures. Spills having potential environmental impact should also be reported to the environmental coordinator. Spill clean-up procedures should also consider environmental impacts.

23-13. Collection of Pyrotechnic Wastes. a. Waste material and scraps will be removed at regular intervals from all operating

areas. All waste material will be segregated by type and compatibility, and kept separate from common wastes. Containers for these materials shall be distinguished by color and labeled. Filled containers should be placed at designated collection points.

b. Care will be exercised to preclude the mixing of small quantities of water with powdered or fine granulations of metals. Pyrotechnic waste may be maintained dry or submerged in water or oil, whichever is appropriate, for disposal. Plastic liners are recommended for waste containers to facilitate cleaning. Liners shall be conductive when the material contained is subject to initiation by static electrical discharge.

23-14. Cleaning of Pyrotechnic Processing Equipment. a. As pyrotechnic materials are typically sensitive to friction, impact, and/or static discharge, cleaning of equipment offers the same hazard potentials as processing. Due to the necessity of personnel proximity to the equipment being cleaned, the hazards of cleaning may exceed those of processing. Therefore, cleaning operations will be afforded the same preplanning and SOP coverage as the production steps.

b. Solvent solution flushing and cleaning by remote control is required for slurry-type mixing operations. For other application, the process equipment will be flushed with a compatible solvent, drained, and process repeated as often as necessary to remove the maximum quantity of pyrotechnic composition. High pressure water wash may be used where compatible with the pyrotechnic composition. Where the solvents used represent either a fire or toxicological threat, appropriate precautions will be taken to control the hazard. Run-off from cleaning operations will be controlled to preclude the creation of a secondary hazard from the spread of contamination.

c. Where remote cleaning cannot be used, personnel protective equipment will be designed and proven by test to afford operator protection from the maximum quantity of material that could be present, and its use will be required.

23-15. Personal Protective Equipment. a. Personal protective equipment shall not be relied upon as the primary means of operator protection. The primary means should be placed upon the reduction of quantities to the minimum and the use of operational shields. Supplemental operator protection may be afforded by high speed deluge systems designed and installed for such purposes. The personal protective apparel prescribed in an SOP will be specifically designated based upon the hazards associated with the operation.

b. The minimum personal protective apparel for personnel exposed to open containers of pyrotechnic or energetic raw materials will consist of the following:

(1) Cotton undergarments and socks. (100% cotton is not required, however, high cotton content is desired).

(2) Conductive-soled safety shoes.

(3) Flame retardant coveralls. (Only those flame retardant, or flame retardant-treated fabrics which have high moisture regain, and that carbonize with minimal shrinkage when exposed to fire will be used. Flame retardant-treated cotton meets this requirement, and its high moisture regain assists in reducing the potential for static electrical charge retention.)

(4) Hair coverings are recommended.

c. In addition to the items listed above, all employees exposed to hazardous quantities (as determined by hazard analysis or tests) of pyrotechnic compositions will wear the additional items describe below. The definition of hazardous quantities will be dependent upon the energy output and sensitivity of the composition and the nature of the operation. The intent is to assure that personnel are afforded realistic protection from the hazards of the operations. Required levels of protective apparel will be specified in appropriate SOP steps.

(1) Thermally protective suit with hood and face plate.

(2) Thermally protective trousers.

(3) Thermally protective gloves or equal.

(4) Respiratory protection as necessary to protect against toxic threats. Such protection must be compatible with other protective apparel.

23-16 Additional Controls. a. Many materials used in the production of pyrotechnics are either toxic or represent fire hazards or both. Operations will be designed to provide protection from these threats. Vapor and dust removal and collection systems must be provided where toxic or flammable dusts or gases are generated. Design and installation of such equipment must meet relevant environmental standards as well as safety requirements.

b. Blankets may be provided in closed but easily opened containers within 25 feet of operations where they may be required for

wrapping employees who have been burned. Where blankets are not provided, alternate means of achieving the same effect should be provided.

c. When required, conductive shoes will be checked for conductivity daily prior to the beginning of work and a permanent log should be maintained of the testing.

23-17. Reworking Pyrotechnic Components. a. All repair, reassembly, or similar operations on loaded pyrotechnic compositions will be accomplished in a separate bay used only for that purpose.

b. Normally, consolidated or extruded pyrotechnic compositions will not be pulverized for reblending operations. Such items should be destroyed. Some compositions, such as HC smoke, may be used. Other, more sensitive materials such as IR flare compositions may not.

23-18. Fire Protection. Where compatible with process materials, deluge systems may be used for the protection of mixing and blending operations, screening, granulation, drying, and pressing of extrusion operations. The response time of the deluge system should be selected to minimize the damage and facilities. Hazard analysis of the operation may dictate other applications.

CHAPTER 24

MANUFACTURE OF CASTABLE COMPOSITE PROPELLANT ROCKET MOTORS

24-1. Introduction. This chapter prescribes safety requirements that are intended to reduce the probability of injury or property damage during the manufacture and loading into rocket motors of castable composite propellants. For the purpose of this chapter, composite propellants are those which consist of a mixture of fuels, binders, and oxidizers with or without other ingredients. This also applies to colloid propellants when they are used as ingredients in composite propellant compositions.

24-2. Operational Shields. The design of operational shields be consistent with the provisions of DA PAM 385-64, and take into account the quantity of propellant involved, confinement that may be present, and the potential initiation hazard involved. In addition to the hazards outlined in chapter 14, the following hazards may be encountered in the processing of composite propellants:

a. Propellant detonation.

b. Unconfined propellant fires.

c. Pressure vessel failure with fragmentation.

d. Pressure vessel failure without fragmentation.

24-3. Facility Layout. a. Batch mixing and associated operations shall be performed in buildings used exclusively for that purpose. Small mixers (Û 50 gallon capacity) may be located in buildings containing other operations, provided the mixer is in a separate bay with operational shields that protect all other operations and unrelated personnel from the mixing operation.

b. In planning the location of new facilities that are intended initially for 1.3 materials, due consideration should be given to the possibility that 1.1 explosives may be processed in future operations.

24-4. Explosive Hazard Classification of In-Process Materials.

a. Prior to propellant manufacture, efforts shall be made to determine the hazard classification of the individual raw materials, the uncured propellant, and the cured propellant. This effort consists of classifying the materials by analogy or previous test data, or by conducting appropriate tests, such as those specified in TB 700-2 for propellant characterization. However, caution must be

OPERATION	HAZARD CLASSIFICATION
Organic oxidizer preparation (including screening and grinding)	1.1
Inorganic oxidizer preparation (including screening and grinding)	1.3
Pre-mix preparation	1.1
Propellant mixing	1.1
Propellant casting	1.3*
Propellant curing	1.3
Propellant finishing	1.3
Rocket motors during finishing	1.3
Finished motors in assembly areas	1.3
Finished motors during temperature conditioning, physical measurements, painting, packaging, etc.	1.3
Rocket motors in static test stands	1.1

* Casting operations involving propellants containing more than 88% solid constituents and/or composed of particles less than 15 microns in diameter are assigned an explosive hazard classification of 1.1.

Table 24-1. Hazard Classifications for Operations Involving Hazard Class 1.3 Propellants

c. If testing reveals that only the uncured propellant is detonable, casting and curing operations must be considered 1.1 explosive hazards. If testing reveals that only the cured propellant is detonable, curing and subsequent operations must be considered 1.1 explosive hazards.

24-5. Oxidizer Processing. a. General.

(1) All oxidizer process equipment shall be bonded and grounded.

(2) Screening, blending, grinding and mechanized drying operations shall be conducted remotely for organic oxidizers, and should be conducted remotely for inorganic oxidizers.

(3) Since oxidizing materials are corrosive to many of the metals used in process equipment, preventative maintenance schedules shall be followed closely.

(4) Many organic lubricants are incompatible with strong oxidizing materials and may form sensitive or explosive compounds when allowed to mix. Oxidizer preparation operations shall be designed to avoid inadvertent contamination of the oxidizer with organic lubricants.

(5) The use of wood or other porous materials in the construction of an oxidizer facility shall be minimized, and if use is unavoidable, such materials shall be coated with impervious fire retardant paint. Copper alloys can form sensitive compounds when exposed to oxidizers such as ammonium perchlorate, and should not be used in oxidizer processing facilities.

(6) Flexible connections (socks) in pipes and duct systems through which oxidizers are conveyed shall be fabricated of fire-retardant materials that are chemically compatible with the oxidizers. The pipes or duct systems shall be made electrically continuous. Flanged connections shall be used in lieu of threaded joints wherever practicable.

(7) Objects such as jewelry or pens that may be accidentally introduced into grinders should not be permitted into oxidizer preparation facilities. All tools should be accounted for by the use of tool checklists or shadow boards.

b. Drying operations.

(1) The maximum safe temperature for drying each type of oxidizer shall be established and shall not be exceeded at any point in the drying operation.

(2) If the dryer is capable of exceeding the maximum safe temperature of the oxidizer being dried, dual thermostatic controls shall be used to prevent overheating.

c. Screening operations.

(1) Screening equipment shall be constructed to preventthe oxidizer from being subjected to pinching, friction, or impact as a result of metal-to-metal contact. Systems should be designed for continuous removal particles less than 15 microns, if practical.

(2) Rooms in which screening operations are conducted shall be cleaned as necessary to prevent hazardous accumulations of dust.

d. Grinding operations.

(1) Impact-type mills shall not be used to grind organic xidizers.

(2) Oxidizers shall be passed through a screen and a magnetic separator immediately prior to entering a grinder or pulverizer in order to assure removal of extraneous material. Screen openings should be the smallest that permit free flow of the oxidizer.

24-6. Preparation of Fuel Compositions. a. Equipment design and handling methods shall minimize formation and accumulation of dust.

b. Compatibility of materials shall be established and controls incorporated to preclude the mixing of materials at a time or in a manner that would result in sensitive compositions.

c. Due to the susceptibility of metal powers to ignition from electrostatic discharge, all dumping, screening, weighing, and handling equipment should be bonded and grounded. Assure the continuity to ground for spatulas, scoops and other tools used to dump, measure, or stir metal powders.

d. Positive measures shall be taken to exclude moisture from metal powder operations. Waste metal powders should be immersed in a compatible nonreactive liquid until disposed.

e. The introduction of an inert gases into process equipment in order to reduce oxygen content should be considered as a means to prevent dust explosions.

f. Objects such as jewelry or pens that may be accidentally introduced into mixers should not be permitted into fuel preparation facilities. All tools should be accounted for by the use of tool checklists or shadow boards.

24-7. Mixing of Fuel Compositions and Oxidizers. a. Facilities and equipment.

(1) Mixer facilities shall be provided to provide the maximum vent space consistent with the structural integrity of the facility. The use of wood or other porous materials in the construction of an mixing facility shall be minimized, and if use is unavoidable, such materials shall be coated with impervious fire retardant paint.

(2) Quick-acting detection and delivery deluge systems should be installed in the facilities to cover points of operation. These systems should be interlocked with the mixer control circuits to prevent mixer operation when deluge system is inoperative.

(3) Propellant mix bowls shall be provided with lightweight covers to prevent materials from dropping into the mixer. The cover design shall allow adequate venting in the event of an ignition in the mixer.

(4) The gear housing of vertical mixers shall be sealed or purged with an inert gas during mixing operations to prevent contamination by dust from the mixing bowl.

(5) Blades and other moving parts of mixers shall be nondestructively tested for cracks, crevices and other imperfections prior to first use, and continued inspections shall be made on a regular basis.

(6) Nuts, bolts, and other hardware on mixers, monorail systems, or in other locations that could loosen and fall into a mixer shall be effectively secured.

b. Mixing operations.

(1) All materials introduced into the mixer during mixing operation shall be done so remotely. The mixing cycles shall be completely remote controlled.

(2) All materials shall be screened prior to entering the mixer. Where the physical characteristics of the material preclude screening, other methods such as magnetic separators or nondestructive testing should be employed to segregate foreign material and preclude their entry into the mixer.

(3) Oxidizers shall be introduced into mixers after the fuel-binder compositions to minimize the probability of the mixture undergoing a deflagration to detonation transition if an ignition occurs during mixing.

(4) Clearances between blades and mixer bowls shall be established as the maximum clearance consistent with quality and process requirements, and should provide for deflection of shafts and wear in journal and bearing areas. Blade clearance shall be checked at sufficient intervals to assure adequate clearances. The openings in screens shall always be smaller than the blade to bowl clearances.

(5) Frequent inspections and changing of the packing gland material shall be accomplished to preclude a build-up of oxidizer and fuel in the packing gland area. Packing materials and lubricants shall be compatible the oxidizer, fuel and propellant. Temperatures in the propellant mass shall be monitored to detect significant temperature rises due to wear or exothermic reactions.

(6) Vertical mixer bowls used as casting cans or transport hoppers shall be nondestructively tested at frequent intervals to detect possible damage of weldments between the bowl and bowl jacket. Blade to bowl measurements shall be made and compared to previous values to determine if warping has resulted from handling.

(7) Spilling or splashing of propellant during discharge of mixers shall be avoided. Operators shall be so positioned during discharge operations that direct, unblocked routes of rapid exit will exist for emergency use.

24-8. Casting Composite Propellants. a. General. The three most common methods of casting are bayonet casting, in which the propellant is introduced into the top of the motor through hoses; bottom casting, in which the propellant is forced by pressure up through an opening in the bottom of the rocket case; and vacuum casting, in which the propellant is passed through a slit plate into a rocket motor case enclosed in a vacuum bell. High strength cases are also used as vacuum bells.

b. Casting facilities. Casting facilities should be constructed of lightweight materials and shall be designed to provide the maximum vent area consistent with the structural integrity of the facility. They shall be designed so that operating personnel have unblocked escape routes at all times. Escape chutes to the outside should be provided from work platforms.

c. Casting equipment.

(1) All casting vessel assemblies shall be designed to preclude internal cracks, crevices, corners, pockets, and any internal configurations which could subject propellant to initiation from impact, friction, or compression.

(2) Lids shall be secured to pressurized casting vessels in a manner which will withstand the rated pressures of the vessels. Frequent tests and inspections shall be made to assure that the clamp or assembly device is functioning properly.

(3) Pressurized casting vessels shall be capable of withstanding at least twice the maximum allowable working pressure to which it can be subjected. Hydrostatic tests (at 1´ times the working pressure) should be conducted after any alteration, abuse, mishandling, or dropping. A log of test results should be maintained for each vessel.

(4) A blowout disk, designed to blowout at 120 percent of the vessel's maximum allowable working pressure, shall be provided.

(5) The internal welded seams shall be inspected frequently by approved methods of weld examination.

(6) Casting vessel support fixtures, such as legs, shall be attached in such a manner that routine handling will not cause damage to the casting vessel internal surface. They shall be proof tested initially at 111 percent of the total weight to be supported and periodic tests and inspections conducted thereafter.

(7) Vibration equipment attachments shall be designed to prevent frictional heat generation on the vessel structure which contains propellant.

(8) Threaded connections shall not be permitted in piping, valve connection, or any part of the casting vessel charging or discharging system. Casting piping and manifold systems shall not be joined with threaded connections. They should be pressure tested at 1´ times the maximum casting pressures. Methods of attachment for casting piping and manifold joints shall provide positive fastening to eliminate failure of mating parts when pressurized.

(9) Valves through which uncured propellant flows shall be designed to prevent compression of propellant between two metal surfaces (e.g., rubber diaphragm-type valves). These valves should be cleaned and inspected after each casting operation. A positive system to prevent propellant flow shall be incorporated into the casting system to stop the flow in the event of primary valve failure. Valve attachments to a nonpressurized casting vessel shall be equipped with flanged mating surfaces and secured by positive methods. The use of "quick release" type fittings shall not be permitted.

(10) Vacuum casting bells shall be designed to withstand the conditions under which casting is accomplished.

(11) Deaeration assemblies shall be designed to prevent pinching or impacting propellant and for ease of assembly and disassembly.

d. Casting operations.

(1) Pressurization of casting vessels shall be performed remotely. Pressure at the casting vessel shall not exceed the working pressure of the vessel. Filters shall be installed in air lines to remove water and oil. Use of safety links is recommended for pressurized casting vessels to restrain the casting vessel lid in the event the attachment device fails when pressurized.

(2) Casting vessel handling method and equipment shall be designed and operated per approved standards. The vessels shall be restrained to prevent movement should a rupture of the relief valve occur.

(3) Mechanical insertion and removal of cores in motors containing cured propellant shall be accomplished remotely or by personnel protected by adequate shields or barricades. When cores are to be inserted mechanically, the equipment should be designed to prevent metal-to-metal contact between the core and motor case below the propellant surface.

(4) Loaded motor cases or casting molds shall be secured during casting and handled in a manner which will prevent overturning or spillage of propellant. For large motors, casting cores shall be secured to prevent movement when loaded motors are transported in any manner.

24-9. Propellant Curing. a. Curing facilities and equipment.

(1) Curing facilities shall be constructed of lightweight materials and should be designed to provide the maximum vent area consistent with the structural integrity of the facility.

(2) The safe temperature for curing the propellant shall be established and dual heat controls shall be used to prevent that temperature from being exceeded.

(3) Heating units or elements shall be designed to eliminate any direct contact between the heating unit or element and the propellant or rocket motor.

(4) Mold supports and other casting and curing fixtures shall be designed to avoid rubbing or pinching of thin layers of propellant between metal surfaces.

(5) Means of pressure relief shall be provided on closed pressurized vessels into which motors are placed for curing.

b. Curing operations

(1) Loaded motor cases or casting molds shall be handled or secured so that overturning will be prevented.

(2) Loaded or partially loaded rocket motors shall be raised or suspended at minimum distances above floor level. If tests or experience indicate that rocket motors may ignite upon dropping, protective measures shall be employed to minimize the possibility of such ignition.

(3) Core popping (initial release or separation of case from propellant) shall be done remotely or from a shielded location. When the core has been "released," final extraction of the core may be accomplished manually. When cores are not designed with a taper (smaller dimension at forward end), extraction of the core from the motor cavity shall be done remotely or from a shielded position.

24-10. Motor Finishing and Assembly. a. Securing motors. Rocket motors and pressure vessels containing cured propellant shall be secured in fixtures capable of withstanding the rated thrust of the assembly (based upon its performance as a rocket motor with a safety factor of 2.5 to offset shock loads) for operations involving the possibility of propellant ignition.

b. Threads.

(1) Where the design of a motor case incorporates internal threads, means shall be provided for preventing contamination of the threads with propellant.

(2) Whenever possible, the design of casting and curing assemblies and fixtures shall exclude internal threads, cracks, and crevices where propellant may be deposited.

(3) All threads shall be cleaned and inspected prior to assembly of component parts.

(4) Assembly of threaded components shall be accomplished by remote control with personnel protected by adequate shielding if a possibility of propellant contamination exists.

c. Mandrel removal. Operations involving mandrel removal shall be conducted remotely.

d. Machining non-case-bonded propellant grains. Propellant grains that are not case-bonded should be machined to the extent necessary prior to loading into motors.

e. Igniter insertion.

(1) The following requirements apply where the design of a motor makes it necessary to insert the igniter within the manufacturing line:

(a) The supply of igniters at the insertion station shall be the minimum consistent with safe and efficient operation.

(b) If removal of the shorting clip is required by the process, the igniter shall remain shorted until immediately prior to insertion.

(c) Process storage facilities for igniters shall be vented to the atmosphere and designed to withstand the effects of an incident involving all igniters within.

(2) Electrical continuity tests for igniters installed in motors shall be performed remotely from other operations.

24-11. Environment and General Practice. a. Tool design.

(1) Where propellant may come into contact with equipment during processing, all metal-to-metal surfaces shall be avoided. There shall be no threads, cracks, crevices, or blind holes in metal parts that may contact the propellant during casting or finishing operations. Teflon-coating metal surfaces such as molds and mandrels will generally prevent the propellant from adhering.

(2) Recommended materials for handtools include the following: aluminum, oil-resistant Neoprene, beryllium-copper alloy, ANSI 300 stainless steel, and tempered steel (for cutting tools such as X-acto knives). Steel cutting tools shall not be allowed to cut through the propellant to the metal. For example, during small sample cutting, the cutting board should be covered with a Teflon sheet.

(3) Tool design or selection shall incorporate safety considerations such as tool speed control, use of nonsparking metals in contact with or close proximity to the propellant, provision of limit switches to prevent over-ranging of tool and possible metal-to-metal contact, explosion proofing of machinery, use of effective coolant where necessary, effective dust and chip removal, ease of cleaning, and provision for adequate grounding. The deluge system shall provide for the quenching water to be directed at the area where the cutting or machining is occurring, since it is the likely point for ignition to occur.

b. Manual operations.

(1) Manual operations shall only be allowed when the propellant is well characterized and it is not feasible to conduct the operation remotely.

(2) Safety goggles shall be worn, and additional shielding shall be provided where feasible. Whenever possible, the operator shall not face the hazardous source directly. Fire-retardant clothing shall be worn, avoiding any type of encumbrances. Protective gloves shall be used when they do not hinder the manual operation.

(3) Tooling should be designed so that cutting pressure can be applied to the tool with only one hand. For certain operations, it may be necessary to use the other hand to assist in guiding the tool to regulate the depth of cut, prevent pinching of the propellant, or avoid metal-to-metal contact.

(4) Such tools as specifically designed cutters can be used for manual trimming, although final trimming may be more safely done by hand when the operation is closer to metal walls.

(5) Parts shall never be forced to fit, as this may indicate that propellant has worked in between mating parts. During operations which pose a threat of propellant contamination to threads and bolt holes, they should be protected by such measures as covering with masking tape.

(6) For highly hazardous manual operations such as hand trimming of motors, a second, qualified individual shall be present or available in the event of an accident. The second individual can also be used to verify the adequacy or completion of critical operational procedures.

c. Remotely controlled operations.

(1) For extremely hazardous propellants and/or configurations of motors, remotely controlled operations using power-driven equipment shall be required.

(2) Automated warning systems and television monitors shall be used to monitor potential trouble spots. Direct line-of-sight viewing, unless appropriately shielded, shall not be allowed. The sound of the operation should also be monitored to catch unusual sounds that could indicate potential problems.

(3) Adequate safety precautions such as barricades, flashing lights, chains, or interlocks shall be used to prevent operators from entering rooms during equipment operations.

The proponent of this regulation is the United States Army Materiel Command. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to the Commander, HQ AMC, ATTN: AMCSF-X, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001.

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