DEPARTMENT OF THE ARMY TECHNICAL MANUAL

STORAGE, SHIPMENT HANDLING AND DISPOSAL OF CHEMICAL AGENTS AND HAZARDOUS CHEMICALS

HEADQUARTERS, DEPARTMENT OF THE ARMY
MARCH 1969

TECHNICAL MANUAL
No. 3-250

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *7 March 1969*

STORAGE, SHIPMENT, HANDLING, AND DISPOSAL OF CHEMICAL AGENTS AND HAZARDOUS CHEMICALS

***This manual supersedes TM 3-250, 13 August 1963.**

CHAPTER 1

INTRODUCTION

1. Purpose

This manual is published for the guidance of personnel in handling, storing, shipping, and disposing of chemical agents and hazardous chemicals.

2. Scope

a. This manual covers end item chemical agents and hazardous chemicals handled by depots and other storage installations. It discusses general characteristics; means of identification; care and handling; storage; surveillance; packing and marking; shipping; renovation; disposal of unserviceable agents and chemicals; safety measures to include detection of leakers, first aid, decontamination, and fire prevention; and classification according to storage compatibility, shipment, surveillance, and fire-fighting operations.

b. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to Commandant, U.S. Army Chemical Center and School, Fort McClellan, Ala. 36201.

c. The material presented in this manual is applicable to both nuclear and nonnuclear warfare and peacetime operations.

3. Classification of Chemical Agents and Hazardous Chemicals

Chemical agents are classified into several groups on the basis of their use: toxic chemical agents, riot control agents, incapacitating agents, smokes, and incendiaries. Chemical agents and hazardous chemicals having similar storage and shipment characteristics are grouped together as follows:

a. Group A. This group includes all toxic chemical agents (i.e., blister and nerve agents) for which impermeable protective clothing and protective mask are required. Common storage and equipment problems are discussed collectively; specific storage and shipment problems and physiological action are individually listed for each chemical agent (ch 4).

b. Group B. This group includes all toxic and incapacitating chemical agents for which the protective mask alone is required, as well as nonburning screening smokes and nonburning mixtures of riot control agents. Storage and shipment problems are discussed as for group A. For convenience, group B chemical agents are grouped as choking agents, blood agents, incapacitating agents, nonburning riot control agents, and nonburning screening smokes (ch 5).

c. Group C. This group consists of the spontaneously flammable agents, white phosphorus and plasticized white phosphorus. Storage and shipment problems are discussed as for group A (ch 6).

d. Group D. This group includes all readily flammable materials such as burning mixtures of riot control and smoke agents, incendiaries, oils, and solvents. Storage and shipment problems are discussed as for group A (ch 6).

e. Miscellaneous Chemicals. Chemicals that do not fall under group A, B, C, or D are grouped together. For convenience, they are discussed under the headings of chemical decontaminants and impregnating chemicals, industrial compressed gases, corrosive liquids, hazardous chemicals are discussed in chapter 7.

f. Ammunition Supply Points (ASP) and Special Ammunition Supply Points (SASP). The groups enumerated in *a* through *e* above apply primarily to CONUS depots. Ammunition service to the army in the theater of operations is provided through ammunition supply points, which handle conventional ammunition including smokes and riot control agents; and through special ammunition supply points, which handle special ammunition including toxic chemical agents and incapacitating agents. An ASP handles the conventional chemical munitions found in groups D, C, and B (excluding blood, choking, and incapacitating agents). A SASP handles

the special chemical munitions found in group A and that part of group B which includes blood, choking, and incapacitating agents.

4. Marking of Chemical Munitions

Markings on chemical munitions are based on their uses and are not definite guides for classification according to storage groupings of the agent fillings.

a. Standard Ammunition Color Coding System. Chemical munitions now in production are marked according to the standard ammunition color coding system (MIL-STD-709A, FM 3-8, and TB 9-1300-246/1). The color code is a visual aid and is a supplement to stenciled or stamped markings on the ammunition. The marking includes information necessary for complete identification of the ammunition; e.g., agent symbol and descriptive word indicating the general nature of the agent on release.

(1) *Toxic, riot control, and incapacitating chemical agents.* Munitions are marked with a base color of gray with one or more bands, appropriately colored, denoting the type of agent and the presence of an explosive element for bursting the casing (high explosive, yellow band; low explosive, brown band).

(a) Toxic chemical agents. One or more green bands are circumscribed about the munition to indicate toxic chemical agents. One green band denotes nonpersistent effect agents; two green bands denote persistent effect agents; and three green bands denote all nerve agents (regardless of duration of effectiveness). The descriptive word "GAS" and the chemical agent symbol are marked in green to indicate the exact filling.

(b) Riot control and incapacitating chemical agents. One red band circumscribed about the munition indicates riot control agents; two red bands indicate incapacitating agents. The chemical agent symbol is marked in red on the munition. Riot control munitions are further marked in red with the descriptive word "RIOT."

(2) *Smokes.* Smoke munitions are designated by a light green background covering the entire munition. The standard symbols of the agent filling, and other information, are marked in black letters on the light green background. White phosphorus (WP) ammunition, because of its additional incendiary effect, is marked with the lettering in light red. An explosive element is indicated by a yellow band.

(3) *Incendiaries*. Munitions containing liquids, jellies, or solid intended to produce damage by fire are designated by a light red background covering the entire munition. The standard symbols for the filling, and other information, are marked in black letters on the light red background. Yellow or brown bands again indicate the presence of explosive elements.

(4) *Practice munitions.* Practice munitions are designated by a blue background with all lettering in white. The presence of a high or low explosive charge is indicated by a yellow or brown band, respectively.

b. Five-Element Marking System. All chemical munitions manufactured before January 1961 follow the *Five-Element Marking System*. According to this system, chemical munitions are indicated by a background color of gray, and are circumscribed with one or two bands to indicate the *duration of effectiveness*. One band circumscribed about the center of the munition indicates a nonpersistent effect agent; two bands indicate a persistent effect agent.

(1) *Toxic chemical agents.* These agents are indicated by green markings on the gray background. Nonpersistent effect agents (by symbol) in this category are GB, CG, and CK. Persistent effect agents include VX, HD, H, and HT. The descriptive word GAS indicates the general nature of the agent filling upon release.

(2) *Riot control agents.* These agents (classified as irritant agents under Five-Element System) are designated by one red band on the gray background. Symbols for the riot control agents are CN, DM, CS, CN1, DM1, CS1, and CS2. The descriptive word GAS again indicates the general nature of the agent on release.

(3) *Smokes.* Smoke munitions are designated by one yellow band on the gray background. Symbols for the agent fillings include HC, WP, and PWP. The general nature of the agent on release is indicated by the word SMOKE.

(4) *Incendiaries.* One violet band on the gray background is used to designate incendiaries. Symbols for the fillings are TH, NP, PT1, and PTV. The descriptive word INCENDIARY indicates the general nature of the agent on release.

c. Cylinder Markings. For markings on compressed gas cylinders and on cylinders used to transport chemical agents under pressure, see MIL-STD-101.

5. Definitions

Properties of chemical agents are discussed in TM 3-215, which covers military chemistry and chemical agents. Certain terminology used to

describe chemical, physical, or physiological properties of chemical agents is discussed in *a* through *i* below, from the viewpoint of problems encountered in field storage and shipment.

a. Vapor Pressure. Vapor pressure of a substance (solid or liquid) is the pressure exerted by its vapor when in equilibrium with the substance (at a given temperature). Vapor pressure is usually expressed in millimeters of mercury.

b. Volatility. This term is used to indicate the tendency of a liquid to assume the vapor state. It may be expressed as the weight of vapor present in a unit volume of air under equilibrium conditions at a specified temperature. Volatility is usually expressed as milligrams of vapor per cubic meter (mg/m^3) of air (*d* below).

c. Boiling Point. This is the temperature at which the vapor pressure of a liquid equals the atmospheric pressure. An estimation of the duration of effectiveness of a chemical agent may be made when its boiling point is known. The higher the boiling point, the lower the vapor pressure and the lower the evaporating tendency at ambient temperatures. For example, mustard (HD) boils at about 228° C. and evaporates relatively slowly at ambient temperatures. Phosgene (CG) boils at about 8° C. and evaporates very rapidly at ambient temperatures.

d. Concentration. Concentration is the amount of chemical agent, regardless of physical state, present in a given volume of air. Concentration usually is expressed in milligrams per cubic meter (mg/m^3) .

e. Duration of Effectiveness. Duration of effectiveness refers to the length of time a chemical agent is effective at the point of release. Duration of effectiveness depends on the inherent properties of a chemical agent and varies with the method of dispersal, weather, and terrain. This manual is concerned with duration of effectiveness in storage or in transit - the time a chemical agent remains effective or continues to present a hazard in case of accidental spillage or leakage, as opposed to tactical duration of effectiveness - the time a chemical agent remains effective when disseminated in the field during actual usage of chemical ammunition. When spilled, a nonpersistent effect agent usually causes casualties through the inhalation of its vapors. (An exception is GB, which can cause casualties both by inhalation and through contact of liquid on the skin.) A persistent effect agent usually causes casualties through contact of liquid on the skin. (Exceptions are VX and the mustard agents H, HD, and HT which can cause casualties both by contact of liquid or vapor with the skin and by inhalation of vapor.)

f. Hydrolysis. Hydrolysis is the reaction of a chemical with water whereby decomposition of the chemical occurs. Hydrolysis reduces the effectiveness of many chemical agents, although, in some, the resulting product of hydrolysis may be in itself a poison (as with agents containing arsenic). The rate of hydrolysis is the rate at which the various chemicals are decomposed by water; thus, it indicates the resistance of a chemical to decomposition by water.

g. Coefficient of Expansion. The coefficient of cubical expansion is defined as the ratio of increase in volume of a substance for a given rise in temperature to the original volume. This value is used to compute the amount of void (outage) to leave in a container when filling it with a chemical agent-particularly a highly volatile chemical agent-to provide for expansion of the contents when the temperature rises.

h. Theoretical Minimum Void. The theoretical minimum void is the minimum amount of space that must be left in a container during filling to allow for expansion of the filling with increase in temperature.

i. Temperature. This manual gives temperatures in both Fahrenheit (°F.) and Centigrade (°C.). To convert one scale to the other, use the following formulas:

$$F = 1.8C + 32$$

$$C = \frac{F - 32}{1.8}$$

CHAPTER 2

EQUIPMENT FOR CHEMICAL STORAGE AND HANDLING

Section I. INTRODUCTION

6. General

This chapter describes in general terms and illustrates the types of containers, equipment, and protective clothing used for storage, shipment, and other handling of bulk chemical agents and chemicals. Some basic operations are described. For more detailed information on chemical handling equipment, see references listed in appendix A.

a. Containers. Containers used for storage and shipment of chemical agents range widely in size and are discussed in paragraphs 7 through 15. The principal types used for shipment to a theater of operations are the 1-ton container and the 55-gallon drum.

b. Equipment and Tools. Equipment and tools used in handling containers of chemical agents are discussed in paragraphs 16 through 31.

Section II. ONE-TON CONTAINERS

7. Use of Containers

One-ton containers are used for storing and shipping liquid or gaseous chemical agents.

8. Description and Data

a. General. There are two types of 1-ton containers, types A and D. These containers are filled with about 170 gallons of agent, allowing approximately a 10-percent void space for expansion. The maximum quantity of any agent is limited by the 8,500-pound maximum allowable gross weight. The containers are tested to withstand a maximum internal pressure of 500 pounds per square inch. One-ton containers (fig. 1) have eduction tubes, valves, and plugs as described.

(1) *Eduction tubes.* All 1-ton containers have two eduction tubes and two valves. Each eduction tube leads from near the side of the container on the interior to one of the two exterior valves. During transfer operations, the end of the eduction tube leading to the upper valve is in the void space above the contents of the container, and the end of the tube connected to the lower valve is in the liquid in the container. This arrangement permits the flow of agent during transfer operations (fig. 2).

(2) *Valves.* There are two general types of valves used in 1-ton containers, the needle valve and the angle valve (figs. 8 and 4). The needle valve comes in 3/4-inch or 1-inch diameter and is used when handling agents that are gaseous at atmospheric pressure (these agents tend to build up relatively high pressures). The angle valve is of 1-inch size only and is used when handling agents that are liquid at atmospheric pressure (these agents do not tend to build up relatively high pressures). A valve-opening wrench is furnished with each container. During shipment, it is attached to a valve stem. The valves are threaded on the outside and closed with safety caps. They are protected during shipment by a shipping bonnet which covers them.

(3) *Plugs.* Each 1-ton container has six plugs, three of which are evenly spaced in each head.

(a) Fusible plugs. This type of plug is brass and contains a lead alloy core which melts at a temperature of 175° F., venting any excess pressure. This plug is used with agents that are gaseous at atmospheric pressure since they tend to build up more pressure and heat than liquid agents. Normally, in storage, the temperature will not build up enough to melt the lead alloy core. However, this is a problem in case of fire during storage and shipment.

(b) Nonfusible plugs. This type of plug is solid brass or steel. It is used with agents that are liquid at atmospheric pressure. These agents do not build up heat as do the gaseous agents. For more

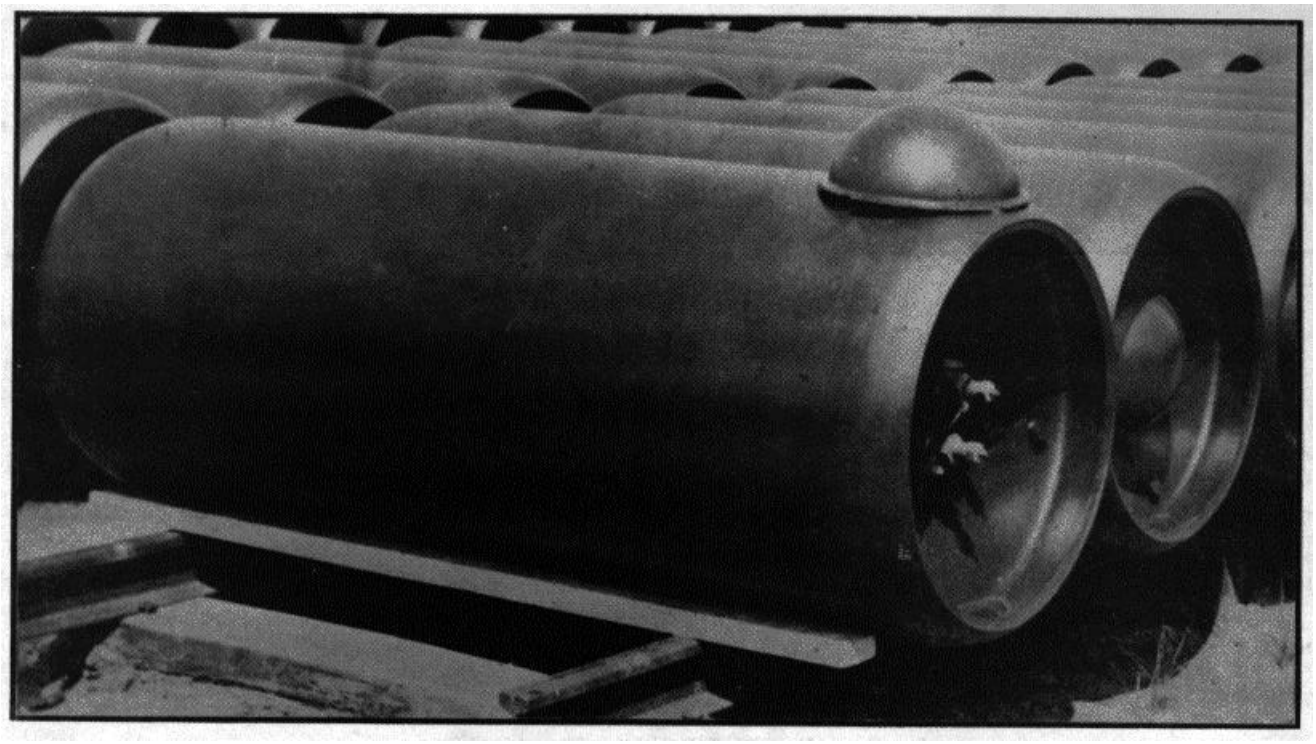


Figure 1. One-ton container.

detailed information about the 1-ton containers, see table 1.

(c) Steel plugs. When 1-ton containers are cleaned, all brass plugs are removed and steel plugs are substituted for them. The threads of the brass plugs would fuse to the steel threads of the container under pressure and heat.

(d) Stainless steel plugs. Certain lots of GB come from the manufacturer with stainless steel plugs. When cleaning the interior of 1-ton containers, all these plugs are removed and other special steel plugs are inserted.

b. Type A 1-Ton Container. The type A 1-ton container is used for shipping and storing agents that are gaseous at atmospheric pressure. The two valves are protected during shipment by a shipping bonnet that fits over the valves and is fastened to the head of the container by three bonnet clips and a bonnet locking clip (fig. 5). Identification of the container (serial number and date tested) is stamped on the front rim.

c. Type D 1-Ton Container. The type D 1-ton container is used for shipping and storing both agents that are gaseous and those that are liquid at atmospheric pressure. Identification is by means of a circular, soldered nameplate on the rear head of the container. A shipping bonnet protects the valves during shipment (fig. 5). Since type D 1-ton containers are used for gaseous agents as well as for liquids, type A probably will not be procured after the present stocks are eliminated.

Table 1. Tabulated Data, One-Ton Containers

Characteristics	Type of Container	
	A	D
Use	Agents that are gaseous at atmospheric pressure.	All gaseous or liquid chemical agents.
Weight (empty)	1,600 pounds	1,600 pounds
Cubage	42.7 cubic feet	42.7 cubic feet
Maximum capacity	190 gallons	190 gallons
Working capacity	170 gallons	170 gallons
Valve type	3/4-inch needle valve	1-inch needle valve 1-inch angle valve

Table 1. Tabulated Data, One-Ton Containers--Continued

Characteristics	Type of Container A	Type of Container D
Distance between valves	4 inches	4 inches
Inside diameter of eduction tube	1/2 inch	1 inch
Overall length	81-1/2 inches	81-1/2 inches
Outside diameter	30-1/2 inches	30-1/2 inches
Thickness of sides	13/32 inch	13/32 inch
Thickness of ends	3/4 inch	3/4 inch
Agents stored with needle valves	CG, CK, C1	CG, CK, C1
Agents stored with angle valves	None	HD, H, HT, GB, VX

9. Operations

Basic operations for transferring chemical agents to and from 1-ton containers are described in paragraphs 130 through 160.

10. Care and Maintenance

a. External Decontamination. Whenever possible, containers should be cleaned externally immediately after they are emptied. This should be accomplished by trained personnel who are familiar with facilities equipped with toxic waste disposal, vacuum, dry air, steam, and other necessary equipment. When lack of facilities and time prevent cleaning and decontamination of the interior of a container, cleaning may be confined to the exterior. It is probable that most exterior contamination will be around the front head of ;he container. The entire head must be decontaminated with bleach slurry, hot water and soap, DANC, or DS2 solution, depending on the agent in the container (TM 3-220). Attention should be given to the valves. Decontamination should be followed by a water rinse, drying, and a test to check for complete decontamination. A container thus cleaned may be refilled with the same agent without further decontamination. Personnel must use protective clothing and equipment suitable for the agent being decontaminated (para 28-31).

b. Internal Decontamination.

(1) *General.* Whenever possible, containers should be cleaned inside immediately after they are emptied, unless they are intended for early reuse with the same agent. The general procedure is to make sure that the container is as nearly empty as possible. Then flush with the proper decontaminant, rinse with neutralizing solution and water, purge with steam, dry with hot air, and seal.

(2) *Toxic chemical agents.*

(a) General. After the quantity and nature of the residue have been determined, add the proper decontaminant to the container for the specific agent (TM 3-220). Roll the container back and forth for a sufficient length of time until the interior has been soaked. Empty the container and wash it with hot soapy water, followed by a clear water rinse. For containers severely contaminated by mustard, see (*b*) below. Test for completeness of decontamination, using a chemical agent detector kit as described in TM 3-220.

(b) Mustard agent decontamination. A container that has been used to store mustard agents may be thoroughly cleaned by the method described in 1 below. If the container is to be reused for an agent other than mustard, it is necessary to remove all traces of the previous filling by the method described in 2 below. The valves should also be cleaned as described in 3 below.

1. The standard method for cleaning an empty container that has been used to store mustard agents is to introduce steam under pressure of about 125 psi through the eduction tubes. Before starting the procedure, all brass plugs are removed and steel plugs, luted with graphite solution, are put in their places. The steam is kept in the container .under pressure for about 1 1/2 hours or until the container reaches a temperature of about 300° F. This treatment normally will melt any sulfur residue of mustard agents (other than large quantities of residual material that may be left by Levinstein mustard, which will require extensive steaming). After treating the container with steam, follow the procedure described below:

(a) Elevate one end of the container to an angle of about 30°. Remove the bottom plug on the raised end of the container and insert an eduction tube so that it reaches the inside bottom of the container. Connect a blowout line with a shutoff valve from this plug outlet to a discharge pit at least 100 feet away on the downwind side. A 55-gallon drum with small holes in the bottom is generally used as a discharge pit. The drum is sunk into the ground. The liquid flowing out of the blowout line goes through the hole, while the solid material is caught.

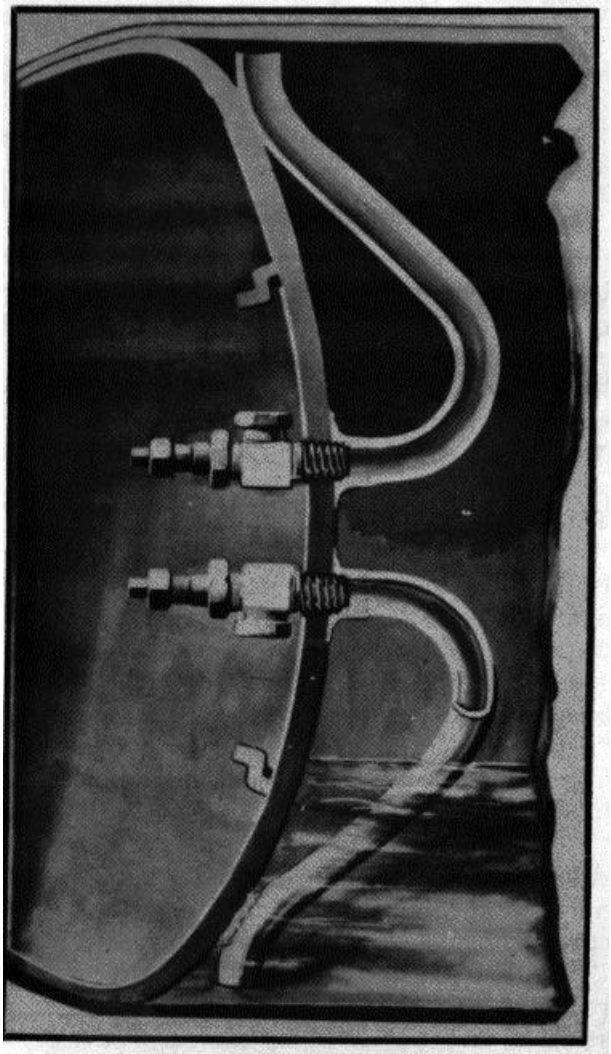


Figure 2. Cutaway view of front head of 1 ton container

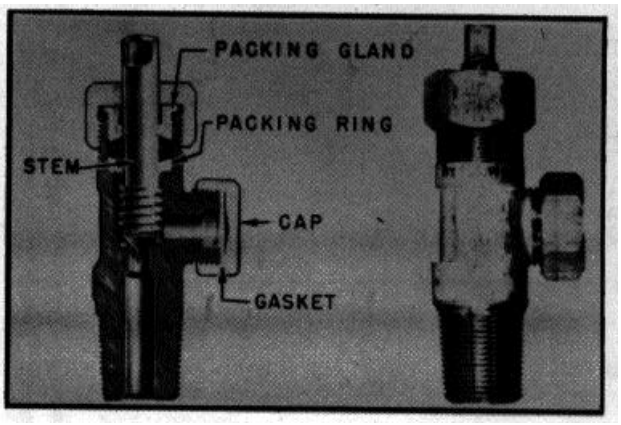


Figure 3. Needle valve.

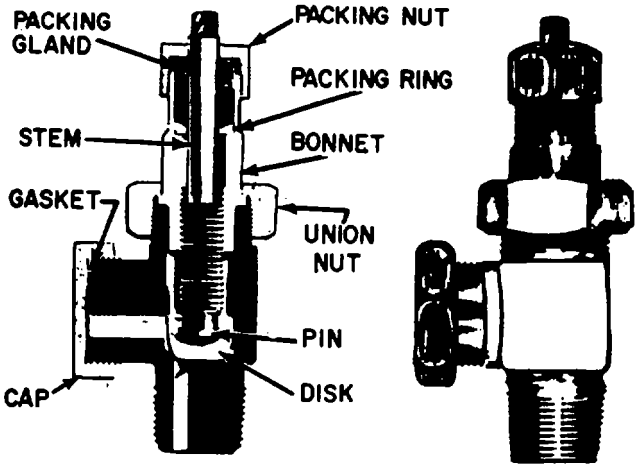


Figure 4. Angle valve.

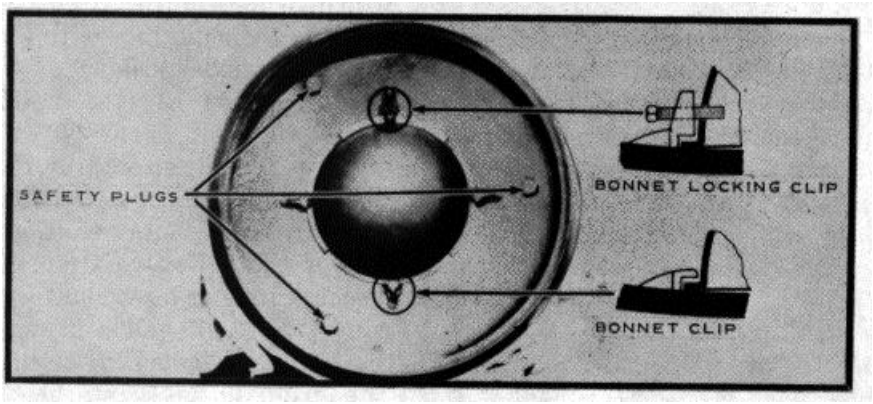


Figure 5. Shipping bonnet for 1-ton containers.

(b) Reverse the slope of the container so that the other end is elevated to an angle of about 30°.

(c) Preheat this blowout line with steam to prevent the sulfur that is to be blown out of the container from hardening and plugging the line.

(d) Introduce live steam into the container through one of the eduction tubes in the front end of the container.

(e) When the color of the steam from the blowout line changes from yellow to white, lower the front end of the container one quarter inch at a time until the color of the steam changes to yellow again. This indicates that sulfur is being blown out of the container. Keep the container at this angle and continue the blowout process until the steam turns white again.

(f) Repeat the process in *(e)* above until the container has been cleaned and emptied.

(g) Permit the container to cool and dry. (Steam at a temperature up to 300° F. will evaporate immediately.)

2. For containers to be reused for agents other than the mustards, follow the procedure described below:

(a) Clean the empty container with steam as described in *1* above. (Be sure there is no moisture left in the container.)

(b) Wash the interior of the cleaned container for about 15 minutes, using either 98 percent sulfuric acid with approximately one-half percent chromium trioxide added, or 20-percent oleum with about 10-percent nitric acid added.

(c) Drain, and use air pressure to remove as much of the remaining acid from the container as possible.

(d) Wash the container with any slightly alkaline solution, and then drain the solution.

(e) Resteam the container with high pressure steam, and afterward dry it with hot compressed air.

3. Remove the valves from the container and disassemble them. Decontaminate the parts with the proper decontaminant, depending on the agent used in the container. Wash the parts in an organic solvent to remove any remains of grease or oil. Reassemble the parts with new packing and reinstall them in the container. Use a luting compound such as a thin coating of graphite grease, shredded asbestos moistened with sodium silicate (water glass solution), or teflon tape.

(c) Gaseous agents. Contamination by agents of a gaseous nature may be removed by using a solution of trisodium phosphate or a similar suitable decontaminant. Rinse with clear water after using the solution until rinse water is only faintly alkaline to red litmus paper.

Note

Following decontamination, clearly mark the container to indicate whether it has been decontaminated inside, outside, or both.

c. Painting. When necessary, a container should be painted to prevent rusting, as follows:

(1) Clean the surface of the container, using a wire brush until all rust and scale have been removed.

(2) Paint the exposed surface with a red oxide primer and follow with a coat of aluminum pigment paint.

(3) Paint special markings on the container to indicate the contents. See MIL-STD-129.

d. Removal of Internal Rust. The removal of internal rust from a container is accomplished by rolling and rinsing several times with hydrochloric acid, followed by neutralization with a rinse of a mild alkaline solution (soda ash), a water rinse, resteaming, and drying with compressed dry air.

Section III. FIFTY-FIVE-GALLON STEEL DRUMS

11. General

Many chemical agents and liquid chemicals can be stored and shipped in 55-gallon-capacity steel drums. A 55-gallon drum weighs approximately 98 pounds empty and up to 800 pounds filled, depending on the type and quantity of the filling. It measures approximately 35 inches in length by 26 inches in diameter, and its cubage is about 13.7 feet. There are two types of 55-gallon drums (fig. 6). Type A has a 2 1/4-inch bung on the side and a 3/4-inch bung in the end. Type B has two 3/4-inch bungs on one end. These drums are used primarily for storing nonburning liquid smokes, cresylic acid, molasses residuum (type A only), and liquid riot control agents. Steel drums of 55-gallon capacity can be used for LIMITED (6 months) STORAGE of HD only with special authorization of the Commanding General, U.S. Army Materiel Command.

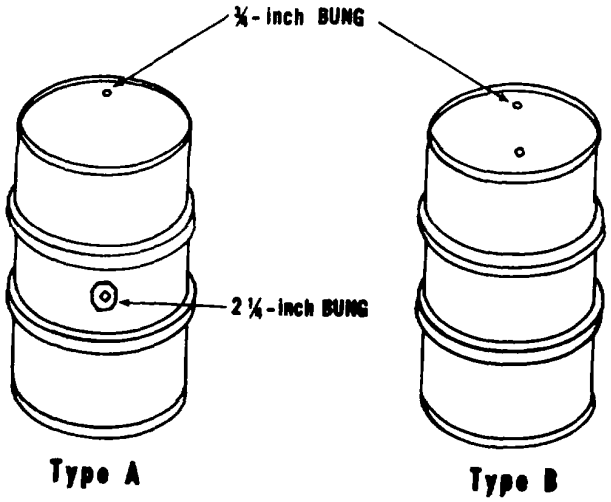


Figure 6. Types of 55-gallon drums.

12. Care and Maintenance

a. Mustard Agents. See paragraph 10*b*(2)(*b*) for information on mustard agent decontamination.

b. Flammable Liquids. A drum that has been used to store flammable liquids may be cleaned inside by the use of steam or water or by aeration. If steam is available, blow it through the empty drum for several minutes. If steam is not available, flood the empty drum with water and let it stand for 24 hours with all openings above water level uncovered. Then drain the drum and force air through it under pressure until only a slight odor, if any, is left.

Section IV. STEEL CYLINDERS

13. Description

Steel cylinders are used to store and ship compressed gases and small amounts of certain toxic chemical agents. Compressed gases must be stored and shipped only in cylinders clearly marked with the name of the gas for which the cylinder is to be used (MIL-STD-101). The name of the gas for which the valve is intended is stamped on the valve. Valves usually are constructed with safety caps containing fusible metal plugs, rupture disks, or both. If the internal temperature builds up too high, the plugs melt or the rupture disks burst to release the excess pressure. All cylinders have transit caps to protect the valves during shipment. Some cylinders have fixed protective collars (fig. 7). See AR 700-68 for further details on compressed gas cylinders. Sizes of cylinders range from a capacity of a few pounds up to 300 pounds. Frequently, the pressure tank of the M2A1 portable flamethrower is used with a 1-inch needle valve for shipping small quantities of all chemical agents except CK.

14. Operations

Compressed gas, except Department of Transportation (DOT) class A compressed gases or liquids, must not be transferred from a cylinder until the pressure of the gas is reduced through a pressure regulator intended for that particular gas. Pressure regulators reduce high internal pressures of cylinders filled with compressed gases to safe working pressures. The name of the gas for which a given pressure regulator is intended is marked on the regulator. Pressure regulators CANNOT be used with gases other than those for which they are intended. Before connecting a pressure regulator to a cylinder of

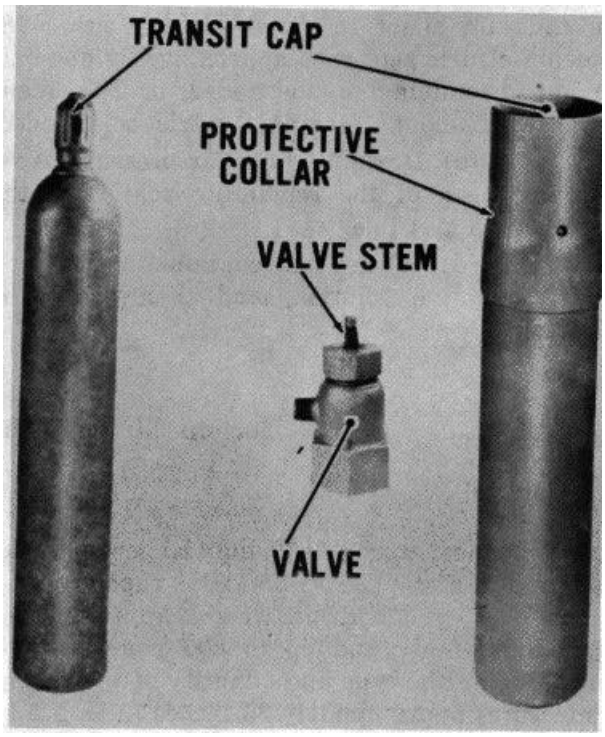


Figure 7. Steel cylinders for compressed gases.

compressed gas and while taking the necessary precautions, "crack" the cylinder valve (open it one-quarter turn and then close it immediately). This action clears the valve of particles of dust or dirt that might otherwise enter the regulator. Before removing a pressure regulator from a cylinder of compressed gas, close the cylinder valve and release all the gas from the regulator (AR 700-68).

15. Care and Maintenance

Whenever possible, a steel cylinder used for storage of chemical agents should be cleaned inside immediately after it has been emptied, according to the method described below. When necessary, the cylinder should be painted to prevent rusting. At least once every 5 years, each cylinder should be retested in accordance with DOT regulations. Industrial compressed gas cylinders procured from other services are normally returned to the issuing service for cleaning and repair. When it is necessary to clean the inside of an empty compressed gas cylinder, the following method is recommended: Hold the cylinder securely in a vise and relieve the pressure. The nature of the contents of the cylinder will dictate whether or not it can be vented in the working area. Remove the valve with a valve removing wrench. With plain water, fill the cylinder to overflowing. Insert the water hose to the bottom of the cylinder, if possible, to secure maximum agitation. When the overflow runs clear, drain the cylinder. Refill the cylinder with an appropriate cleaning solution such as 6 ounces of trisodium phosphate to 1 gallon of water, or a 15-percent solution of caustic soda in water. If steam is available, introduce it into the solution until volatile liquid, scum, and sludge no longer appear at the top of the container. If steam is not available, allow the solution to stand in the cylinder; agitate frequently to loosen the sediment. Drain the cylinder, rinse with plain water until water is only faintly alkaline to red litmus paper, and then drain again, allowing the cylinder to dry well. Replace the valves carefully, using one of the following luting compounds: shredded asbestos moistened with sodium silicate, flake graphite, or teflon tape.

Caution

Do not use white lead or other oily luting compound.

Section V. MISCELLANEOUS HANDLING EQUIPMENT

16. General

Chemical equipment described in this section is provided to assist in field operations with chemical agents.

17. M1 Drum-Hoisting Tripod

The M1 drum-hoisting tripod is an assembly fitted with a hoist and is used during transfer operations to raise 55-gallon drums to the height required for gravity flow of the filling into other containers.

a. Description. When in position, the tripod is approximately 8 1/2 feet high and the tripod legs are approximately 8 feet apart at ground level (fig. 8).

b. Operation. A filled 55-gallon drum is placed on its side and rolled into position immediately under the hoist. The side vent opening, if any, should be in the topmost position. One hook of the hoist sling is placed under the chime at each end of the drum. The hoist sling is then attached to the hoist, and the drum is raised.

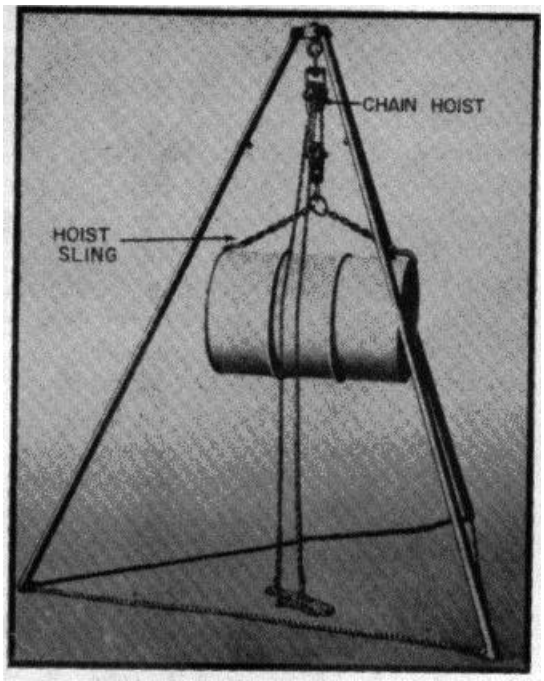


Figure 8. M1 drum-hoisting tripod.

18. M3 Airplane Smoke Tank Filling Line

The M3 filling line is designed primarily for transferring liquid chemical agents from bulk containers to M10

airplane smoke tanks. However, it may also be used in other transfer operations, such as filling 55-gallon drums. The assembly includes adapters that permit it to be used with different sized connections on 1-ton containers and 55-gallon drums. The assembly (fig. 9) consists of the following parts:

a. Hose. The hose is 1 1/4-inch pipe size and has a length of 52-1/2 inches between two gate valves, one of which is located at each end. It is made of Monel metal or bronze and is of spiral, interlocking construction.

b. Retaining Valve. This is a 1-1/2-inch threaded single wedge, disk type, 125-pound pressure, bronze gate valve with a nonrising stem. It is located at the inlet end of the assembly. It controls the flow of agent from the bulk container into the hose assembly.

c. Filling Valve. This valve is identical in size to the retaining valve and is attached at the outlet end of the filling line. It is used to control the flow of liquid into the container being filled.

d. Adapters. Adapters are designed for containers having connections of the following sizes:

2 1/4-inch, 2-inch, 3/4-inch (8 NPT), and 3/4 inch (14 NPT).

e. Filling Nozzles. Filling nozzles are designed to screw into the filling valve assembly and to be inserted into the inlet of the container to be filled. (Nozzles are calibrated with markings to correspond to M10 airplane smoke tanks. Disregard these markings when filling other containers.)

19. M2A1 Hand-Driven Dispensing Pump

The M2A1 pump (fig. 10) is used to transfer liquid smoke from 55-gallon drums to airplane smoke tanks by pumping instead of by gravity flow. The pump mechanism has a special safety feature to prevent the escape of fumes during the transferring operations. Lines are provided for both filling and venting. Air and vapor displaced by liquid entering the container being filled through the filling line are led back through the vent line to the bulk container, in which openings to the outside air are kept closed. The container being filled must have a suitable connection for the vent-and-filling nozzle. If no suitable connection is available, the nozzle may be inserted into the opening of the transfer container. The pump is a hand-operated, rotary-bucket-type pump delivering approximately 4.3 gallons of liquid

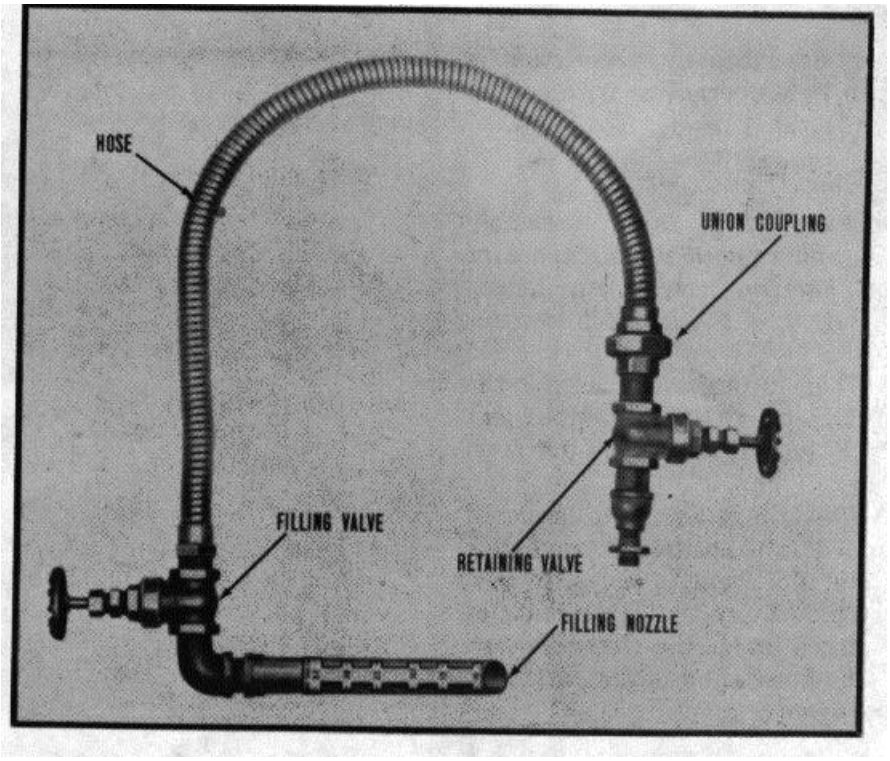


Figure 9. M3 airplane smoke tank filling line.

per minute when operated at a speed of 30 revolutions per minute, or about 1 gallon for each seven turns of the handle. The apparatus may be used as a closed or open system.

20. M1 Valve Replacement Mechanism

The M1 valve replacement mechanism is used to replace faulty needle valves on 1-ton containers. The mechanism should always be used when pressure in the container exceeds 50 pounds per square inch. See TM 3-4940-200-15 for details of description and operation of the mechanism.

a. Description (fig. 11). The mechanism fits over the front head of the 1-ton container to protect personnel from escaping agent during the changing of a faulty valve. The working portions are mounted at the center of a circular shield. The mechanism weighs 90 pounds.

b. Operation. The operation of this mechanism is complicated, and inexperienced personnel should be required to go through several "dry runs" before attempting operations on a container filled with an agent under pressure.

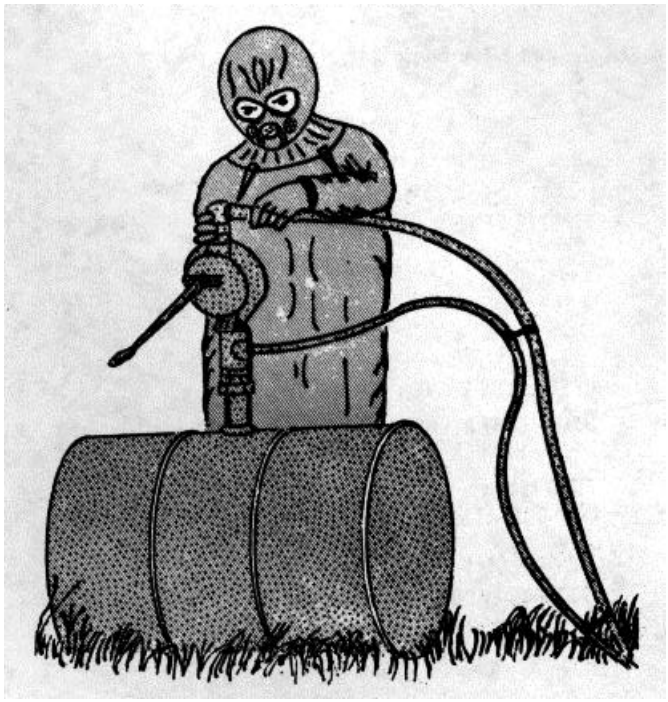


Figure 10. M2A1 hand-driven dispensing pump.

21. M2 Land Mine Field Filling Apparatus

The M2 land mine field filling apparatus is designed for field filling of 1-gallon chemical land mines from 55-gallon drums or 1-ton containers by the gravity flow method.

a. Description (fig. 12). The M2 land mine field filling apparatus is composed of a pipette assembly and a pedestal assembly. Three metal clamps fasten the pipette assembly to the chime of the bulk container. A pedestal assembly supports the mine and provides for raising and lowering the mine before and after filling.

b. Operation. Place the bulk container on a suitable elevated platform with the emptying opening in the lowest position and with a suitable venting arrangement at the top to admit air as the filling is withdrawn. Fasten the pipette assembly securely to the bulk container. The pipette assembly measures the filling for one mine on the downstroke of the operating arm. When the arm is pushed up, another filling is measured into the pipette. A drip cup catches any dripping after the filled mine is withdrawn. Two men using this apparatus can fill 40 mines in an hour. For details about the operation of the apparatus, see TM 3-1040-222-15.

22. M1 Grab Beam

The M1 grab beam is designed to hold a 1-ton container securely when it is lifted and carried from one place to another. It may be used with any type of hoist having a capacity sufficient to carry the total load (fig. 13).

a. Description. The grab beam has three principal parts--the beam, hooks, and yoke and weighs approximately 150 pounds.

b. Operation. Two men are required to lift and carry the grab beam. One man can ordinarily attach the beam to the 1-ton container.

(1) To hoist, first engage the hook of the hoist with the yoke of the grab beam. Then elevate the beam so that a hook can be securely engaged under each chime of the 1-ton container. The load may then be hoisted.

(2) All personnel should be required to stand clear while the container is being lowered because the grab beam may fall off the container to the ground when the weight of the load is removed. (Usually, only the hooks are released from the container when the weight of the load is removed.)

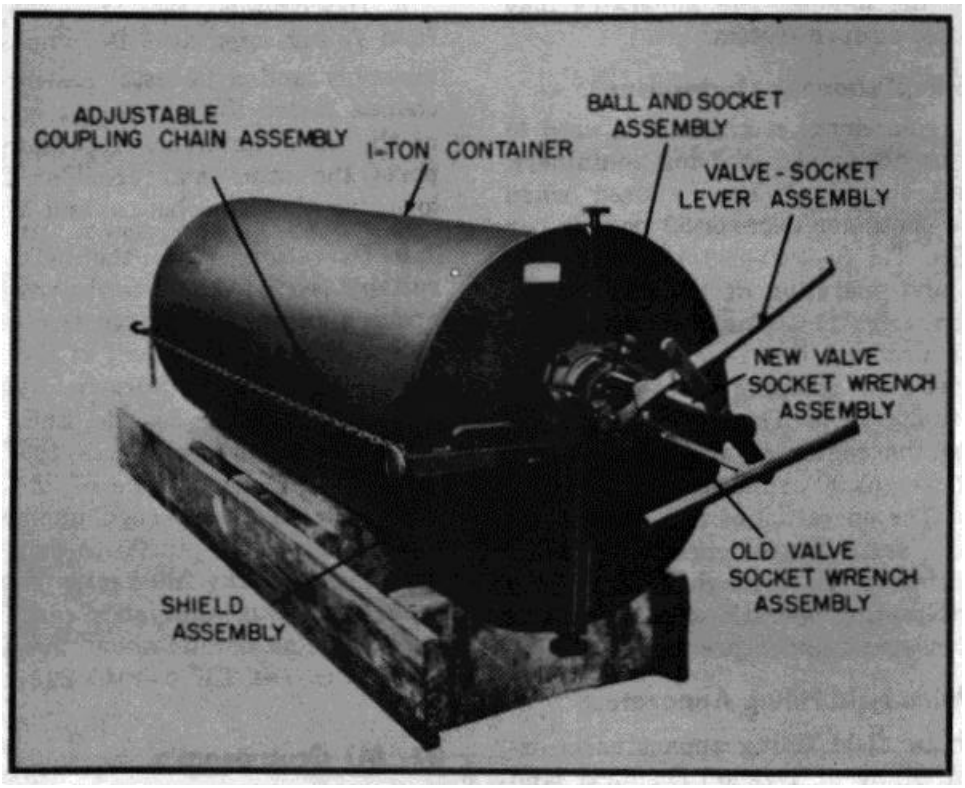


Figure 11. M1 valve replacement mechanism on 1-ton container.

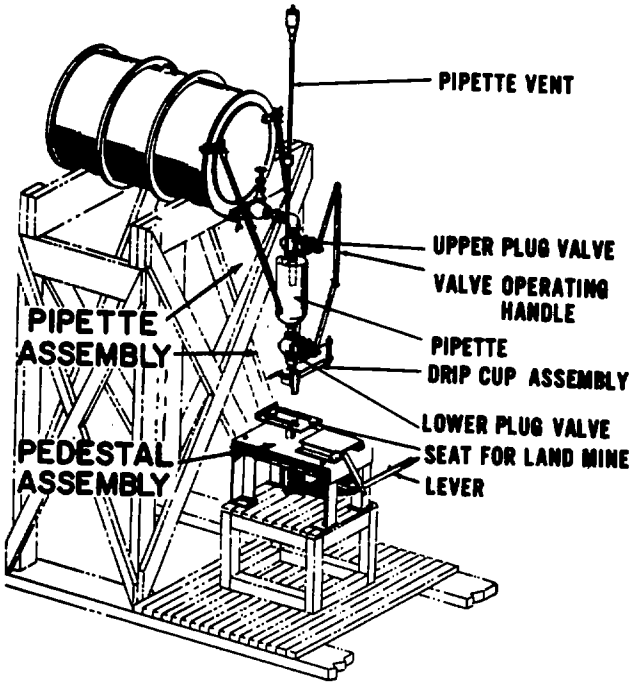


Figure 12. M2 land mine field filling apparatus.

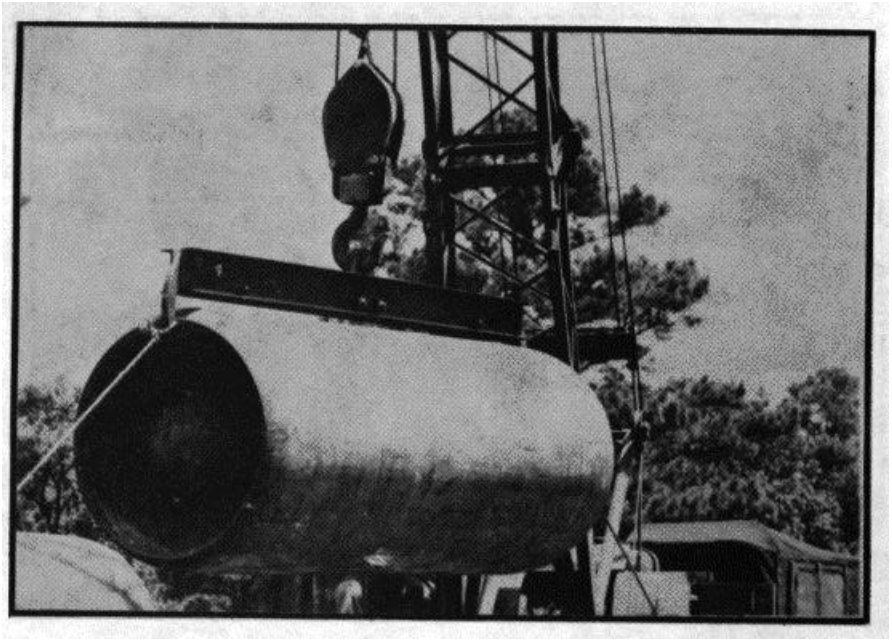


Figure 13. M1 grab beam being used to load 1-ton container on 2 1/2-ton truck.

Section VI. FIELD HANDLING EXPEDIENTS

23. General

It may sometimes be necessary to improvise hoisting equipment or elevated platforms during field operations. Improvisations may include wooden platforms or ramps, block and tackle hoists, tank trucks, bulk containers, and general purpose vehicles. This section describes a few types of improvisations that are satisfactory for handling 1-ton containers.

24. Cribbing

A crib stand may be constructed of logs or wood, 4 to 8 feet long and about 4 feet high. If no hoist is available, the container may be rolled onto the stand by means of a ramp at least 10 feet long, as illustrated in figure 14. A number of wooden blocks should be used to anchor the container as it is pushed up the ramp. It can also be rolled up the incline by coiling a fiber rope around the circumference and pulling from the opposite side.

25. Lumber Platform

If suitable lumber is available, a finished platform may be constructed, as illustrated in figure 15. The following platform material is required:

a. Four pieces, 4- by 6-inch lumber, 4 feet long.

b. Four pieces, 2- by 6-inch lumber, 8 1-/2 feet long.

c. Four pieces, 2- by 6-inch lumber, 8 feet long.

d. Four pieces, 2- by 6-inch lumber, 4 feet long.

e. Spikes--60-penny, 40-penny, and 20-penny.

f. Bolts--1/2 inch by 9 inches, with nuts and washers.

26. Hill or Ditch

A roadside ditch or hill may be utilized as a platform, provided the side of the ditch or hill is reinforced to prevent cave-in. Another field expedient is to construct a platform in a ditch. The container rests on timbers constructed on top of a mound of earth (fig. 16).

27. Double-A-Frame

A double-A-frame may be constructed to lift containers onto a stand (fig. 17). The standard 2-ton differential hoist may be attached as shown. Either a chain or a grab beam may be used to fasten the container to the hoist. This type frame must be built of sturdy timber.

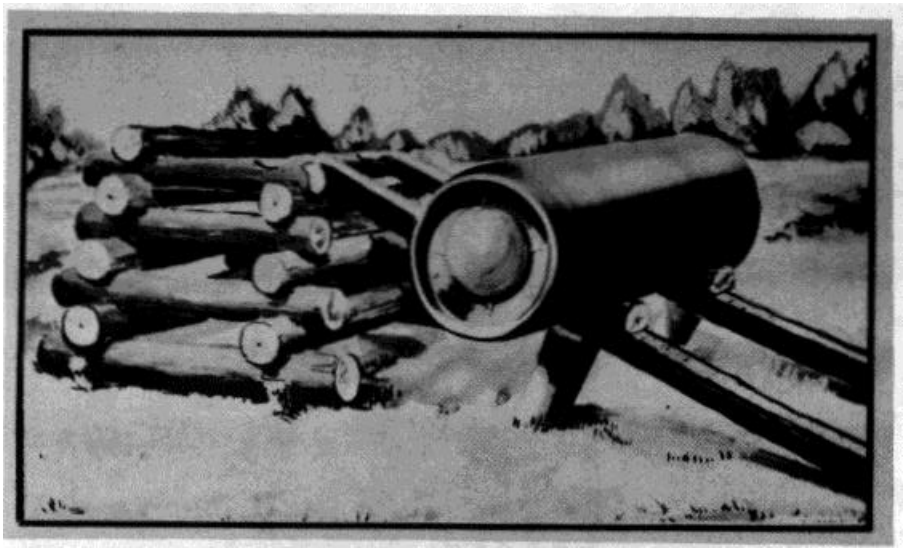


Figure 14. Improvised log cribbing and ramp.

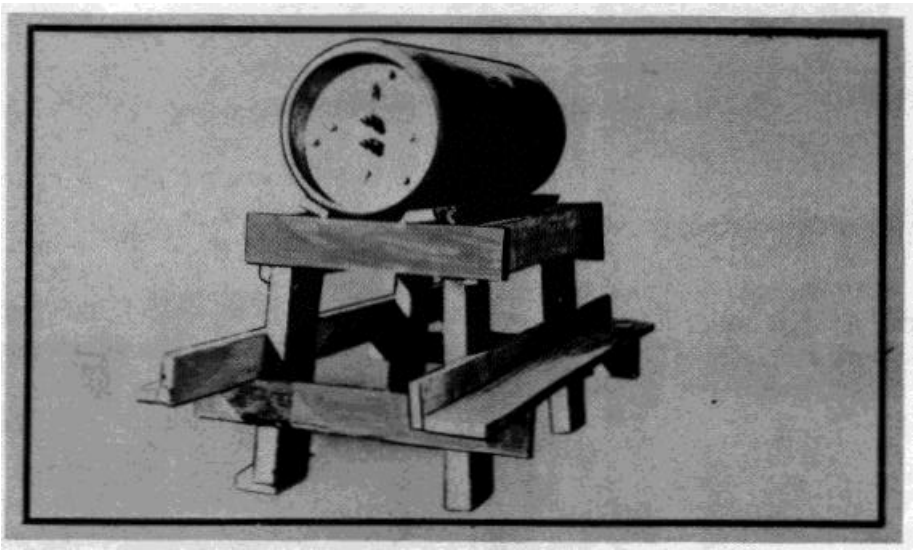


Figure 15. Improvised platform made of lumber

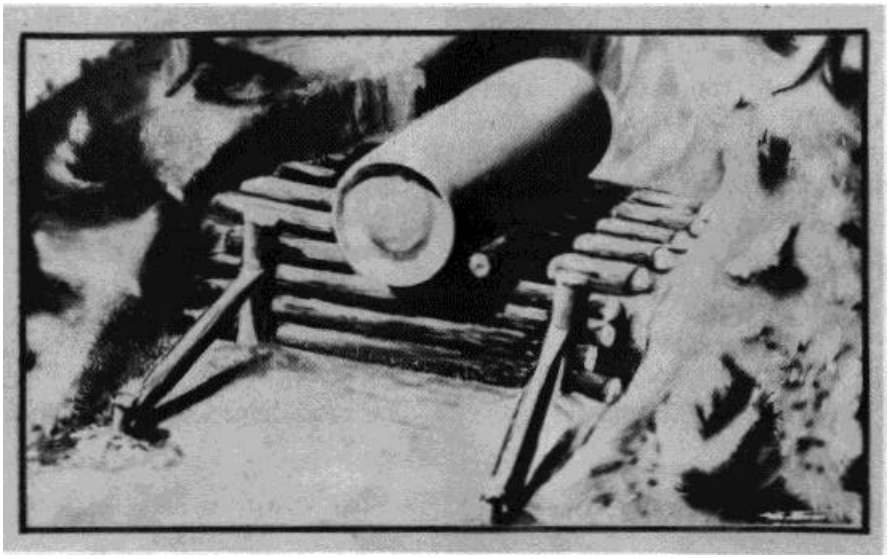


Figure 16. Improvised platform in ditch.

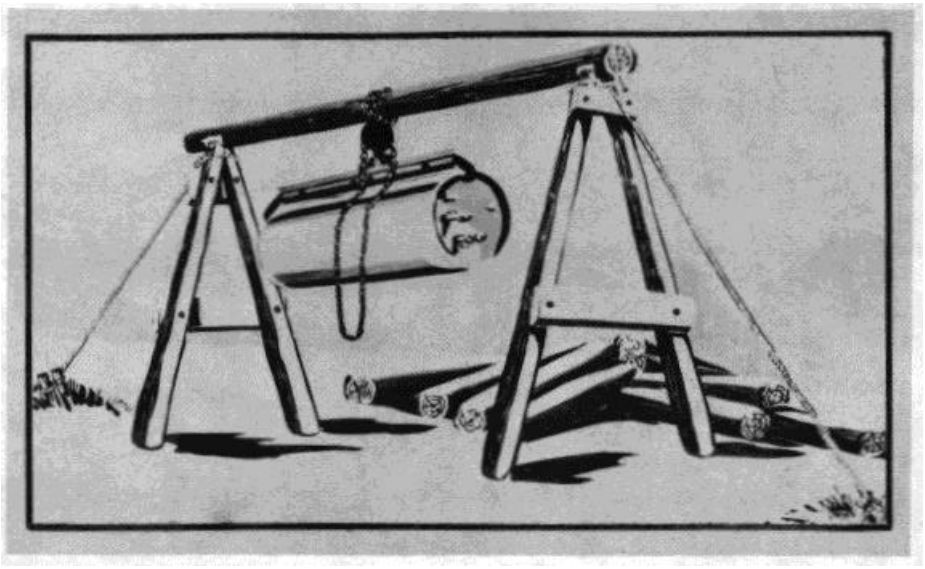


Figure 17. Improvised double-A-frame with standard hoist.

Section VII. PROTECTIVE CLOTHING AND EQUIPMENT

28. General

Protective clothing is used by individuals handling chemical agents. Various combinations of protective clothing worn by an individual give him different degrees of protection.

29. Impermeable Protective Clothing

Impermeable protective clothing is made of cotton cloth coated on both sides with butyl rubber. The material does not allow the passage of air through its fabric and therefore provides adequate protection against chemical and biological agents. This clothing is intended primarily for protection of personnel engaged in extremely hazardous decontamination work or in other special operations involving danger from spillage or splash of liquid chemical agents. For specific details see TM 10-277.

30. Permeable Protective Clothing

Two types of permeable protective clothing have been standardized. The standard "A" system is based on a protective liner concept. The standard "B" system is comprised of a two-layer system of certain impregnated items of general and special issue clothing. The protective mask, protective mask hood, protective gloves, protective socks, and leather combat boots which are treated with vesicant gas resistant leather dressing (protective dubbing) are used with both systems of protective clothing. For specific details of both types of clothing, see TM 10-277.

31. Protective Mask

The field protective mask alone is sufficient protection for individuals handling most agents of a gaseous nature except where concentrations exceed 2 percent by volume in air (field concentration), or where the agent may be readily absorbed through the skin. Besides the field protective mask, there are special purpose masks for hazardous chemicals such as ammonia, for which the field protective mask does not afford protection. See TM 3-522-15, TM 3-4240-202-14, TM 3-4240-258-14, and other TMs listed in appendix A for detailed information on protective masks and special purpose masks.

CHAPTER 3

DEPOT LAYOUT AND STORAGE PROCEDURES

Section I. GENERAL

32. Installation Handling Chemical Agents

There are many installations that store, handle, and ship containers of chemical agents and hazardous chemicals in both the zone of interior and theaters of operations. Although storage procedures and principles of depot layout are basically the same for most installations handling chemical agents, there are some differences caused by geographical location, climatic conditions, terrain conditions, tactical situations, and regulations (such as the DOT shipping regulations in the continental United States).

a. Zone of Interior. Chemical muntions and containers of chemical agents are stored, handled, and shipped by designated depots in the continental United States, certain arsenals, proving grounds, ports of embarkation, and training centers.

b. Theaters of Operations. Ports of debarkation and special ammunition supply points (SASP) in the theaters of operations will store, ship, and handle chemical munitions.

33. Storage Responsibilities

The Army Materiel Command, Munitions Command, is responsible for procurement, storage, and issue of chemical agents and designated chemicals in bulk. When chemical ammunition end items are shipped to installations, they become the responsibility of the installation commander. The following installations are those primarily concerned with storage of chemical agents and chemicals in bulk: Army depots (that contain chemical items); ports of debarkation and ports of embarkation; and ammunition supply points (ASP) and special ammunition supply points.

34. Special Storage Problems

In an active theater of operations, the location of the depots may be temporary, changing with the strategic and tactical situation. Local labor may be inadequately trained and may change frequently. All types of facilities may have to be improved or even improvised. Storage techniques vary according to the zones of the earth in which the depots are located, as follows:

a. Artic and Subartic. These areas present problems of camouflage, snow, extreme cold, and, during the spring thaws, deep mud. Cautious selection of storage areas in winter when the ground is frozen, ample use of dunnage, removal of snow, and careful maintenance of handling equipment are required. Furthermore, individual items of materiel and equipment, originally designed and primarily produced for temperate zone use, cannot be expected to function as effectively under artic conditions (FM 31-70).

(1) In certain areas, a natural phenomenon known as "icefog" settles and forms solid ice coatings on materiel with which it comes in contact. This may require equipment to be covered with tarpaulins or temporary shelter.

(2) Tundras (treeless artic plains) usually consist of solidly frozen earth covered with dark, mucky soil. Above the mucky soil may be a layer of vegetation consisting of grass, moss, and lichen. This top layer of vegetation will support and propagate fires. During periods of warm weather, the subsoil may become a complete bog or marsh, unless a good surfacing material has been applied. Containers must be supported on adequate dunnage.

(3) A wide variation in atmospheric conditions may prevail, from periods of heavy snow and extreme cold to heavy rainfall and warmth.

b. Desert. Desert areas present problems of camouflage, great heat, and lack of water. Dispersion and some sort of overhead cover are usually required.

(1) High temperatures cause expansion of fillings in containers. Containers, therefore, usually require regular and frequent surveillance and frequent venting.

(2) High winds may blow away tarpaulins and other covers unless they are firmly anchored. Winds may blow sand over containers and completely cover them.

(3) Dry wadies (creek beds) may become inundated by flash flooding during heavy rains and should not be included in the depot area.

c. Tropical and Subtropical. These areas present problems of extreme humidity, rainfall, and heat. Extensive use of dunnage and careful maintenance are required.

(1) Terrain usually consists of deep slopes that are heavily wooded with deep underbrush. Streams usually overflow during the rainy season, and low terrain near them should be avoided.

(2) In areas characterized by frequent or heavy rains, containers should be stored on high dunnage as a precaution against muddy terrain.

(3) High temperatures and humidity accelerate formation of rust, growth of spores and fungi, and activities of destructive insects such as wood borers.

Section II. DEPOT LAYOUT

35. General

The principles and recommendations provided here as a guide are designed to facilitate depot operations and to protect and preserve stocks of materiel vulnerable to loss by the elements, by carelessness, and by enemy action. Tactical conditions may interfere with the technical requirements for an ideal storage area; however, as many desirable features should be incorporated in the selected storage area as possible under the conditions prevailing.

36. Selection of Storage Site

The following factors, listed in order of importance, should be considered in the selection of a storage area.

a. Road Access. The existence of roads that .will remain passable for vehicles under all weather conditions and that require a minimum of maintenance is an important factor. Alternate routes should be available.

b. Rail Access. Proximity to a railhead is desirable for any site that is to be developed into a large depot.

c. Terrain. The ground should be as level as possible and yet should possess good drainage characteristics. Level terrain in which natural barriers exist at intervals appropriate to separate field storage units and/or field storage categories is desirable.

d. Isolation. Storage sites should be located, commensurate with tactical requirements, as far as possible from hospitals and from important military installations, airfields, docks, factories, and similar facilities subject to enemy attack. Downwind hazard to populated areas must be considered, also.

e. Fire Prevention. The fire hazard is greatest where flammable vegetation exists. An adequate water supply adjacent to the storage site must be available.

f. Security. The area selected should possess features that make it readily defensible with a minimum expenditure of manpower and materials against any enemy attack.

g. Dispersion and Expansion. The area should be large enough to take care of expansion requirements and of dispersion requirements for protection against artillery or air attack.

h. Concealment. The selected area should provide natural concealment.

37. Depot Layout Plan

One of the most important phases of depot planning is the depot layout plan. A good depot layout plan facilitates depot operations, provides for easy traffic control, and promotes safety. A space allotment plan should be prepared as the first step to inform subordinates of the areas and facilities allocated to them. Traffic routes should be indicated on the plan, together with areas reserved for expansion and for special facilities. Before any attempt is made to occupy the area, the depot layout should be implemented by suitable signs and markers on the ground. The following areas should be designated:

a. Gas Chamber. The gas chamber or tent should be small and located at the entrance to the storage area. It should be filled with *chlorine* so that individuals can check the fit of their protective masks and test the effectiveness of the *chemical* filters of their masks before entering the area. Since toxic agents may be involved in this type of operation, the protective mask should not be checked in a gas chamber using CS or CN since these agents will test only the mechanical filter for effectiveness.

b. Transfer Area. A specific area should be designated for transferring chemical agents from one container to another, particularly for blister agents and nerve agents.

c. Decontamination Area. A specific area should be designated adjacent to, or near the transfer area for

decontaminating empty containers and special handling equipment.

d. Air-Raid and Protective Shelters for Personnel. These shelters should be appropriately located throughout the area. Protection against blast of nuclear or similar type weapons can be given by locating air-raid shelters underground. Shelters should have zigzag entrances and baffle walls to deflect pressure waves and to block radiation. There should be an adequate earth cover over shelters (TM 5-311, FM 5-15, and FM 21-40).

e. Decontamination Stations. These stations should be conveniently located near the group A storage and transfer areas. Suitable decontamination stations should be constructed for use by personnel handling agents and for general use in the event of a hostile chemical attack (TM 3-220).

f. Nuclear Defense Areas. Appropriate areas should be designated for storage of critical materiel. Materiel considered critical should be protected by bunkers or revetments. Such protection is considered of value against thermal radiation.

g. Road Net. Main roads, aisles, and cross aisles should be located so that they form an efficient road net servicing main depot entrances.

h. Barriers. The provisions of AR 1903 pertaining to the construction of structural and perimeter barriers, walls, fences, utility openings, gates and entrances, and other physical security standards will be complied with.

38. Roads and Aisles

In a large area depot containing chemical items, the principle of straight line flow of roads and aisles should be followed to facilitate the movement of vehicles and cranes. A general guide for the establishment of roads and aisles is provided below:

a. Main roads and aisles should be at least 20 feet wide and should extend through the length of the storage area.

b. Crossroads and aisles should be at least 10 feet wide and should be located where needed for access from main roads.

c. Storage areas between aisles may be approximately 60 feet in depth.

d. Areas for shipping and receiving should be located near loading facilities along the main road paralleling the long axis of the area.

39. Firebreaks

The construction and maintenance of firebreaks within a storage area are probably the greatest factors in preventing the spread of fires. However, the tactical situation may require restriction or curtailment of the use of firebreaks. Unless specific orders are issued to the contrary, firebreaks should be planned in accordance with the following criteria:

a. Firebreaks should be wide enough to provide protection against flame progression in a strong wind. Generally, firebreaks should be at least 50 feet in width. Width will vary according to the local situation.

b. Where the top soil contains sufficient organic matter to burn, it should be removed down to the mineral subsoil.

40. Quantity-Distance Factor

In addition to considering the downwind vapor hazard for toxic chemical agents, another important consideration in planning the depot layout is the quantity-distance factor for groups or stacks of containers of chemical agents. The quantity-distance factor refers to the maximum safe quantity of chemical agents recommended to be stored in an area, and the minimum safe distance recommended for this quantity to be located from adjacent groups or stacks of containers of chemical agents or explosives and from inhabited areas or buildings.

a. Field Storage Category (FSC). Field storage category refers to ammunition having common characteristics such as sensitivity to fire, detonation, and stability. Containers filled with nerve agents must be stored separately and at least 300 feet from all other types of chemical agents.

b. Field Storage Unit (FSU). Field storage unit refers to a group or stack of containers of chemical agents located at a sufficient distance from adjacent groups of containers (FSU's) to provide reasonable protection against the spread of fire, detonation, or contamination. A field storage unit normally should contain no more than 400 gross tons of chemical agents. The distance between FSU's should be about 300 feet. Groups or stacks of containers within the FSU normally should contain no more than 20 gross tons. The distance between groups or stacks of containers should be at least 50 feet.

Note

For detailed information, see TM 9-1300-06.

Section III. STORAGE PROCEDURES

41. General

Depot storage operations generally denote activity-supplies constantly moving forward to the using unit. Storage of chemical agents, however, is normally passive and presents a cumulative problem of adequate storage space until such time as the tactical situation requires actual expenditures of chemical agents. It is therefore necessary to correctly utilize storage space and to properly maintain the containers. Because of the hazardous nature of some chemical agents, extreme safety precautions must be observed in storage procedures.

42. Basic Storage Principles

Primarily, items are stored by Federal Supply Classification class. Within classes, items may be stored by categorical groups to facilitate storage and issue. Relative activity or turnover is a factor to be considered in determining stock location. Active items should be stored, if possible, near the receiving and shipping area. To facilitate surveillance inspection on a lot basis, chemical agents of one lot should be stored together by lot. Additional principles for storage of containers of chemical agents are listed below:

a. Inspection. Containers of chemical agents and hazardous chemicals should be inspected periodically to detect dangerous conditions, such as leakers or excessive corrosion.

b. Keeping Containers Dry. Containers should be kept off the ground on dunnage such as logs, pallets, and rails.

c. Facilitation of Inspections. To facilitate inspections, containers should be stored so that both ends are available for inspections.

d. Provision for Ventilation. When containers are covered with a tarpaulin or a similar protector against high temperatures produced by the sun, enough clearance should be allowed to provide for adequate ventilation.

e. Control of Corrosion. Containers should be externally cleaned and painted to minimize corrosion of the exterior.

f. Identification. To facilitate proper identification of containers, they should be arranged in storage so that their markings are visible.

g. Rotation of Stock. Because certain items, such as CK or STB, tend to deteriorate or lose strength during storage, they should be stored so that they can be issued according to the date of manufacture or serviceability status.

43. Inspection

Containers of chemical agents and hazardous chemicals should be inspected upon receipt for storage and at periodic intervals thereafter (paras 52 through 59). They should be inspected to determine the following:

a. Condition of Paint. The containers should be inspected for cracked or peeled paint.

b. Extent of Corrosion. The extent of corrosion or rust of the container should be determined. External corrosion is considered excessive if the total corroded area is over 25 percent of the container surface; moderate, if from 5 to 25 percent; and normal, if under 5 percent.

c. Condition of Outlets. Filling plugs, valves, and seams should be inspected for leaks.

d. Internal Pressure. The degree of internal pressure should be ascertained (para 56) to determine the necessity for venting (releasing) high internal pressure.

e. Stability or Degree of Decomposition. When applicable, the filling should be pressure tested or sampled to check its stability or degree of decomposition. A sampling schedule must be established and followed to detect any deterioration in time to make proper disposition of the more dangerous chemical agents. For example, CK in advanced stages of decomposition undergoes violent chemical changes that can result in an explosion comparable to that of a high explosive.

f. Condition of Wood or Fiber. The wood or fiber containers should be inspected for damage that would permit moisture to affect the contents.

44. Detection of Leakers

The most common methods for detecting leaks from containers of known chemical agents in a depot are by the use of the detector kit, detector crayon, detector paper, and special nerve agent detectors.

a. Chemical Agent Detector Kit. The ABC-M18A2 kit consists of an olive drab, cotton duck carrier containing an air sampling bulb, detector tubes, solution bottles, chemical reagents, instruction cards, detector tickets, and accessory items. It will detect and identify chemical agents by color changes in tubes through which contaminated air has been drawn with the bulb. VX can be detected by the use of the detector paper. See TM 3-6665-254-12.

b. Detector Crayon. Vesicant detector crayon is a pink, chalk-like crayon that changes to blue when contaminated with either liquid or concentrated

vapor of a blister agent. It is rubbed around valves, plugs, and seams of containers of blister agent to detect leaks.

c. Detector Paper. ABC-M8 VGH chemical agent detector paper is a light-pink paper impregnated with a chemical compound that turns dark green, yellow, or red when in contact with V-agent, G-agent, or H, respectively, in liquid form. DS2, DANC solution, and certain solvents, however, also cause a color change on the paper.

d. Nerve-Agent Detectors. The use of pigeons, canaries, rabbits, or other animals to indicate the presence of nerve agents in the air is an excellent supplement to the other means of identification. Although these animals are susceptible to fatal diseases, if an animal is found dead it should be assumed that a nerve agent is present in the air until it is proved otherwise. Automatic alarms are available for use indoors and are being developed for field use. These alarms constantly sample air and give audible and visual signals when a nerve agent is present in the air in concentrations above the limits for which the alarm has been set.

Section IV. SAFETY

45. General

The hazards inherent in handling certain chemical agents and hazardous chemicals are such that special safety instructions are required. A high degree of safety may be achieved in handling chemical agents and hazardous chemicals by designating a specific individual in an organization to be responsible for planning, coordinating, and supervising a safety program.

a. Responsibility. The unit commander of a depot or the installation commander, where more than one unit is involved, is responsible for establishing and enforcing safety procedures. Within a designated working group or party, the senior officer, noncommissioned officer, or supervisory civilian in charge is responsible for having personnel follow detailed safety procedures.

b. Training. All personnel engaged in handling chemical agents and hazardous chemicals should have special training in detecting the presence of chemical agents by the use of detectors (para 44), in recognizing symptoms of chemical agent poisoning in themselves and others, in first-aid procedures, in decontaminating procedures, in the proper wearing of protective clothing and the protective mask, and in the use of special equipment required in emergencies. Personnel should be instructed to report for work daily with cleanly shaven faces to insure an airtight fit of the protective mask. The cooperation of personnel in safety matters may be obtained through an educational program illustrating possible results to those who are careless in handling chemical agents and hazardous chemicals.

c. Supervisory Personnel. Supervisory personnel should be thoroughly trained to handle chemical agents and hazardous chemicals and to take correct action in an emergency.

d. Safety Plan. The establishment and enforcement of a safety plan systematically exposes and reduces hazards in an installation handling chemical items. A safety plan should cover the three main hazards-fire, contamination, and sabotage. Frequent drills should be conducted.

e. Local Disaster Plan. It is the responsibility of every unit commander to prepare a local disaster plan to be followed in the event of a disaster. Such a plan should include measures to be taken to reduce injury to personnel and damage to property, and to preserve evidence pertinent to cause and effect.

46. General Safety Precautions

When personnel are engaged in routine handling of containers of chemical agents, they should be instructed to observe the following general safety precautions:

a. Storage Group A Chemical Agents. When handling group A chemical agents, complete impermeable protective clothing (TM 10-277) will be worn whenever a known or suspected leaker is encountered. Deluge showers should be readily available. After the structure or area has been determined to be free of contamination, personnel may wear the following minimum protective clothing.

(1) Butyl rubber boots.

(2) Butyl rubber apron extending below top of boots.

(3) Butyl rubber gloves.

(4) Special purpose or M17 series protective mask in slung position.

(5) Unimpregnated coveralls, underwear, and socks. Personal clothing will not be worn; government-issued clothing must be worn.

b. Storage Group B Chemical Agents. When handling containers of group B chemical agents, personnel should have protective masks and first-aid equipment immediately available for use.

When handling liquid smoke, rubber aprons, rubber boots, and rubber gloves are also necessary.

c. Storage Group C Chemical Agents. When handling containers of group C chemical agents, personnel should have drums of water and other fire-fighting equipment and first-aid equipment immediately available for use.

d. Storage Group D Chemical Agents. When handling containers of group D chemical agents, personnel should have fire-fighting equipment and first-aid equipment immediately available for use.

e. Corrosive Liquids. When handling containers of corrosive liquids or acid-type chemical agents, personnel should wear rubber boots, rubber aprons, rubber gloves, and safety goggles. Protective masks, drums of water, and first-aid equipment should be immediately available for use.

f. Corrosive Solids. When handling containers of corrosive solids, personnel should wear rubber boots, rubber aprons, rubber gloves, and safety goggles. The protective mask and hood, drums of water, and first-aid equipment should be immediately available for use.

47. Fire Prevention

Fire prevention pertains to the measures designed to detect and eliminate causes of fire, fire-safety procedures, and the passive means utilized to confine a fire, once it breaks out, to the place of origin. The following factors should be considered:

a. Depot Layout. The depot should be laid out with adequate firebreaks, convenient to sources of water for fighting fires, in an area with the minimum combustible material. The area should offer some protection against direct rays of the sun in hot climates. Highly flammable chemicals should be stored separately from other chemicals.

b. Fire Points. Fire points should be conveniently located throughout the depot area. They should be clearly marked with bright or reflector paint for easy identification in the dark. Each fire point should be equipped with a suitable fire alarm, several long-handled shovels, a pile of sand, buckets, and water-filled barrels. The water barrels should be periodically inspected and kept filled. During freezing weather, an antifreeze, such as salt, should be added to the water to keep it from freezing. Buckets should be painted to prevent rust.

c. Safety Smoking Points. Safety smoking points should be designated, convenient to NO SMOKING areas.

d. Fire-Alarm System. A good fire-alarm system should be installed.

e. Water Supply. When fire-fighting equipment with suction hose is available, large water storage facilities should be made available at convenient locations.

f. Fire-Fighting Markers. To provide a guide to fire fighters in determining the type of hazard existing in an area, specific storage areas should be marked with the approved fire symbols (app B).

g. Overhead Protection. For designated stacks of containers of chemical agents, overhead protection against direct rays of the sun should be provided. It is important to allow adequate clearance to provide ventilation on top and underneath stacks.

h. Housekeeping. Covered fire-resistant cans should be located at convenient points for the disposal of oily rags and waste. Volatile flammable liquids should be kept covered. Flammable rubbish should not be allowed to accumulate.

i. Fire-Fighting Plan. A written fire-fighting plan should be prepared and prominently posted at convenient locations. This plan should announce the signals for fire alarms and for all clear, assign specific duties to personnel, list the next higher headquarters and other authorities to be notified in case of fire, list the places where help can be obtained if needed, and furnish all other pertinent information.

48. Safety Measures Against Liquid Contamination

Storage areas for blister agents and nerve agents should be separate from each other and from storage areas of all other chemical agents. The storage area for nerve agents should be enclosed, by cyclone-type fencing, if practicable, and should always be well guarded. The following safety measures should be observed:

a. Placarding. Dangerous areas should be suitably placarded with signs and markings (app B).

b. Parking Areas. Parking areas for vehicles should be designated upwind of the prevailing wind direction.

c. Sanitary Facilities and Showers. Sanitary facilities and showers should be provided upwind of the prevailing wind direction.

d. Personnel Decontamination Point. Decontamination points and clothing exchanges should be conveniently located upwind of the prevailing wind

direction. Emergency decontamination points should be located within the storage area; these should provide water and soap. Arrangements should be made for decontamination and reimpregnation of contaminated protective clothing.

e. Decontaminating Material. Decontaminating material and equipment should be conveniently located at points around the storage area.

f. Disposal Area. A suitable area should be designated for disposal of chemical agents and contaminated containers that cannot be salvaged.

g. Reserve Stock. A suitable reserve of protective masks, filter elements and canisters, clothing, decontaminants, and first-aid supplies should be established for use in emergencies.

h. Personnel Check. Personnel should be checked before entering the storage area to insure that they are wearing proper protective clothing and equipment.

i. Special Precautions for Storing Nerve Agents. In addition to observing the safety measures outlined in a through h above, the measures outlined in paragraph 49 also should be observed, since nerve agents present both a liquid hazard and a vapor hazard to personnel.

49. Safety Measures Against Vapor Hazard

The following safety measures apply particularly to storage areas containing G-type nerve agents because they present a serious vapor hazard to personnel, in addition to the liquid contamination hazard (para 48).

a. Detection Equipment. A sufficient number of detection devices (para 44) should be employed to reveal any presence of G-agent vapor within the storage area. Detection devices also should be placed strategically around the storage area at a 400- to 800-meter radius so that the hazard downwind may be evaluated.

b. Personnel. Personnel should not be permitted to enter the nerve-agent storage area alone, or should not be left alone while working. Personnel having any cuts or abrasions should be checked by medical personnel to insure that these injuries are satisfactorily covered before they are permitted to work in the area. Immediately upon completion of daily duty, personnel should be given a physical check by a qualified technician to determine whether or not symptoms of nerve-agent poisoning exist. Showers or baths should then be required, followed by a change of clothing. If nerve-agent symptoms are present, immediate first aid will be required and the individual evacuated to a hospital immediately. It is also suggested that another check be made about 2 hours after the first check, since personnel experiencing low-level exposures may not show symptoms immediately.

c. Protection and First-Aid Equipment. All personnel are checked prior to entering the storage area to determine whether they have the proper protective and first-aid equipment and understand its use.

d. Limitation of Exposure. The minimum number of personnel should be exposed for the minimum length of time in the nerve-agent storage area. Jobs not necessary to routine storage operations should not be performed in the storage area.

e. Criteria for Replacing Filter Elements or Canisters of Masks. The local safety SOP will determine the frequency of the replacement of the filter elements or canisters of masks. Filter elements or canisters must be replaced if they—

(1) Have been exposed to blood agents. (Blood agents may break down the filter elements or canisters after one exposure.)

(2) Have been immersed in water.

(3) Are visibly damaged or deteriorated.

(4) Impose severe impediment to breathing.

f. Eating, Drinking, and Smoking. Personnel are prohibited from eating, drinking, chewing, or smoking in the storage area. After leaving the storage area, personnel are required to be checked for contamination and be decontaminated if necessary, and to wash their hands and faces before eating.

g. Wind Direction and Speed Indicators. Wind vanes or other wind direction indicators should be located at the transfer and disposal areas and also at other desirable locations in the storage area. Wind speed indicators also should be available. In the absence of indicators, personnel should be trained to estimate wind direction and speed.

50. Antisabotage Measures

The following safety measures should be observed to reduce the possibility of sabotage.

a. Guards or Sentries. Guards or sentries are maintained around the storage area 24 hours a day and should patrol the perimeter of the nerve-agent storage area at a distance of approximately 300 yards. Guards must carry protective masks and first-aid equipment.

b. Security Screening. All local labor employed in the storage area must have security clearance (AR 190-3).

c. Passes and Identification. A system of passes and identification must be established for all personnel entering the storage area. See AR 190-3

for policies on entry control and security credentials, and AR 606-5 for procedures for fabrication of identification media.

d. Local Defense. Military personnel are organized for local defense against possible guerrilla attack.

51. Decontamination

Decontamination is the process of neutralizing the harmful effects of a chemical agent by covering the agent, removing it, absorbing it, destroying it, or changing it into harmless substances through the action of chemical decontaminants. Chemical decontaminants are used when relatively rapid and complete decontamination is required, but they are not very effective under conditions of extreme cold (below 20° F.). See TM 3-220 for detailed information on decontaminating materials, equipment, and procedures. Personnel should be familiar with the methods and equipment used to decontaminate all agents.

Section V. SURVEILLANCE AND CLASSIFICATION

52. General

Chemical agents and chemicals undergo periodic surveillance (inspection and evaluation) for determination of their degree of serviceability. Serviceability standards, given in SB 3-30-series, 3-applicable FSC series, and AR 742-series, designate the exact basis for surveillance of each item of chemical supply. As a result of surveillance, chemical supplies are evaluated according to their degree of serviceability. Chemical agents and hazardous chemicals stored in bulk containers present an additional surveillance problem. During storage, some of them may decompose and undergo violent chemical changes that can result in a dangerous explosion. Others generate high internal pressure that can rupture the container. This section is concerned with surveillance procedures that are conducted for the purpose of detecting deterioration of chemical agents that might affect their functioning, handling, and storage, or render them hazardous to human life or property. This involves pressure testing and sampling procedures that require the services of experienced personnel, such as chemical laboratory technicians. In a theater of operations, the chemical laboratory can perform this service.

53. Surveillance by Lot

To conduct surveillance by lot, containers of a chemical agent must be grouped into lots according to the applicable serviceability standard. The following definitions may be found in greater detail in pertinent standards of the SB 3-30-series:

a. Manufacturer's Lot. This consists of containers of a chemical agent identified by the manufacturer (or arsenal) as a lot at the time of manufacture.

b. Miscellaneous Lot. This consists of a limited collection of fragments of manufacturer's lots, all of which are uniform with respect to certain criteria set forth in the applicable serviceability standard.

c. Grand Lot. This consists of containers of a chemical agent that are uniform with respect to conditions or criteria set forth in the applicable serviceability standard.

d. Depot Lot. This consists of an aggregation of containers of a chemical agent grouped together for purposes of inspection in a depot.

e. Mixed Lot. This consists of containers of a chemical agent that do not show complete information concerning manufacturer's lot numbers and time of manufacture.

54. Sampling by Lot

Sampling, as defined in the SB 3-30-series, refers to the process of selecting one or more containers of a chemical agent of a lot for purposes of inspection. A random sample is one so chosen that every container will have an equal chance of being selected. A representative sample is so chosen that the pertinent conditions existing within the lot are represented in the sample. A sample is selected in accordance with the sampling tables provided by the applicable serviceability standard. For example, table I (Surveillance of Grand Lots and Manufacturer's Lots) in SB 3-30-225 indicates that for a lot size of 101 to 500 containers, the sample size for visual and pressure test will be 40 and the number of containers (of mustard) sampled for chemical analysis will be 2. Sampling tables and other criteria may be changed from time to time in revisions of the supply bulletin to reflect quality information gathered in previous surveillance of the item.

55. Evaluation of A Sample

After a sample has been selected in accordance with the applicable sampling table, it is inspected

in accordance with the detailed procedures provided by the applicable serviceability standard. For example, SB 3-30-225 prescribes the exact visual examination, chemical test procedure, and pressure test procedure to be followed for certain liquid chemical agents. The lot is declared serviceable or acceptable if the number of critical defects observed in the sample does not exceed the acceptance number for the applicable sample size. A critical defect is one that results in materially decreasing the usability of the chemical agent or of the container and is prescribed in the applicable serviceability standard. For example, the acceptance number for a grand lot of 101 to 500 containers of mustard is three; that is, for the lot to be acceptable, no more than three of the containers inspected can be found to have a critical defect.

56. Pressure Testing

A determination as to whether or not chemical agents, especially certain unstable gaseous agents such as CK, have deteriorated to a dangerous condition is made by testing the container for pressure. The pressure obtained from these tests is compared to a table of normal vapor pressure for the agent at the prevailing atmospheric temperature, in accordance with the standards established in the applicable serviceability standard. If the pressure of a container of chemical agent varies from the standards established, such action is taken as indicated in the serviceability standards. If there has been a recent significant change in the atmospheric temperature, a pressure change should be suspected until the temperature. of the contents of the container is known to be at equilibrium with the atmospheric temperature.

For gaseous chemical agents, table 2 has been prepared to show the normal absolute pressure that should exist at various atmospheric temperatures and the corresponding gage pressure. Although the figures in the table are approximate, a variation of 50 percent from them indicates serious deterioration of the agent tested. Gaseous chemical agents that have deteriorated may be dangerous and should be disposed of without delay.

Table 2. Normal Vapor Pressure for Gaseous Chemical Agents at Given Atmospheric Temperatures[1]

Chemical agent	Vapor pressure in pounds per square inch		Atmospheric temperature in degrees	
	Absolute pressure	Gage pressure	Centigrade	Fahrenheit
	7	0	-10	14
	11	0	0	32

Table 2. Normal Vapor Pressure for Gaseous Chemical Agents at Given Atmospheric Temperatures[1] Continued

Chemical agent	Vapor pressure in pounds per square inch		Atmospheric temperature in degrees	
	Absolute pressure	Gage pressure	Centigrade	Fahrenheit
CG	16	1	10	50
	23	8	20	68
	31	16	30	86
	41	26	40	104
	5	0	-10	14
	9	0	0	32
CK	13	0	10	50
	19	4	20	68
	28	13	30	86
	37	22	40	104

[1]These are approximate figures. Fifty-percent deviation from these figures indicates serious deterioration of the chemical agent tested.

a. Procedure. To determine the pressure in a container, such as a 1-ton container, proceed as follows:

(1) Remove the shipping bonnet. Aline the valves vertically.

(2) Check for exterior contamination, decontaminate if necessary.

(3) Remove the cap from the upper valve and attach an adapter.

(4) Screw a correct-type pressure gage tightly into the adapter.

(5) Open the upper valve one-quarter turn and close it.

(6) Take the pressure reading and record it.

(7) Remove the gage and adapter, and replace the cap on the valve.

(8) Take great care in removing gage and adapter because the eduction tube may have contained trapped liquid agent.

(9) Replace the shipping bonnet.

Note

Personnel testing pressures of group A agent containers must have on full protective clothing and mask.

b. Schedule. The following schedule of pressure testing should be established and maintained for all containers filled with chemical agents:

(1) In temperate climates, test approximately once every 6 months.

(2) In tropical climates, test once every 2 to 3 months.

57. Condition Codes

AR 725-50 prescribes a standard coding pattern for reporting conditions managed by USAAPSA. The condition codes are one-position, alphabetic characters used to classify commodities as to their degree of serviceability, condition, and completeness in terms of

readiness for issue and use or to identify actions under way to change the status of materiel.

58. Serviceability Reports

Upon completion of evaluation of containers of chemical agents and chemicals, depots are required to submit serviceability reports to the Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-QA, Edgewood Arsenal, Maryland 21010. The complete serviceability report consists of one copy of each of the following forms prescribed in the applicable serviceability standard:

a. DA Form 984 (Materiel Serviceability Report).

b. DA Form 985 (Data Sheet for Grand Lots, Miscellaneous Lots, or Depot Lots).

c. DA Form 986 (Test Data Sheet, Serviceability of Burning-Type Munitions).

d. DA Form 987 (Test Data Sheet, Serviceability of Materiel Other Than Burning-Type Munitions).

e. DA Form 988 (Visual Inspection Sheet, Serviceability of Materiel).

59. Surveillance Plan

Surveillance begins with the arrival of containers of chemical agents and chemicals at a depot. The date of the last surveillance inspection of chemical agents received from the zone of interior should be stenciled on each container. Surveillance is subsequently conducted for lots of chemical agents or chemicals in accordance with the surveillance cycle prescribed in the applicable serviceability standard. The surveillance cycle refers to the length of the intervals between surveillance. For example, SB 3-30-225 prescribes surveillance for containers of liquid chemical agents on the basis of grand lots or mixed lots at intervals not to exceed 18 months; however, pressure testing and visual inspection are to be conducted every 6 months. To perform cyclic surveillance on a routine basis, the establishment of a surveillance plan is essential. Such a plan requires an accurate record of dates of surveillance inspections of all lots of chemical agents and chemicals in the depot.

Section VI. STANDING OPERATING PROCEDURES

60. General

Standing operating procedures are instructions by which the commander prescribes procedures to be followed in matters that he wishes to make routine. They provide for coordination of the depot's technical, administrative, and tactical operations. This section discusses those SOP's that are technical in nature and that are peculiar to the handling of bulk chemical agents and munitions in a depot. Administrative standing operating procedures, such as a stock-control SOP, are normally covered in type unit field manuals and/or other DA publications (app A). Tactical SOP's, such as an action-against-hostile-ground-attack SOP, also are covered in type unit field manuals and, in addition, usually must conform to the SOP of the area command in which the depot may be located.

61. Storage and Shipment SOP

The storage and shipment SOP should list all the applicable procedures to be followed for specified groups of chemical agents from receipt of the shipments through the storage and shipment phases. In this SOP, emphasis should be placed on the techniques of handling chemical agents safely.

62. Fire-Prevention SOP

A fire-prevention SOP should include those procedures and precautions that apply in general to all depots, and should stress procedures that apply especially to storage of chemical agents. It should provide for the organization and operation of a fire-prevention organization, regular fire inspections to detect and eliminate fire hazards, establishment and enforcement of fire regulations, inspection and maintenance of fire-fighting equipment, and the investigation of fires to determine the cause and the action necessary to prevent similar incidents.

63. Safety SOP

In compliance with AR 385-10, AR 385-40, and TM 9-1300-206, a safety SOP should establish a safety organization and provide for: inspections to determine principal hazards and initiate action to eliminate, correct, or control these conditions; a system for submitting reports of accidents; a system for investigating accidents to determine

causes and action to eliminate them; and continuous inspection of operating activities to detect unsafe practices and to recommend corrective action. The safety SOP should prescribe general and specific safety procedures to be followed by personnel in handling chemical agents and hazardous chemicals and the necessary training of these personnel.

64. Security SOP

A security SOP should provide for the organization, administration, training, and operations of a security organization (AR 190-3). It should provide for active and passive defensive measures; security checks for civilian labor employed in the storage area; a system of passes and identification; and a positive system for safeguarding the area where critical chemical munitions, such as nerve agents, are stored.

65. Surveillance and Inspection SOP

The surveillance and inspection SOP should list the regulations that furnish surveillance and inspection instructions for specific chemical agents and chemicals, the personnel responsible for operations, and the special procedures that are to be followed in the depot.

66. Fire-Fighting SOP

A fire-fighting SOP should provide for the organization, administration, training, and operations of a fire-fighting organization.

67. Emergency SOP

This SOP should describe the actions to be taken in an emergency such as the discovery of a leak in a container of chemical agent. It should establish an alarm system that includes provisions for a portable percussion-type alarm to be used to warn exposed, unprotected personnel approaching the immediate danger area.

68. Emergency-Destruction SOP

The emergency-destruction SOP should clearly indicate which chemical agents and chemicals may be destroyed in an emergency and which may not be destroyed without specific written orders authorizing such destruction. The SOP should indicate the approved method for destruction for specific agents.

CHAPTER 4
STORAGE AND HANDLING OF GROUP A CHEMICAL AGENTS

Section I. INTRODUCTION

69. General

This chapter describes the storage and handling problems of group A chemical agents and gives useful information about these agents. For detailed information on individual agents, see TM 8215.

70. Safety

a. Physiological Effect and Treatment. Group A chemical agents are very dangerous. The effects of nerve agents on personnel may be noticeable within a few seconds or minutes. Immediate first aid, followed as soon as possible by professional medical treatment, is necessary. Effects of other agents, such as the blister agents, may not be noticeable until several hours after contamination. By then, first-aid measures are seldom effective and only professional medical treatment can help.

b. Protective Clothing. When nerve agents are handled, impermeable protective clothing must be worn (para 29). Safety rules in paragraphs 45 through 51 must be observed. When blister agents are handled, the minimum protection required is permeable protective clothing, rubber apron, rubber gloves, boot covers, and the protective mask with hood. However, impregnated clothing and the protective mask with hood alone will protect against vapors.

c. Outage (Void Space) of Containers. In filling a container, sufficient outage must be left to allow for expansion of the agent. The filling densities (percent ratio of the weight of agent in a container to the weight of water the container will hold) of chemical agents vary greatly. One-ton containers are filled to a maximum of 170 gallons (total capacity is 190 gallons), which allows about a 10-percent void. Similarly, 55 gallon drums are filled with 50 gallons of liquid.

d. Safety (Standby) Man. In handling toxic chemical agents, one man must not be permitted to work alone. The working crew must include a separate safety man equipped with a field protective mask, a special purpose mask, or an all-purpose gas mask with an all-purpose canister or other suitable canister (TM 8-4240-281-12), and a gas casualty treatment medical supply set. The safety man should constantly observe operations from a safe distance upwind and be prepared to rescue any member of the working crew who shows distress. The safety man must be capable of administering first aid for toxic chemical agents. In the case of nerve agents, the buddy system should be employed where one person observes another for the first symptom of agent effect.

Section II. BLISTER AGENTS

71. Mustards (HD and H)

The blister agents are chemicals of relatively low volatility that have a blistering effect upon the skin, eyes, and lung tissue. HD is the symbol for distilled mustard, and H is the symbol for Levinstein mustard that contains certain impurities.

Since HD is obtained by distilling H, the characteristics of HD and H are similar. Hence, only HD is considered in the following discussion. H, because it contains impurities that cause it to deteriorate and to corrode and clog eduction tubes, presents greater storage problems than does HD. When pure, mustard is a colorless or nearly colorless liquid. However, the plant product is usually a straw-colored to brown oily liquid.

a. Solvents. Alcohol, carbon disulfide, carbon tetrachloride, and oil.

b. Duration of Effectiveness. Duration of effectiveness depends upon means of dissemination and other factors. Mustards are normally considered to have a comparatively long duration of effectiveness.

c. Storage (paras 41 through 44). HD is stable in containers at temperatures under 252° F. and has no action on metals. It is usually a liquid in temperate climates. It normally is stored in 1-ton containers. As with other agents, when 1 ton containers of mustard are stored, the valves on each container should be in horizontal alinement. This will prevent sludge from clogging the lower eduction tube.

d. Shipping (ch 9). The DOT classification of mustard is extremely dangerous poison, class A. DA Label 69 (Warning-Beware of Fumes-Poison Gas) (fig. 37) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

e. Detection (para 44). Leakage of mustard in storage normally is detected by its odor, which resembles that of garlic or horseradish, or by detector paper or crayon, or by the chemical agent detector kit.

f. Decontamination (para 51). Surfaces contaminated with mustard can be decontaminated with DS2, DANC, and bleach slurry or dry mix, depending on the surface.

Caution

When dry STB (supertropical bleach) comes in contact with mustard, enough heat normally is generated to produce a fire.

g. Surveillance (SB 3-30-225). Routine inspection should be made to detect leaks, breaks, or other defects in containers. Pressure test and vent containers at least once every 6 months, or more often if they are stored under continuous tropic or desert conditions.

h. Physiological Action and First Aid. Mustard is a powerful blister agent that burns the skin, eyes, and lung tissues. Exposure to even an extremely slight concentration is capable of causing severe burns that appear from 4 to 24 hours after exposure. Decontamination of HD or H on the skin is accomplished by using the skin decontaminating pad found in the M13 individual decontaminating and reimpregnating kit, or protective ointment from the M5A4 protection and treatment kit. For liquid mustard in the eyes, hold the lids open and flush with clear water for one-half minute to 2 minutes. For contamination of both skin and eyes, seek medical aid after first-aid measures have been taken. For detailed information pertaining to first aid and decontamination measures, see FM 21-41 and TM 8-285.

i. Fire. There is a distinct vapor hazard from burning mustard when burning conditions are not controlled.

72. HT

HT is a mixture of HD (60 percent) and T (40 percent). T is a sulfur and chlorine compound of a clear yellow color with an odor similar to that of H. Properties of HT are similar to those of HD (para 71). The duration of effectiveness of HT is somewhat longer than that of HD.

Section III. NERVE AGENTS

73. General

Nerve agents are highly toxic, quick-acting chemicals that affect the muscular coordination of the victim. Because of the extreme toxicity of these agents, they are considered as special hazardous chemicals and must be separated from other group A agents. When personnel are working in areas where these agents are stored in 1-ton containers, either a 400-gallon power-driven decontaminating apparatus (PDDA) or a 500-gallon PDDA must be present and filled with a 10 percent caustic solution. Two 55-gallon drums, one filled with 5-percent sodium carbonate solution and one filled with clear water, must also be available for personnel decontamination.

74. Sarin (GB)

a. Solvents. Organic solvents.

b. Duration of Effectiveness. The duration of effectiveness is dependent upon the method of dispersion. In a cloud of fine particles, the duration of effectiveness is very short, while in winter, large droplets or splashes will remain for some time (hours or days).

c. Shipping (ch 9). The DOT classification of GB is extremely dangerous poison, class A. DA Label 69 (Warning-Beware of Fumes-Poison Gas) (fig. 37) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

d. Detection (para 44). Leakage of GB normally is detected by a chemical agent detector kit. An automatic alarm is available for plant use. Pigeons, canaries, and rabbits are very useful in detection of GB. GB is a colorless liquid and is practically odorless.

e. Decontamination (para 51). Surfaces contaminated with GB can be decontaminated with DS2, bleach slurry, 10-percent caustic solution, dilute water solutions of alkalies (5-percent washing soda or lye solutions), or hot soapy water.

f. Surveillance. The serviceability standard is published in a supply bulletin of the 3-30-series Careful inspection must be made to detect leaks, breaks, or other defects in containers.

g. Safety. Stringent control over all personnel practices must be exercised in the interest of safety (paras 45 through 51). A study of casualties incurred by personnel handling GB discloses the following basic reasons for accidents.

(1) A failure to evaluate the degree and duration of the hazard. For example, a shift in wind direction could bring agents back to the area of a leaker after personnel have removed protective masks.

(2) Unsuspected presence of contaminated material in an area considered to be nonhazardous. For example, contaminated mud might be tracked into a closed vehicle.

(3) Unsuspected presence of GB in clothing such as field jackets, in cold weather, with subsequent evolving of the agent in a warm, closed vehicle or room.

h. Physiological Action and First Aid. GB is a powerful, quick-acting nerve agent. GB causes muscular spasms and death within a matter of minutes after contamination either by liquid contact with the skin or by inhalation of the vapors. The symptoms, in normal order of appearance, are runny nose; tightness of chest; dimness of vision and pinpointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea, vomiting, cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsions. These symptoms are followed by cessation of breathing and death. Symptoms appear much more slowly from skin dosage than from respiratory dosages. If any of these symptoms appear, put on the protective mask immediately if the air is still contaminated; or if a mask is not available, cover the face with a cloth saturated with water.

(1) For liquid GB on the skin, immediately wash the liquid off the skin with a stream of water and then wash the contaminated area with soap and water. Remove all contaminated clothing quickly and carefully, taking necessary precautions to prevent self-contamination. If nerve agent poisoning symptoms develop, immediately inject the atropine from one automatic injector into a muscle, preferably the thigh muscle (FM 21-40). Artificial respiration may be necessary.

(2) For liquid in the eyes, flush with clear water or with solution of bicarbonate of soda and immediately inject atropine into a muscle, preferably the thigh muscle. Absorption of GB through the eyes is extremely rapid.

(3) For exposure to GB liquid or vapor, administer one atropine injection into a muscle (preferably thigh) when nerve-agent poisoning symptoms develop. If, in a contaminated atmosphere, the victim has stopped breathing and time does not permit his removal to a clean atmosphere, administer artificial respiration using the M17A1 field protective mask resuscitation system described in TM 8285. If time permits removal of the victim to a clean atmosphere, administer artificial respiration by using the mouth-to-mouth resuscitation method described in TM 8-285. If more atropine is needed, two additional automatic injectors may be administered at 8-minute intervals. Should the needs of the individual casualty demand more atropine, additional injections may be given by the officer or non-commissioned officer in charge. If available, use an oxygen breathing apparatus. Evacuate casualty to a hospital without delay.

75. VX

VX is a nerve agent similar to GB but of lower volatility. Characteristics of VX are similar to those of GB except where noted below.

a. Duration of Effectiveness. Considerably longer than that of GB.

b. Detection. The M18A2 detector kit has the capability to detect the presence of VX liquid.

c. Decontamination (para 51). Surfaces contaminated with VX can be decontaminated with DS2, DANC, 10-percent HTH solution, bleach slurry, 30- to 35-percent solution of sodium hypochlorite, or M5 protective ointment.

d. Physiological Action and First Aid. VX takes effect in 3 to 10 minutes. Symptoms are identical to those of GB. Liquid splashes on the skin should be decontaminated by using the skin decontaminating pad found in the M13 individual decontaminating and reimpregnating kit or by using protective ointment. First aid is similar to that used for GB poisoning. See FM 2141 and TM 8-285 for additional information.

CHAPTER 5
STORAGE AND HANDLING OF GROUP B CHEMICAL AGENTS

Section I. INTRODUCTION

76. General

This chapter describes the problems that may be encountered in the storage and handling of group B chemical agents in a storage area, and furnishes useful information about individual agents. Group B includes gaseous toxic chemical agents, for which the protective mask is sufficient protection, incapacitating agents (BZ), nonburning screening smokes (FS, FM), and nonburning mixtures of riot control agents as either solutions or micropulverized solids. Burning mixtures of smokes or riot control agents are in group D. Some of the chemical agents are under high pressure in containers and present dangerous storage and shipping problems because, for various reasons, excessive internal pressures can develop and cause the containers to rupture or explode. Constant surveillance is required to detect indications of dangerous pressure in containers. When handling chemical agents under pressure, personnel must be required to take firm safety measures. For detailed information about individual agents, see TM 3-215.

77. Safety

In general, containers of highly volatile chemical agents that may be under high pressure must not be permitted to come in contact with fire, sparks, or electrical circuits; any one of these can cause an explosion. They should not be stored with group D flammable burning mixtures nor near such flammables as oils, gasolines, and waste. Containers of chemical agents under high pressure must not be used as rollers or supports, or for any other purpose than to contain the agents. Personnel must not tamper with the safety devices on containers.

a. Valves. Valves on containers of chemical agents under high pressure must be opened slowly with the prescribed wrench or tool. First, "crack" the valve by opening it one-quarter turn and then closing it immediately; this action cleans the valve of dust and dirt. If it is necessary to heat the container in a warm bath to promote more rapid discharge of the filling, the temperature of the container must not be allowed to exceed 170° F. (Although fusible plugs melt at about 175° F., they may soften at a lower temperature.) Do not place the container in a warm bath until the outlet valve is open and the agent is flowing.

b. Pressure Regulators. A pressure regulator must be attached to the outlet valve of a container of chemical agent under high pressure to produce a safe working pressure (para 14).

c. Protective Clothing. The protective mask alone provides adequate protection for most group B agents. When corrosive liquid smokes are handled, rubber boots, rubber gloves, and rubber aprons (with sleeves) are also necessary. When bulk solid riot control agents are handled, rubber gloves and mask hood should be worn; other protective items such as rubber apron and rubber boots or boot covers may be worn.

d. Outage. See paragraph 70c.

e. Safety (Standby) Man. See paragraph 70d.

78. Storage

Group B chemical agents normally are stored and shipped in 1-ton containers or 55-gallon drums, depending on the agent. When using 1-ton containers, fusible safety plugs are used. Containers of chemical agents with high vapor pressure must not be exposed to heat. They should be stored under cover and protected from the direct rays of the sun, especially in tropical or desert areas. Good ventilation should be provided since it helps keep temperatures of containers moderate. Revetments, open-side sheds, well-shaded areas, underground storage, or tarpaulins should be used to protect unstable chemical agents such as CK. See paragraphs 35 through 40 for information on depot layout. See paragraphs 141

through 143 for information on transfer procedures.

79. Surveillance

The surveillance instructions for group B chemical agents given herein are necessarily of a general nature. The specific inspection procedure for each chemical agent must be conducted in accordance with applicable serviceability standards.

As with group A agents, group B chemical agents require periodic inspections to detect leaks, breaks, or other defects in containers. Some chemical agents such as CK require periodic pressure testing of containers and valves (para 56) and/ or drawing samples from containers. Special detector papers can be prepared by a chemical laboratory to be used for detecting leakers of some agents. Spots and color changes indicate the presence of the agent for which the test is being made, and the intensity of the change in color indicates the degree of concentration. (The characteristic color change for CG is given in paragraph 80*e*, and for CK, in paragraph 82*e*.) A fresh strip of detector paper that is not discolored, as prescribed below, must be used each time. Detector test paper No. 2, when impregnated with solution E (*b* below), is used to detect concentrations of CG; and when sensitized with solution D (a below), to detect CK. The test paper is prepared in 1/2-inch-wide strips and spotted at 3/4-inch intervals with a solution of 10 grams of sodium carbonate (anhydrous) in 100 milliliters of water. Use the tip of an eyedropper filled with the solution to apply 1/2-inch spots to the paper. Hand the strips to dry and then cut them to 3-inch lengths. These papers keep indefinitely.

a. Solution D. Prepare by dissolving 4 grams of betanaphthylamine and 2 grams of DB(4-(p-Nitrobenzyl)-pyridine) in 100 milliliters of acetone. (DB-8 can be procured from Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-DME-4, Edgewood Arsenal, Maryland 21010.) Keep the solution in a tightly stoppered bottle. Discard the solution if it dries dark on white filter paper.

b. Solution E. Prepare by dissolving 6 grams of phenylalphanaphthylamine and 2 grams of paradimethylaminobenzaldehyde in 92 milliliters of acetone. Keep the solution in a stoppered bottle. Discard the solution if it dries dark on white filter paper.

Section II. CHOKING AND BLOOD AGENTS

80. Phosgene (CG)

a. Solvents for. Benzene, light fuel oil, and toluene.

b. Duration of Effectiveness. Very few minutes depending on weather conditions.

c. Storage (paras 41 through 44). Phosgene is stable in dry steel containers, but corrodes wet metals vigorously.

d. Shipping (ch 9). The DOT classification of phosgene is extremely dangerous poison, class A.

DA Label 69 (Warning-Beware of Fumes-Poison Gas) (fig. 37) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

e. Detection (para 44). Leakage of phosgene in storage may be detected by its odor, which is similar to that of fresh cut hay, ensilage, or green tomatoes. CG is normally a colorless gas, except at temperatures below 8° C. when it is a liquid; the impure liquid has a yellow or orange-brown color. The fumes from a bottle of ammonia will cause phosgene to form white fumes. Concentrations of CG can be detected by use of a chemical agent detector kit or detector test paper No. 2 that has been impregnated with solution E (para 79b). If the test paper shows a green color with light red spots after a 5-minute exposure, CG is present in the air.

f. Decontamination. Normally, aeration is sufficient. If further decontamination is necessary, surfaces contaminated with CG can be decontaminated with steam, DS2, or water followed by a 10-percent alkaline solution.

g. Surveillance. Routine inspections should be made to detect leaks, breaks, or other defects in containers and valves. Pressure tests must be performed at least once every 6 months; if CG is stored under continuous tropic conditions, pressure tests must be performed once every 3 months (para 56).

h. Physiological Action and First Aid. CG causes uncontrollable coughing, tightness in the chest, choking sensation, and headache. Low concentrations that are not particularly irritating may, after an interval of several hours, produce serious symptoms. In any case, the severity of poisoning is not apparent for 3 to 4 hours. To treat a person who has been exposed to CG

vapor, keep him quiet and warm in fresh air. In serious cases, seek medical care.

81. Chlorine (Cl)

Although chlorine is not a standard chemical agent, it is a standard training agent and falls in group B category for storage.

a. Solvent for. Carbon tetrachloride.

b. Duration of Effectiveness. In summer, 1 to 5 minutes; in winter, 1 to 10 minutes.

c. Storage (paras 41 through 44). Chlorine is stable and has no action on metals when dry; when wet, it corrodes metals vigorously. It hydrolyzes very slowly. Liquid chlorine normally is stored in 1-ton containers or in steel cylinders. It is not a fire hazard, but should not be stored near highly flammable substances such as gasoline or oils. It should be protected against extremes in weather, particularly continuous dampness. If it is necessary to change valves on a 1 ton container without the use of a valve replacement mechanism, cooling the container to below 68° F. will reduce the internal pressure and facilitate the operation. A salt-ice mixture bath, plain water bath, and spray are simple methods for cooling a container.

d. Shipping (ch 9). The DOT classification of chlorine is nonflammable compressed gas. DA Label 65 (Keep Cool-Caution-Nonflammable -Compressed Gas) (fig. 54) is required for shipment by surface transportation in the continental United States. DA Label 66 (Nonflammable Compressed Gas) (fig. 55) is required for shipment by commercial or military air.

e. Detection (para 44). Leakage of chlorine in storage may be detected by its pungent and disagreeable odor. Chlorine is a heavy greenish-yellow gas.

f. Decontamination. Normally, aeration is sufficient. If further decontamination is necessary, spray the contaminated surface with plain water or with a solution of 220 parts of sodium bisulfate and 175 parts of sodium carbonate in 1,000 parts of water.

g. Surveillance. Routine inspection should be made to detect leaks, breaks, or other defects in containers.

h. Physiological Action and First Aid. Chlorine causes intense irritation of the nose and throat, coughing, and burning of the upper respiratory tract. To treat a person who has been exposed to chlorine vapor, remove him to fresh air and place him on his back. Caution the patient to resist as much as possible the impulse to cough; coughing is the primary cause of all reported casualties. Administer a moderate sedative or a moderate stimulate, either of which will relieve the tendency to cough and soothe the inflamed membranes. If the patient stops breathing, administer artificial respiration.

82. Cyanogen Chloride (CK)

a. Solvents for. Ether, alcohol, and water.

b. Duration of Effectiveness. 1 to 10 minutes.

c. Storage. CK, stabilized with 5-percent-by weight anhydrous tetrasodiumpyrophosphate, is stable when stored in 1-ton containers or steel cylinders. It attacks iron, steel, and silver very slowly; it has no action on lead. It is slowly hydrolyzed by water. When deteriorated to a certain stage, CK may explode with great violence. It is not a fire hazard, but should not be stored near gasoline or oils.

d. Shipping (ch 9). The DOT classification of cyanogen chloride is extremely dangerous poison, class A. DA Label 69 (Warning-Beware of Fumes-Poison Gas) (fig. 37) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

e. Detection (para 44). Leakage of CK in storage is normally detected by the use of a chemical agent detector kit or test detector paper No. 2 that has been sensitized with solution D (para 79a). If a bluish-red or purple color and orange spots appear on the test detector paper within 5 minutes, CK is present in the air. CK can be detected by its irritation to the eyes and respiratory tract before its odor, which is irritating, becomes noticeable.

f. Decontamination. Aeration, DS2, or NaOH (lye) solution.

g. Surveillance. Routine inspection must be made to detect leaks, breaks, or other defects in containers and valves. Pressure test at least once every 6 months and more often if containers are stored under tropic conditions (para 56). An SNVR (soluble nonvolatile residual) test is the most conclusive indication of deterioration.

h. Physiological Action and First Aid. CK irritates the eyes and respiratory tract, even in low concentrations. It produces intense irritation of the lungs, which leads to a very quick edema. This irritation may cause involuntary breath holding. Death from acute poisoning is preceded by convulsions and respiratory arrest. To treat a person who has been exposed to CK vapor, remove him to fresh air and crush two ampuls of

amyl nitrite and hold them close to the nose of the casualty (or insert them inside the protective mask if in a contaminated atmosphere). Repeat at 8-minute intervals until eight ampuls have been used. Treatment must be instituted at once. If necessary, administer artificial respiration. Keep the patient warm and quiet and give him warm liquids to drink. Get medical aid.

Section III. RIOT CONTROL AND INCAPACITATING AGENTS

83. Adamsite (DM)

DM is used in burning mixtures while DM1 is a micropulverized solid, nonburning mixture. However, only DM1 is stored in this group. The burning mixture is stored in group D.

a. Solvents for. Acetone, benzene, and chloroform.

b. Duration of Effectiveness. Depends on weather conditions. The duration of effectiveness of DM1 can be quite long.

c. Storage. DM1 is stable in steel containers and has very slight action on metals. Water hydrolyzes DM1 very slowly to an orange-brown substance. The fumes are flammable; DM1 should not be exposed to direct rays of the sun if stored under tropic conditions.

d. Shipping (ch 9). The DOT classification of adamsite is irritating substance, class C. DA Label 25 (Caution-Tear Gas or Tear Gas Producing Materials) (fig. 41) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 88) is required for shipment by commercial or military air.

e. Detection. DM1, when pure, is a practically odorless bright canary-yellow crystalline solid, but it is usually found as a greenish-yellow to black solid. (See physiological effects below.) *f. Decontamination.* Wash the contaminated surfaces with weak bleach slurry or DS2.

g. Surveillance. See SB 8-8-series. Periodic inspection should be made to detect storage conditions conducive to excessive heating.

h. Physiological Action and First Aid. The first symptoms are usually a burning sensation in the nose and throat and watering of the eyes and nose. Even in small quantities DM causes headache, nausea, and violent sneezing; these symptoms are followed by temporary physical and mental debility. To treat a person who has been exposed to DM vapor, remove him to fresh air and away from heat. Have him rinse his nose and throat with salt water or bicarbonate of soda solution. Wash exposed skin and scalp with soap and water and allow to dry on the skin; dust the skin with berated talcum. Let the patient sniff chlorine vapor from a solution of bleach; if the patient's reactions are severe, let him carefully breathe chloroform from a gas casualty first-aid kit. If he becomes delirious, watch him carefully to prevent self-injury. When the patient can be moved, he should be washed thoroughly. In severe cases obtain medical assistance.

84. Chloroacetophenone (CN)

a. Solvents for. Alcohol, benzene, chloroform, and ether.

b. Duration of Effectiveness. Several days as a solid.

c. Storage. CN1 is stable in metal barrels;. it does not attack metals. It is not hydrolyzed by water.

d. Shipping (ch 9). The DOT classification of CN is tear gas, class C. DA Label 25 (Tear Gas) (fig. 41) is required for shipment by surface transportation in the continental United States.

DA Label 67 (Poison Gas Label-Poison) (fig. 88) is required for shipment by commercial or military air.

e. Detection. CN1 is a white crystalline solid.

It has an odor like that of apple blossoms.

When dispersed as an irritant solution, the odor of the solvent is apparent.

f. Decontamination. Wash contaminated surfaces with hot sodium carbonate, sodium hydroxide, or soapy water solution.

g. Surveillance (SB 8-80-228). Routine inspection is required.

h. Physiological Action and First Aid. CN irritates the eyes and the skin and causes a burn- ing sensation. It causes intense weeping, but does not permanently injure the eyes. To treat a person who has been exposed to CN aerosol, remove him to fresh air and face him toward the wind with his eyes open. If, very rarely, some CN remains in the eye, it should be flushed out promptly with water or saline of water if available. A 1/4-percent solution of sodium sulfite, if avail- able, is more effective in dissolving and neutralizing CN. The eyes should not be rubbed or bandaged. Dermatitis and superficial skin burns may be treated with Compound Calamine Lotion for symptomatic relief. The treatment of deeper burns is the same as for thermal burns of like severity (TM 8-285).

85. CN, Chloroform Solution (CNC)

The standard mixture of CNC is 30 percent by weight of CN in 70 percent by weight of chloroform.

a. Duration of Effectiveness. Short as a vapor.

b. Storage. CNC is stable in metal drums. It is not hydrolyzed by water.

c. Shipping (chap. 9). The DOT classification of CNC is tear gas, class C. DA Label 25 (Tear Gas) (fig. 41) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

d. Detection. The odor of CNC is like that of chloroform.

e. Decontamination. Wash contaminated surfaces with hot solution of sodium bicarbonate or sodium sulfite.

f. Surveillance (SB -80-228). Routine inspection is required.

g. Physiological Action and First Aid. Similar to that for CN.

86. CN, Benzene, and Carbon Tetrachloride Solution (CNB)

CNB is a solution of chloroacetophenone in benzene and carbon tetrachloride. The standard mixture of CNB contains 10-percent CN, 45-percent carbon tetrachloride, and 45-percent benzene by weight.

a. Duration of Effectiveness. Low as a vapor.

b. Storage. CNB is stable in metal drums. It is not hydrolyzed by water.

c. Shipping (ch 9). The DOT classification of CNB is tear gas, class C. DA Label 25 (Tear Gas) (fig. 41) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

d. Detection. The odor of CNB is like that of benzene.

e. Decontamination. Wash contaminated surfaces with a 5-percent solution by weight of sodium hydroxide in 95-percent alcohol or with a mixture of 20 parts water and 80 parts carbitol (diethylene glycol).

f. Surveillance. See SB 3-30-228. Routine inspection is required.

g. Physiological Action and First Aid. Similar to that for CN.

Warning

Carbon tetrachloride is very toxic and caution should be used when handling this agent.

87. CS

CS is similar to but more powerful than CN.
CS1 is a micropulverized powder. CS2 is modified CS1 treated with liquid' silicone, resulting in increased fluidity and persistency.

a. Storage. CS is stored in heat-sealed polyethylene-aluminum clothbacked bags overwrapped in paper shipping sacks inside 55-gallon steel drums. More recently, the use of 3 1/2-gallon plastic containers in a wood box has been introduced and may appear in various depots.

b. Shipping. Same as requirements for CN.

c. Detection. White crystalline solid. Odor is pungent.

d. Decontamination. A solution containing 10 percent monoethanolamine and about 0.8 percent of a nonionic detergent such as Tritan X-100.

e. Surveillance. Same as for CN.

f. Physiological Action and First Aid. Eyes must be thoroughly irrigated with water or saline of water, or a 1/4-percent solution of sodium sulfite, if available, and the casualty must be sent for medical treatment of eyes. Flush skin areas with water immediately and send casualty for medical treatment. (Detailed information is available in TM 8-285.) *g. Fire Hazard.* CS1 dust is readily ignited by weak sparks and constitutes a severe explosive hazard. Minimum explosive dust concentration is 0.025 oz/cu ft.

88. BZ

Incapacitating agent BZ is a very potent psychoactive compound which produces mental and physical incapacitation when inhaled. Symptoms become evident 30 to 60 minutes after exposure, and maximum effects of the agent occur in 4 to 8 hours, lasting 8 or 4 days in untreated cases. BZ is used in burning mixtures which aerosolize the agent. The agent is packed in munitions in micropulverized form; however, if leakages should occur and become suspended in the air, inhalation of the particles will produce the same effects and symptoms as the aerosol.

a. Solvent for. 5-percent acetic acid solution.

b. Duration of Effectiveness. Approximately 10 minutes in aerosol form. The duration of effectiveness of BZ in micropulverized form can be indefinite in dry areas.

c. Storage. BZ is stored in its munitions.

d. Shipping. The DOT classification of BZ is less dangerous poison, class B. DA Label 71 (Warning-Poison-Do Not Drop) (fig. 40) is required for shipment by surface transportation in the continental United States. DA Label 67

(Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial or military air.

e. Detection. BZ in micropulverized form is white or off-white in color. At present, no reliable field test is available for the detection of agent BZ. For information on laboratory procedures for detecting BZ, write to Commanding Officer, Edgewood Arsenal, ATTN: SMUEA-D, Edgewood Arsenal, Maryland 21010.

f. Decontamination. Decontamination of personnel can be accomplished by washing contaminated parts with soap and water. Flush eyes with clear water only. Clothing and equipment should be shaken or brushed and thoroughly washed. Hypochlorite or alcohol caustic solutions are suitable decontaminants for BZ on materiel. BZ can be removed by scrubbing, pressure hosing, or drenching the surface with a detergent-wetting solution followed by hosing with clear water.

g. Physiological Action and First Aid. BZ primarily affects the brain, producing giddiness, disorientation, hallucinations, and drowsiness. Physiological effects include dry, flushed skin, increased heartbeat, urinary retention, constipation, headache, and a general slowing of mental and physical activity. Because a person exposed to BZ cannot sweat, the danger of heat stroke is the primary concern in first aid. Remove excessive clothing if the environmental temperature is above 70° F. Move the victim to fresh air. To prevent him from injurying himself or others as symptoms develop, restrictive care must be provided. Individuals who cannot stand must be lifted to a litter and strapped in. Individuals who are ambulatory must be regarded as potentially belligerent and should be separated from each other, confined, and closely observed before and during medical treatment. The drug physostigmine salicylate is highly effective in treating BZ victims if administered approximately 4 hours following exposure. Only medical personnel should administer the drug, however; and treatment does not shorten the duration of BZ intoxication. Premature discontinuation of therapy will result in relapse.

Section IV. NONBURNING SCREENING SMOKES

89. Sulfur Trioxide in Chlorosulfonic Acid (FPS)

FS consists of sulfur trioxide (SO^3.) in chlorosulfonic acid ($C1SO^3H$). The standard solution of FS consists of about 55-percent sulfur trioxide dissolved in 45-percent chlorosulfonic acid, by weight.

a. Duration of Effectiveness. Low as a vapor.

b. Storage. FS is stable when stored in dry metal drums. It vigorously corrodes metals in the presence of moisture. When in contact with water, it reacts violently, generating large quantities of heat. It must be stored away from flammables. It is not a fire hazard, but it can cause fires by coming in contact with other materials.

c. Shipping (ch 9). The DOT classification of FS is corrosive liquid. DA Label 13 (Caution-Acid-Do Not Drop) (fig. 49) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

d. Detection. FS has a strong, acrid odor and produces large quantities of white smoke.

e. Protection. Protective mask is required for all concentrations of FS smoke. In addition, personnel handling liquid FS should wear rubber gloves, rubber aprons (with sleeves), and rubber boots.

f. Decontamination. Wash contaminated surfaces with any available alkali solution.

g. Cleaning Storage Containers. Wash with a decontaminating solution and then rinse thoroughly with water.

h. Surveillance (SB 3-30-277). Routine inspection of containers should be made to detect leaks, rust, or other defects.

i. Physiological Action and First Aid. Liquid FS burns violently. FS smoke causes slight irritation of the throat and eyes and a prickling sensation of the skin. The sulfur trioxide gives off suffocating fumes that cause coughing and a feeling of constriction around the chest. For liquid on skin, wash with a large amount of water, then with sodium bicarbonate solution. Treat as an ordinary burn. For liquid in eyes, wash with water and then administer eye and nose drops from a gas casualty treatment set.

90. Titanium Tetrochloride (FM)

The chemical formula for titanium tetrachloride is $TiC1_4$.

a. Duration of Effectiveness. Low as a vapor.

b. Storage. FM is stable in steel drums, if dry.

It vigorously corrodes metals in the presence of moisture; it is hydrolyzed by water. FM is not a fire hazard.

c. Shipping (ch 9). The DOT classification of titanium tetrachloride is corrosive liquid. DA Label 13 (Caution-Acid-Do Not Drop) (fig. 49) is required for shipment by surface transportation

in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

d. Detection. FM is a heavy, colorless liquid and has a mildly acrid or pungent odor. It can readily be detected by the large quantity of smoke produced when it leaks from a container.

e. Protection. Protective mask is required only for heavy concentrations of FM. When handling liquid FM, rubber gloves, rubber aprons (with sleeves), and rubber boots should be worn.

f. Decontamination. Wash contaminated surfaces with any available alkali solution.

g. Cleaning Storage Containers. Wash with a decontaminating solution and then rinse thoroughly with fresh water.

h. Surveillance (SB 830-277). Routine inspection of containers should be made to detect leaks or other defects.

i. Physiological Action and First Aid. Same as for FS.

CHAPTER 6
STORAGE AND HANDLING OF GROUP C AND D CHEMICAL AGENTS

Section I. INTRODUCTION

91. General

This chapter describes the storage and handling problems of groups C and D chemical agents that may be encountered in a storage area, and furnishes useful data and information about individual items. Chemical agents in groups C and D include spontaneously flammable and readily flammable materials and burning mixtures of riot control agents and HC smoke. However, the riot control agents are stored separately from other group D chemical agents. (For information about individual riot control agents, see paragraphs 83 through 87.) White phosphorus and plasticized white phosphorus, spontaneously flammable materials, are discussed in paragraph 95. Flammable oils and solvents are discussed in paragraphs 96 and 99. Flammables include liquids and solids as defined in a and b below.

a. Flammable Liquids. A flammable liquid is any liquid that gives off flammable vapors at or below a temperature of 80° F. The Underwriters' Laboratories classification for grading relative hazard of commonly used flammable liquids is listed below:

Flammable liquid	Rating
Carbon disulfide	110
Ether	100
Gasoline	90-100
Alcohol (ethyl)	60-70
Kerosene	30-40

b. Flammable Solids. A flammable solid is a solid substance, other than one classified as an explosive, which is liable to cause fire through friction, through absorption of moisture, or through spontaneous chemical changes.

92. Safety

Flammables require very careful handling. Mixtures of air and fumes from flammable liquids are explosive and dangerous; hence, close supervision of personnel smoking is necessary. Flammable liquids with high vapor pressures require special handling. Some flammable liquids, such as xylenol, react like carbolic acid in contact with the skin and require special protective measures. Empty containers previously used for flammable liquids also require special handling. Special safety measures are discussed in a through g below.

a. Outage (Void). In filling containers with flammable liquids, it is necessary to leave sufficient void in each container to allow for expansion of the filling due to increase in atmospheric temperature. The correct void (outage) that must be left in a container depends on two factors--the coefficient of expansion of the liquid, and the maximum possible increase in temperature to which there is any likelihood the container may be subjected either in storage or in shipment. Outage is calculated on the basis of the total capacity of the container. To determine outage of some of the commonly used flammable liquids, the following coefficients of expansion (increase in volume per unit volume per degree Fahrenheit) in table 3 can be used along with figure 18:

Table 3. Tabulated Data on Commonly Used Flammable Liquids

Flammable liquid	Coefficient of expansion	Flammable liquid	Coefficient of expansion
Acetone	0.00085	Gasoline or naphtha	
Amyl acetate	0.00068	50° - 55° A. P. I.	0.00055
Benzol (benzene)	0.00071	55.1° - 60° A. P. I.	0.00060
Carbon disulfide	0.00070	60.1° - 65° A. P. I.	0.00065

Table 3. Tabulated Data on Commonly Used Flammable Liquid Continued

Flammable liquid	Coefficient of expansion	Flammable liquid	Coefficient of expansion
Ether	0.00098	65.1° - 75° A. P. I.	0.00070
Ethyl acetate	0.00079	70.1° - 75° A. P. I.	0.00075
Ethyl (grain) alcohol	0.00062	75.1° - 80° A. P. I.	0.00080
Methyl (wood) alcohol	0.00072	80.1° - 85° A. P. I.	0.00085
Tuluol (toluene)	0.00072	85.1° - 90° A. P. I.	0.00090

Note: The A. P. I. (American Petroleum Institute) scale is calculated as follows:

$$\text{A.P.I. degree} = \left\{ \frac{141.5}{\text{sp. gr}} \right\} - 131.5$$

The following is an example of how to determine outage: The temperature of a flammable liquid at the time of filling or loading is 70° F. and its coefficient of expansion (as shown in table 3) is 0.00080. Refer to figure 18; lay a ruler on the chart running from 70° F. to 0.00080 as shown by the dotted line. The required outage is 2.4 percent, which is the percentage at the point where the ruler crosses the outage scale. (Additional outage must be provided to allow for the variances in munitions.)

b. Smoking. No smoking should be permitted within 50 feet of storage or handling areas of flammables. The area must be properly marked. (A safe smoking area should be designated.)

c. High Pressure Flammables. Flammable liquids having a vapor pressure exceeding 40 pounds per square inch absolute at 100° F., as determined by the Reid Method covered by the American Society for Testing Materials Method of Test for Vapor Pressure of Petroleum Products, require DA Label 31 (Caution-Flammable-Compressed Gas) (fig. 53). Bungs of containers of high pressure flammables must not be entirely unscrewed until all interior pressure has escaped through the loosened threads. DOT regulations require, in addition to DA Label 81, that DA Label 48 (Caution-Unscrew This Bung Slowly) (fig. 45) be placed near the bung or opening.

d. Acid Flammables. When handling acid-type flammables, personnel should wear rubber gloves, rubber aprons, and goggles or similar type protective clothing.

e. Empty Containers. Empty containers that have been used for flammable liquids must not be repaired until they have been cleaned (para 10) or aerated. When offered for shipment, empty containers must have their filling and vent holes closed.

f. Lights. Only electric lights should be used.

g. Fire. Suitable fire extinguishers must be readily available.

93. Storage

Although a variety of containers can be used for flammable liquids, they usually are stored and shipped in 55-gallon drums. Flammable solids are stored and shipped in metal-lined wood or fiber containers, fiber drums, or 30-gallon steel drums. Containers of flammable liquids should not be exposed to heat. Leakage or distortion of containers filled with flammable liquids (caused by an increase in internal pressure) normally can be avoided by leaving a sufficient outage in the container. See paragraphs 35 through 40 for information on depot layout.

94. Surveillance

The surveillance instructions given herein for flammables are necessarily of a general nature. The specific inspection procedure for each is in accordance with the applicable serviceability standard. In general, containers filled with flammable liquids do not require special surveillance. Routine inspection of containers to detect leaks, distortion, breaks, or other defects is considered adequate. Distortion of containers is usually an indication of excessive internal pressure and a sign that venting is necessary.

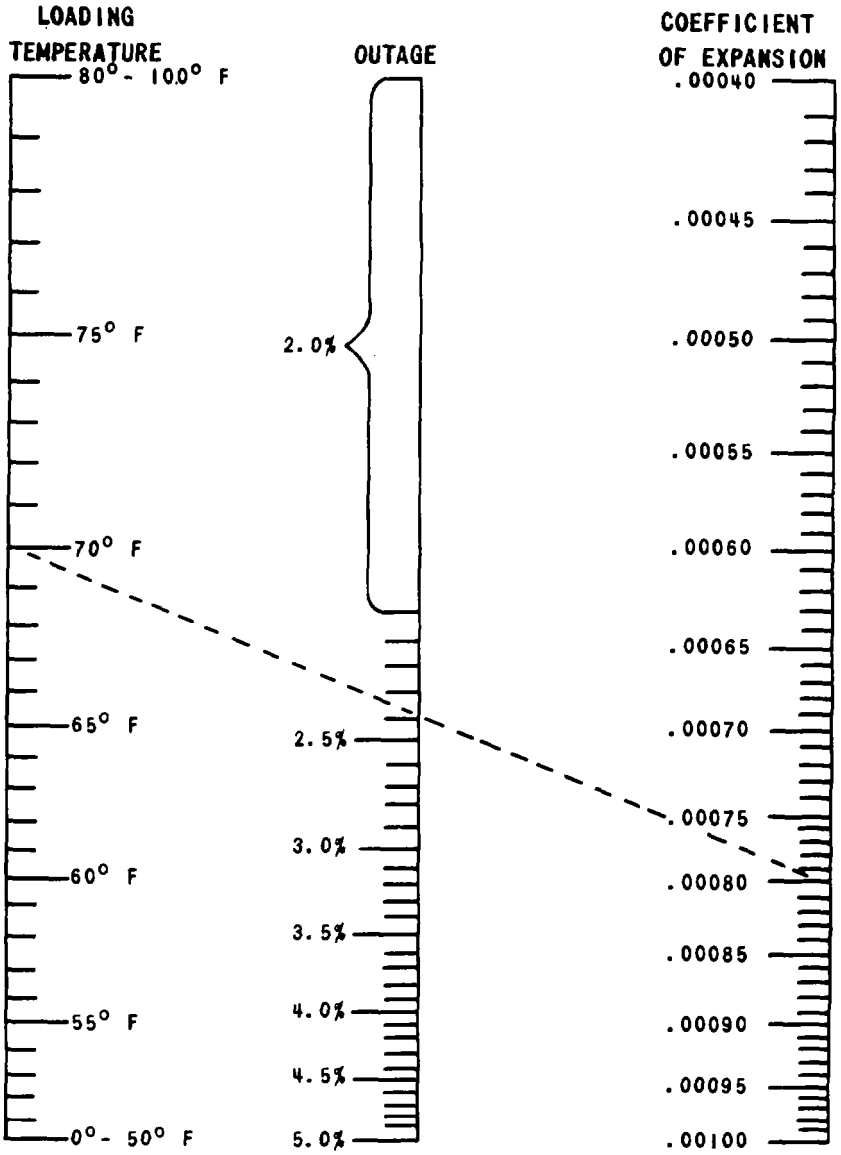


Figure 18. Outage (void) nomogram for flammable liquids.

Section II. STORAGE GROUP C (SPONTANEOUS FLAMMABLES)

95. White Phosphorous (WP and PWP)

White phosphorus (WP) is spontaneously flammable. [Plasticized white phosphorus (PWP) is granulated WP in gel (rubber and xylene); its characteristics are similar to those of WP.]

a. Solvent for. Carbon disulfide.

b. Storage. WP is stable in munitions and steel drums not in contact with air or oxygen, or under water in drums or tanks. It has no action on metals. Since it is spontaneously flammable, it is a fire hazard and must be stored separately from other flammables.

c. Shipping (ch 9). The DOT classification of WP is flammable solid. DA Label 57 (Flammable Solids and Oxidizing Materials-Caution-Do Not Drop) (fig. 47) is required for shipment by surface transportation in the continental United States. DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable) (fig. 48) is required for commercial and military air shipments.

d. Detection. WP is a pale yellow, translucent, crystalline solid of a waxy consistency. It has an odor like that of matches. WP particles burn when exposed to the air and produce dense smoke.

e. Protection. No protection is required against smoke. A fireproof suit is required for protection against burning particles.

f. Decontamination. None is required.

g. Cleaning Storage Containers. Rinse thoroughly with hot water.

h. Surveillance. Routine inspection is required to detect leaks.

i. Physiological Action and First Aid. Solid WP particles burn the flesh. WP vapors are very poisonous, causing bone decay. WP smoke is relatively harmless. For WP particles burning flesh, immediately plunge portions of the body burned by WP particles under water; this stops WP from burning. Apply a 5-percent solution of copper sulfate to the particles embedded in the skin; this will produce an airproof, black coating over the particles. The phosphorous particles (copper-plated and black-colored) should be removed by washing or with forceps, and the injury should be treated as an ordinary burn. Oily base salves must not be used to treat WP burns because WP is soluble in oil and may cause systemic poisoning. If no copper sulfate is available, keep the burning part of the body under water, or apply saturated wet compresses to it until medical help arrives.

Section III. STORAGE GROUP D (INCENDIARIES)

96. Incendiary Oil Mixtures

There are several types of incendiary oil mixtures that are used in flamethrowers, flame field expedients, incendiary bombs, and fire bombs. They include gasoline gelled with a thickener such as M1, M2, or M4 thickener or isobutyl methacrylate (IM); PT1 mixture, consisting of gasoline thickened with IM and mixed with magnesium dust paste in a kerosene and asphalt base (goop); and PTV mixture, which is similar to PT1 mixture.

a. Susceptibility to Spontaneous Heating. None.

b. Storage. Incendiary oil mixtures (with octal, NP, IM, PT1, or PTV) are flammable and are fire hazards.

(1) *M1 thickener* (napalm) is an aluminum stearate granular soap. It is packed in 100-pound or 16 8/4-pound fiber drums or in 5 1/4-pound cans. It is stable in storage except when in contact with water. It is not a fire hazard but can be ignited to burn slowly.

(2) *M2 thickener* (antiagglomerated napalm) is a treated aluminum stearate granular soap. It is not a fire hazard but can be ignited to burn slowly.

(3) *M4 thickener* is an aluminum soap of iso-octanic acid. It is not a fire hazard.

(4) *Isobutyl methacrylate* (IM) is a thickener and is packed in standard commercial containers. It is stable in storage and is not a fire hazard.

(5) *PT1, PTV, and goop* are stable in storage. They are flammables and are fire hazards.

c. Shipping (ch 9). There is not DOT restriction on shipment of M1, M2, or M4 thickener or of isobutyl methacrylate in standard containers. The DOT classification for any of the incendiary oil mixtures is flammable liquid. DA Label 47 (Caution-Leaking Packages Must Be Removed to a Safe Place) (fig. 44) is required for shipment by surface transportation in the continental United States. DA Label 56 (Flammable Liquids -Flammable) (fig. 46) is required for commercial and military air shipments.

d. Detection.

(1) *M1, M2, and M4 thickeners* are white to light-brown granular powders.

(2) *IM* is a white granular powder.

(3) *PT1 and PTV* are soft, black, elastic, homogeneous mixtures.

e. Protection. No special protection is necessary in handling incendiary oil mixtures.

f. Decontamination. None is required.

g. Cleaning Storage Containers. Wash with a solvent such as gasoline.

h. Surveillance (SB -30-3). Routine inspection should be made to detect breaks or other defects in containers and any accumulation of moisture.

i. Physiological Action and First Aid. Incendiary oil mixtures have no physiological action except when burning, at which time these mixtures cause severe burns. Treat an incendiary oil burn as an ordinary burn.

j. Fire. Fires started by incendiary oils should be attacked at once with sand or earth (to smother flames) or with foam, carbon dioxide, or water-fog type fire extinguishers.

97. Magnesium (Mg)

Magnesium is an element widely used in incendiaries either in solid or powder form. Since it has no military symbol, the chemical symbol (mg) is used.

a. Susceptibility to Spontaneous Heating. None.

b. Explosive Limits. Magnesium dust in air can be explosive.

c. Storage. Magnesium dust is stable in munitions or tightly closed metal or metal-lined containers. Water in contact with magnesium liberates hydrogen that is highly flammable and explosive. Powdered magnesium is a serious fire hazard and is easily ignited.

d. Shipping (ch 9). The DOT classification of magnesium dust is flammable solid. DA Label 57 (Flammable Solids and Oxidizing Materials-Caution-Do Not Drop) (fig. 47) is required for shipment by surface transportation in the continental United States. DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable) (fig. 48) is required for commercial and military air shipments.

e. Detection. Magnesium is a silvery metal powder that tarnishes to gray color upon exposure to air.

f. Protection. None is required except in fighting fires.

g. Decontamination. None is needed.

h. Cleaning Storage Containers. Empty containers by shaking them thoroughly and then rinse with fresh water.

i. Surveillance. Routine inspection should be made to detect breaks or other defects in munitions or containers and any accumulation of moisture.

j. Physiological Action and First Aid. Magnesium has no physiological action except when burning, at which time it causes severe burns. Treat a magnesium burn as an ordinary burn.

k. Fire. Sand or earth or carbon dioxide type fire extinguisher should be used to extinguish magnesium fires. Water must not be used on magnesium fires because it accelerates burning.

98. Thermate (TH)

Thermate (TH) is a standard incendiary consisting of a mixture of thermite (finely powdered aluminum and iron oxide) and various additives.

a. Susceptibility to Spontaneous Heating. None.

b. Storage. TH is stable when stored in metal drums. Although it is a fire hazard, there is little danger of TH catching fire unless it is stored with an igniter.

c. Shipping (ch 9). The DOT classification of TH is flammable solid. DA Label 57 (Flammable Solids and Oxidizing Materials-Caution-Do Not Drop) (fig. 47) is required for shipment by surface transportation in the continental United States. DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable) (fig. 48) is required for commercial and military air shipments.

d. Detection. Thermate is essentially a mixture of metallic powders. When burning, TH melts most metals.

e. Protection. None is required except in fighting fires.

f. Decontamination. None is needed.

g. Cleaning Storage Containers. Empty containers by shaking them thoroughly and then rinse with water.

h. Surveillance. Routine inspection should be made to detect breaks or defects in munitions or containers and to prevent accumulation of fire hazards.

i. Physiological Action and First Aid. Thermate has no physiological action except when burning, at which time it causes severe burns. Treat a thermate burn as an ordinary burn.

j. Fire. TH burns with an intense heat; it cannot be extinguished with water or chemicals. Use sand or earth.

Section IV. SCREENING SMOKES

99. Fog Oil (SGF 2)

a. Susceptibility to Spontaneous Heating. None.

b. Storage. Fog oil normally is stored in 55 gallon drums; it is stable under all storage conditions. Fog oil is a fire hazard.

c. Shipping. The DOT classification of fog oil is flammable liquid. DA Label 47 (Caution-Leaking Packages Must Be Removed to a Safe Place) (fig. 44) is required for shipment by surface transportation in the continental United States. DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable) (fig. 48) is required for commercial and military air shipments.

d. Detection. SGF is similar to other petroleum oils.

e. Decontamination. None is required.

f. Cleaning Storage Containers. Wash with a solvent or steam.

g. Surveillance. Routine inspection should be made to detect leaks, breaks, or other defects in containers.

h. Physiological Action and First Aid. When fog oil is not burning, it has no physiological reaction. Exposure to fog oil smoke for prolonged periods near a smoke generator can produce lung and throat irritation. However, there is no physiological reaction from moderate exposure to fog

oil smoke even near a smoke generator. Treat a fog oil burn as an ordinary burn.

i. Fire. Use foam, water-fog, or carbon dioxide type fire extinguishers to extinguish fog oil fires.

100. HC Smoke Mixture (HC)

HC is made up of a mixture of grained aluminum (Al), zinc oxide (ZnO), and hexachloroethane (C^2C1^6). Although HC produces a slightly irritating smoke, it is considered a group D chemical agent because of its flammable nature.

a. Characteristics. HC is a gray-white mixture.

b. Storage. If dry, HC is stable in steel drums and munitions, with no action on metals. It is considered to be a fire hazard, since small amounts of water react with it to generate heat and can cause spontaneous combustion. HC mixtures are stored in watertight containers in a dry place, away from other flammables.

c. Shipping (ch 9). The DOT classification of hexachloroethane-zinc mixture is flammable solid.

DA Label 57 (Flammable Solids and Oxidizing Materials-Caution-Do Not Drop) (fig. 47) is required for shipment by surface transportation in the continental United States. DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable) (fig. 48) is required for commercial and military air shipments.

d. Detection. HC has a camphorlike odor. A heavy concentration of HC smoke causes a suffocating feeling.

e. Protection. Normally, no protection is necessary for exposures to HC smoke in field concentrations. A protective mask with a good mechanical filter or an oxygen breathing apparatus is required in heavy concentrations or for long periods of exposure to HC smoke.

f. Decontamination. None is needed.

g. Cleaning Storage Containers. Wash thoroughly with large amounts of water.

h. Surveillance (SB 3-30-series). Periodic inspection should be made to detect corrosion of containers or dangerous accumulation of moisture.

i. Physiological Action and First Aid. There is no physiological reaction from solid HC. Heavy concentrations of smoke can cause gastritis and irritation and inflammation of the respiratory passages. The average HC smoke concentration causes a slightly suffocating and irritating feeling. Normally, first aid is not needed. Remove patient to fresh air.

CHAPTER 7
STORAGE AND HANDLING OF HAZARDOUS CHEMICALS

Note

Chemicals that do not fall in the four groups already mentioned (A, B, C, D) are stored separately as hazardous chemicals. In this group are generally found chemical decontaminants and impregnating chemicals, solvents, industrial compressed gases, simulated chemical agents, corrosive liquids, and hazardous chemicals. When any chemical to be stored or handled is not described in this chapter, commercial references, chemical dictionaries, and handbooks of chemistry and physics should be used. For information on disposal of chemicals, see Army Materiel Command Regulations of the 385-series

Section I. CHEMICAL DECONTAMINANTS AND IMPREGNATING CHEMICALS

101. General

This section describes the storage and handling problems of chemical decontaminants and impregnating chemicals that may be encountered in a storage area containing chemical items, and furnishes useful data and information about individual items. Chemical decontaminants include those used alone, such as bleach, DS2, and BPL, and those used in combinations, such as RH 195 dissolved in acetylene tetrachloride (DANC solution). Impregnating chemicals are those used to impregnate clothing for protection against chemical agents.

a. Safety. Most of these chemicals are not especially dangerous to handle unless they come in contact with the skin or are inhaled.

b. Storage. Considerable quantities of chemical decontaminants and impregnating chemicals will be stored in depots, whether or not CBR operations are initiated. Stocks of these chemicals, therefore, should be conveniently located to facilitate handling. Containers most commonly used include the following: 55-gallon steel drums, 50 pound metal containers, 150-pound fiberboard containers, wooden boxes, and 2-compartment metal containers.

c. Surveillance. Surveillance instructions given for these chemicals are necessarily of a general nature. Specific inspection procedure for each chemical is in accordance with the applicable serviceability standard. In general, containers of chemical decontaminants and impregnating chemicals should be inspected for leaks, breaks, or other defects.

102. Acetylene Tetrachloride (Tetrachloroethane)

Acetylene tetrachloride is a commercial product that is used as a solvent for decontaminating agent RH 195 in preparation of DANC solution.

a. Storage. Acetylene tetrachloride is normally stored in 55-gallon drums and is stable. It attacks metals in the presence of moisture. It is not a fire hazard and is nonflammable.

b. Shipping (ch 9). There are no DOT restrictions for shipment of acetylene tetrachloride in standard shipping containers in the continental United States. DA Label 46 (Danger-Tetrachloroethane) (fig. 19), recommended by the Manufacturing Chemists' Association, should be used. Operational necessity approval is required for shipment by military air (see TM 38250 for complete information).

c. Detection. Acetylene tetrachloride is a colorless liquid, normally detected by its chloroformlike odor.

d. Protection. Protection against fumes is normally required since acetylene tetrachloride is highly toxic to personnel working in the presence of fumes in a closed or unventilated space. A protective mask or oxygen breathing apparatus should be worn under these conditions. Rubber gloves should be worn by personnel handling liquid acetylene tetrachloride.

e. Decontamination. Flush with large quantities of water and wash with soap containing lanolin.

f. Cleaning Storage Containers. Cleaning procedure is the same as that used for flammable liquids.

g. Disposal. Acetylene tetrachloride can be poured on or in the ground for disposal, if care

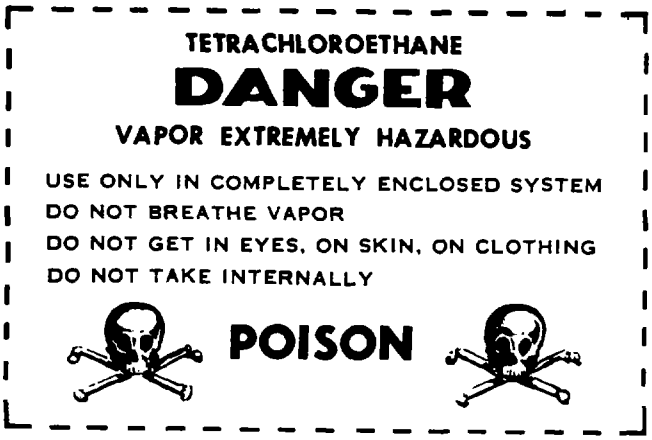


Figure 19. DA Label 46 (Danger - Tetrachloroethane).

is taken not to contaminate sources of drinking water and drainage systems. Large operations must be conducted at least 1 mile from inhabited localities, with personnel involved keeping to the windward side.

h. Surveillance (SB 330-203). Routine inspection should be made to detect leaks or other defects in containers.

i. Physiological Action and First Aid. Fumes of tetrachloroethane are toxic, and liquid on the skin can cause poisoning. Fumes have a cumulative toxic effect when inhaled and when in contact with the skin. Toxic symptoms include irritation of the mucous membrane, pressure in the head, dizziness, and fatigue. For liquid acetylene tetrachloride on the skin, wash liquid off with soap and water or plain water. If patient is overcome by fumes, remove him to fresh air and, if necessary, administer artificial respiration.

103. Supertropical Bleach (STB)

Supertropical bleach (decontaminating agent, STB) consists of commercial bleach to which about 6-percent calcium oxide has been added. It is commonly used to decontaminate blister and nerve agents. Bleach decomposes when heated. It reacts violently with liquid mustards, evolving much heat and frequently flame.

a. Storage. Supertropical bleach is fairly stable. Bleach usually is shipped in tightly closed 50 pound metal containers. The storage date should be marked, for under normal storage conditions this bleach loses about 1 percent per month of its 30- to 35-percent available chlorine content. The stock should be used in order of date of manufacture or status of serviceability. Bleach is not a fire hazard, but it can explode when heated to temperatures above 150° C. (302° F.). It should be stored in a cool, dry place. In the presence of moisture, bleach corrodes metal and is injurious to most fabrics.

b. Shipping (ch 9). There are no DOT restrictions for shipment of bleach in standard commercial containers in the continental United States.

c. Detection. Bleach is a white powder having a characteristic chlorine odor.

d. Protection. No special protection is required except when bleach is present in the air in the form of dust; then personnel should wear protective masks and either old or protective clothing.

e. Decontamination. Flush with large quantities of water and wash with soap containing lanolin.

f. Cleaning Storage Containers. Rinse thoroughly with water.

g. Disposal. Because of its commercial value, bleach ordinarily is not destroyed. If disposal becomes necessary, however, it can be buried (para 202).

h. Surveillance (SB 3-30-226). Routine inspection should be made to detect breaks or other defects in containers. Containers discovered to be generating heat should be removed and disposed of at once. A sample test should be made at least once a year in accordance with the serviceability standard.

i. Physiological Action and First Aid. Bleach dust is irritating to the skin, eyes, and throat.

If bleach is spilled on the skin or gets into the eyes, flush immediately with plain water.

104. Chlorinated Paraffin

Chlorinated paraffin is the standard binding material used in the process of impregnating protective clothing.

a. Susceptibility to Spontaneous Heating. None.

b. Storage. Chlorinated paraffin is stored in 55-gallon drums It is not stable and gradually decomposes in storage with the formation of hydrochloric acid that reacts with metals. Stock should be used in order of date of manufacture or status of serviceability. Moisture must be kept out of containers of chlorinated paraffin; water ruins it for use with solvents. Although chlorinated paraffin burns readily, it is not considered a particularly dangerous fire hazard.

c. Shipping (ch 9). There are no DOT restrictions on shipment of chlorinated paraffin in standard commercial containers in the continental United States.

d. Detection. Chlorinated paraffin can be detected by its pungent odor of chlorine and by its appearance. Normally, it is a thick, creamy, caramel-colored material.

e. Decontamination. None is required.

f. Cleaning Storage Containers. Wash with an organic solvent and then rinse with water.

g. Disposal. Because of its commercial value, chlorinated paraffin ordinarily is not destroyed.

If disposal becomes necessary, however, it can be burned (para 202).

h. Surveillance (SB 3-30-275). Routine inspections should be made to detect breaks or other defects in containers and any accumulation of moisture. Any suspicion of moisture in the container requires that the contents be condemned. Chlorinated paraffin in stock 6 months or more may lose its translucency, become opaque, and contain black spots. In this condition, it is not usable and should be condemned.

i. Physiological Action and First Aid. Chlorinated paraffin has no action on the skin except when decomposed, at which time the hydrochloric acid in it can cause burns; in this case flush the burned area immediately with water.

105. RH 195

RH 195 is combined with acetylene tetrachloride to prepare DANC solution, which is a standard decontaminant.

a. Storage. RH 195 decomposes gradually in storage. It is less stable in hot or moist storage and should be stored in a cool, dry place, if practicable. It usually is shipped in the upper compartment of a 2-compartment metal drum; it is also shipped in a single metal container, heavy pressed paper container, or wood drum. RH 195 corrodes most metals, although considerably less so than does ordinary bleach.

b. Shipping (ch 9). There are no DOT restrictions on the shipment of RH 195 in standard shipping containers in the continental United States.

c. Detection. RH 195 normally is detected by its chlorine-like odor and its appearance; it is a white to cream-colored, granular powder.

d. Protection. No special protection is required except when RH 195 dust is present in the air; then protective mask and either old or protective clothing should be worn.

e. Decontamination. None is required.

f. Cleaning Storage Containers. Wash metal containers with a solvent and then rinse with water.

g. Disposal. RH 195 may be disposed of by burning.

h. Surveillance. Routine inspection is required to detect breaks or other defects in containers.

i. Physiological Action and First Aid. RH 195 dust is slightly corrosive to the skin, eyes, and throat. If RH 195 is spilled on the skin or gets into the eyes, wash with plain water.

106. DS2

DS2 is a standard chemical decontaminant.

a. Storage. DS2 solution, in original containers and placed on hardstands, is stable in storage if protected from temperature extremes. DS2 solution is harmful to painted surfaces and will cause blistering and peeling. It is not compatible with STB.

b. Shipping. DS2 is a flammable liquid. DA Label 47 (Caution-Leaking Packages Must Be Removed to a Safe Place) (fig. 44) is required for shipment by surface transportation in the continental United States. DA Label 56 (Flammable Liquids-Flammable) (fig. 46) is required for commercial and military air shipments.

c. Detection. It is a light-amber-colored solution with a slightly sweet odor.

d. Protection. Rubber gloves should be worn.

e. Decontamination. Water should be used.

f. Disposal. DS2 may be disposed of by burning.

g. Surveillance. Periodic checks should be made to detect breaks in storage containers.

h. Physiological Action and First Aid. DS2 is caustic and will irritate the skin and eyes. Wipe off contaminated areas and rinse freely with water to remove spills. Irritation to the skin from exposure should be treated like any chemical burn.

107. Beta-Propiolactone (BPL)

Beta-propiolactone is the standard decontaminant for biological agents.

a. Storage. BPL is stable for 3 months without refrigeration. For longer periods, it should be stored at temperatures of not more than 40° F. It is normally packaged in 1-gallon pails.

b. Shipping. The DOT classification of BPL is corrosive liquid. DA Label 13 (CautionAcid-Do Not Drop) (fig. 49) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

c. Detection. It is a colorless liquid.

d. Protection. Protective mask and clothes tied at ankles and wrists should be used. If a person

is in the area for more than a few minutes, he should wear a butyl rubber suit. Protective mask should be worn until the area is shown to be free from BPL by detector tube test. Shower after exposure to BPL.

e. Decontamination. Wash with water.

f. Surveillance. Periodic checks should be made to detect breaks in storage containers.

g. Disposal. BPL can be disposed of by mixing with water, which hydrolyzes it to the reasonably harmless beta-hydroxy propionic acid. Then this acid can be washed away with additional water.

h. Physiological Action. BPL irritates the lungs. It also has vesicant properties. Avoid unprotected, prolonged contact with BPL. If spillage on the skin occurs, flush immediately with water.

108. Impregnite

XXCCS impregnite, a finely ground mixture of the active ingredient CC2 impregnite with a stabilizer, zinc oxide, is the standard item used in the water suspension process of impregnation.

a. Storage. Impregnite is fairly stable, although it decomposes gradually. It usually is shipped in 75-pound fiber containers. These containers must be handled carefully because prolonged contact with impregnite causes them to be brittle and to break easily. Dry storage is necessary; exposure to moisture deteriorates impregnite. If stored in the open, containers of impregnite should be covered with tarpaulins.

b. Shipping. There are no DOT restrictions on shipment of impregnite in standard shipping containers in the continental United States.

c. Detection. Impregnite normally is detected by its chlorine-like odor and its appearance; it is a fine white granular crystal powder.

d. Protection. None is required.

e. Decontamination. None is required.

f. Disposal. Impregnite can be disposed of by burning.

g. Surveillance (SB 830-275). Routine inspection should be made to detect breaks or other defects in containers and any accumulation of moisture.

h. Physiological Action and First Aid. There is no appreciable physiological action. If impregnite spills on the skin or gets into the eyes, wash with plain water.

109. Polyvinyl Alcohol (PVA)

Polyvinyl alcohol is the standard emulsifying agent used in the process of impregnating protective clothing. The standard commercial product "Elvanol" is one of a series of polyvinyl alcohols.

a. Characteristics. PVA is soluble in hot or cold water; it is dissolved or decomposed by strong acids and is softened or dissolved by alkalies and weak acids. It adheres as a thin film to porous water-absorbent surfaces such as fabrics; the film stretches and is tear-resistant. PVA is impermeable to most gases except air, water vapor, and ammonia. It is oil- and solvent-resistant. It is flammable and burns at the same rate as paper. PVA decomposes above 200° C.

b. Storage. PVA should be stored in a cool, dark place. When heated to above 212° F. (100° C.), it discolors, becomes brittle, and loses some of its water solubility. It is a fire hazard.

c. Shipping. There are no DOT restrictions on shipment of PVA in standard shipping containers in the continental United States.

d. Detection. PVA is a white to cream-colored granular powder.

e. Protection. None is required.

f. Decontamination. None is required.

g. Cleaning Storage Containers. Rinse thoroughly with fresh water.

h. Disposal. Because of its commercial value, polyvinyl alcohol ordinarily is not destroyed. If disposal becomes necessary, however, it can be burned.

i. Surveillance (SB 330-280). Routine inspection should be made to insure that containers are not stored near heat.

j. Physiological Action and First Aid. PVA is not toxic in any form and, normally, first aid is not required.

110. Santomerse

Santomerse, a commercial product, is a dispersing agent used as a substitute for PVA in impregnating protective clothing.

a. Storage. Santomerse tends to cake after long storage periods.

b. Shipping. There are no DOT restrictions on shipment of Santomerse in standard shipping containers in the continental United States.

c. Detection. Santomerse is in the form of yellowish-white flakes.

d. Decontamination. None is required.

e. Disposal. Santomerse may be sold through commercial channels if possible.

f. Surveillance. Periodic inspections should be made to detect breaks in storage containers.

g. Physiological Action. Santomerse is not harmful.

111. Sodium Hydroxide

Sodium hydroxide is a decontaminant that destroys many chemical agents in the presence of moisture. Sodium hydroxide, also known as sodium hydrate, caustic soda, or lye, is hazardous.

a. Solvents for. Water and alcohol.

b. Storage. Sodium hydroxide is stable when stored in tightly sealed drums. It absorbs moisture and carbon dioxide. It is not a fire hazard, but it liberates considerable heat when mixed with water.

c. Shipping (ch 9). The DOT classification of sodium hydroxide solution is corrosive liquid.

DA Label 64 (Caution-Alkaline Caustic Liquid -Do Not Drop (Surface Transportation)) (fig. 51) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

d. Detection. Sodium hydrate is a white solid in the form of flakes, powder, beads, or lumps, which dissolves easily in water.

e. Protection. Goggles or protective mask, rubber gloves, and rubber apron (with sleeves) are required.

f. Decontamination. Flush with large amounts of water.

g. Cleaning Storage Containers. Rinse thoroughly with water.

h. Disposal. Because of its commercial value, sodium hydroxide ordinarily is not destroyed. If disposal becomes necessary, however, it can be buried if care is taken not to contaminate sources of drinking water and drainage systems (para 202), i. Surveillance. Routine inspection should be made to detect breaks or other defects in containers.

j. Physiological Action and First Aid. Sodium hydroxide is a very caustic alkali, attacking the skin and eyes wherever it touches. For caustic soda on the skin, wash the affected parts with water; follow by 2-percent solution of acetic acid. Flush eyes with large amounts of water and seek medical aid immediately.

Section II. SOLVENTS

112. General

There are many solvents used in connection with chemical activities. Acetylene tetrachloride is an important nonflammable solvent used with decontaminating agent RH 195 to form DANC solution; it is described in paragraph 102. Commonly used solvents, described in this paragraph, are benzene, carbon disulfide, gasoline, kerosene, and xylenol (cresylic acid).

Note

Gasoline is a solvent that is also used as a fuel for incendiary oil mixtures (para 96). Cresylic acid is a peptizer, used to hasten or facilitate the formation of gasoline gel.

a. Flash Point (°F., closed cup). Benzene, 12; carbon disulfide, -22; gasoline, -50; kerosene, 150; xylenol, 75.

b. Storage. All of the above solvents normally are shipped and stored in 55-gallon drums and are stable under anticipated operating conditions. They should be handled where there is plenty of ventilation. All are fire hazards, carbon disulfide being the most dangerous of the group since its vapor can be ignited by a heavy blow. Before repairs may be made to empty containers, they must be cleaned or aerated.

c. Shipping (ch 9). The DOT classification of the above solvents is flammable liquid, not otherwise specified (n.o.s.). DA Label 47 (Caution-Leaking Packages Must Be Removed to a Safe Place-Do Not Drop) (fig. 44) is required for shipment by surface transportation in the continental United States. DA Label 56 (Flammable Liquids-Flammable) (fig. 46) is required for commercial and military air shipments.

d. Detection. Normally, by odor.

e. Protection. Some of these solvents are quite toxic. A protective mask, an acid and organic vapor gas mask, or an oxygen breathing apparatus should be worn by personnel working in a high concentration of solvent vapors, depending on the solvent.

f. Decontamination. None is required.

g. Disposal. Ordinarily, these solvents are not destroyed because of their commercial value.

They can be disposed of by burning in a standard burning pit (para 202).

h. Surveillance. Routine inspection should be made to detect leaks, breaks, or other defects in containers. Frequent inspection is necessary to detect potential or actual fire hazards.

i. Physiological Action and First Aid. Concentrated fumes are toxic, and liquid on the skin can cause poisoning. For liquid on the skin, wash skin with soap and water or plain water. If patient is overcome by fumes, provide fresh air

and administer artificial respiration if necessary. Treat a solvent burn as an ordinary burn.

j. Fire. Use sand or earth to fight fires. Foam, water-fog, or carbon dioxide-type fire extinguishers also may be used.

Section III. INDUSTRIAL COMPRESSED GASES

113. General

This section describes the depot storage and handling problems of those compressed gases likely to be encountered in chemical operations. A compressed gas is defined as any material or mixture having in the container either an absolute pressure exceeding 40 pounds per square inch at 70° F., or an absolute pressure exceeding 104 pounds per square inch at 130° F., or both, or any liquid flammable material having a vapor pressure exceeding 40 pounds per square inch, absolute, at 100° F.

a. Containers. Compressed gases must be stored and shipped in metal cylinders clearly marked with the name of the gas for which the cylinder is to be used. For color coding and markings on compressed gas cylinders, see MIL STD-101. The amount of liquefied gas charged into cylinders is determined by weight. Containers used in an upright position should be secured by a chain or a strap to prevent them from falling over.

(1) *Filling density.* The filling density is the percent ratio of the weight of the gas in a container to the weight of water that the container will hold at 60° F. For example, the maximum filling density permitted under DOT regulations for shipment by common carrier in the continental United States for anhydrous ammonia is 54 percent; for chlorine, 125 percent; and for liquefied carbon dioxide, 68 percent.

(2) *Filling limits.* The liquid portion of the compressed gas, if any, must not completely fill the container at 130° F. For mixtures, the liquid portion of the gas, plus any additional liquid or solid, must not completely fill the container at 130° F. The pressure in the cylinder at 70° F. must not exceed the service pressure for which the container is designed; the pressure in the cylinder at 130° F. must not exceed one and one fourth times the service pressure for which the container is designed, except in the case of acetylene, nitrous oxide, and liquefied carbon disulfide.

b. Valves. The name of the gas for which a valve is intended is stamped on the valve. Cylinder valves must be opened slowly, with only the wrenches or tools approved for this purpose. Valves usually are constructed with safety caps containing fusible metal plugs, rupture disks, or both. The fusible plug melts and/or the rupture disk bursts to release gas if the internal pressure of a cylinder filled with compressed gas becomes excessive through exposure to heat.

c. Pressure Regulators. Pressure regulators reduce high internal pressure of cylinders filled with compressed gases to a safe working pressure. Compressed gas must not be transferred from a cylinder until after the pressure regulator intended for that particular gas is used to reduce the internal pressure of the cylinder. The name of the gas for which a given pressure regulator is intended is marked on it. Pressure regulators must not be interchanged for use with gases other than those for which they are intended. Before connecting a pressure regulator to a cylinder of compressed gas, "crack" the cylinder valve by opening it one-quarter turn and then closing it immediately. This action clears the valve of particles of dust or dirt that might otherwise enter the regulator. Before removing a pressure regulator from a cylinder of compressed gas, close the cylinder valve and release all the gas from the regulator.

d. Cleaning Storage Containers. See paragraph 15.

114. Acetylene

Acetylene is used for welding, cutting, and illumination. It is a colorless, flammable gas that is lighter than air. When breathed, it acts as an anesthetic.

a. Storage. Acetylene, dissolved in acetone, is stored and shipped in stubby cylinders. When mixed with air or oxygen, it becomes a dangerous explosive. The cylinders must be stored upright to prevent possible drawing out of the acetone. They should not be stored in direct sunlight. The maximum allowable filling pressure is 250 pounds per square inch at 70° F.

b. Shipping (ch 9). The DOT classification of acetylene is flammable gas. DA Label 31 (Caution-Flammable-Compressed Gas) (fig. 53) is required for shipment by surface transportation in the continental United States. DA Label 56 (Flammable Liquids-Flammable) (fig. 46) is required for commercial and military air shipments.

c. Detection. Acetylene can be detected by its garlic-like odor.

d. Protection. None is normally required. When a concentration of acetylene is encountered in an enclosed space, a protective mask should be used.

e. Decontamination. None is required.

f. Disposal. Because of its commercial value, acetylene ordinarily is not destroyed; if disposal becomes necessary, however, it can be accomplished by venting (para 202).

Warning

Great care must be exercised in venting acetylene because a mixture of acetylene and air can be easily ignited by spark or flame with explosive results.

g. Surveillance. Routine inspection should be made with soapy water to detect leaks from valves of containers.

h. Physiological Action and First Aid. Acetylene may cause suffocation. If an individual is overcome by fumes, remove him to fresh air and, if necessary, administer artificial respiration.

115. Carbon Dioxide

Carbon dioxide is used to provide pressure in operations involving transfer of certain chemical agents from one container to another. It also is used in fire extinguishers.

a. Storage. Carbon dioxide is shipped and stored under compression as a liquid. It is not a fire hazard. The maximum allowable filling pressure is 2,015 pounds per square inch at 70° F.

b. Shipping (ch 9). The DOT classification of carbon dioxide is nonflammable gas. DA Label 65 (Keep Cool-Caution-Nonflammable-Compressed Gas) (fig. 54) is required for shipment by surface transportation in the continental United States. DA Label 66 (Nonflammable Compressed Gas) (fig. 55) is required for shipment by commercial or military air.

c. Detection. None.

d. Protection. None is required.

e. Decontamination. None is required.

f. Disposal. Because of its commercial value, carbon dioxide ordinarily is not destroyed; it can, if necessary, however, be disposed of by venting (para 202).

g. Surveillance. Routine inspection should be made to detect leaks or other defects in valves.

h. Physiological Action and First Aid. Carbon dioxide has no physiological action except in heavy concentrations in an enclosed space, when it will not support breathing. If an individual is overcome by fumes, remove him to fresh air and, if necessary, administer artificial respiration.

116. Hydrogen

Hydrogen is used principally for underwater cutting and welding.

a. Storage. Hydrogen is shipped and stored in a gaseous state. It is a fire hazard and, when mixed with air or oxygen, can be exploded by a spark or a flame. Only nonsparking tools must be used around cylinders of hydrogen. Hydrogen must be stored separately from oxygen. The maximum allowable filling pressure is 2,015 pounds per square inch at 70° F.

b. Shipping (ch 9). The DOT classification of hydrogen is flammable gas. DA Label 31 (Caution-Flammable-Compressed Gas) (fig. 53) is required for shipment by surface transportation in the continental United States. DA Label 56 (Flammable Liquids-Flammable) (fig. 46) is required for commercial and military air shipments.

c. Detection. None.

d. Protection. None is required.

e. Decontamination. None is required.

f. Disposal. Dispose of hydrogen by commercial sale, if possible, or by venting (para 202).

Caution

Great care must be exercised in venting hydrogen because the mixture of hydrogen and air can be easily ignited by spark or flame with explosive results.

g. Surveillance. Routine inspection should be made to detect leaks or other defects in valves of containers. To check for leaks, use soapy water or, in very cold weather, linseed oil around valve openings.

h. Physiological Action and First Aid. Hydrogen has no physiological action, but excessive quantities in an enclosed space may cause suffocation. If an individual is overcome by fumes, remove him to fresh air and, if necessary, administer artificial respiration.

117. Nitrogen

Nitrogen may be used to provide pressure in transferring operations. It is a colorless and odorless inert gas that is slightly lighter than air. It is nonflammable.

a. Storage. Nitrogen is stored and shipped in a gaseous state. It is not a fire hazard. The maximum allowable filling pressure is 2,015 pounds per square inch at 70° F.

b. Shipping (ch 9). The DOT classification of nitrogen is nonflammable gas. DA Label 65 (Keep Cool-Caution-Nonflammable-Compressed Gas) (fig. 54) is required for shipment by surface transportation in the continental

United States. DA Label 66 (Nonflammable Compressed Gas) (fig. 55) is required for shipment by commercial or military air.

c. Detection. None.

d. Protection. None is required.

e. Decontamination. None is required.

f. Disposal. Dispose of nitrogen by venting (para 202).

g. Surveillance. Routine inspection should be made to detect leaks or other defects in valves of containers.

h. Physiological Action and First Aid. Nitrogen has no physiological action when breathed, but excessive quantities in an enclosed space may cause suffocation. If an individual is overcome by fumes remove him to fresh air and, if necessary, administer artificial respiration.

118. Oxygen

Oxygen is used as a first-aid measure in some extreme cases of chemical poisoning, for breathing at high altitudes, and in cutting and welding.

a. Storage. Oxygen is stored and shipped in a gaseous state. It is considered to be a dangerous fire hazard because it supports combustion and accelerates fires. No oil must be permitted to come in contact with containers of oxygen or any part of the container valves. Containers filled with oxygen must not be stored near any flammable material, particularly oil, grease, or any other substance likely to start a fire. The maximum allowable filling pressure is 2,015 pounds per square inch at 70° F.

b. Shipping (ch 9). The DOT classification of oxygen is nonflammable gas. DA Label 65 (Keep Cool-Caution-Nonflammable-Compressed Gas) (fig. 54) is required for shipment by surface transportation in the continental United States. DA Label 66 (Nonflammable Compressed Gas) (fig. 55) is required for shipment by commercial or military air.

c. Detection. None.

d. Protection. Personnel handling oxygen containers must be careful to have tools, clothing, gloves, and hands free of grease.

e. Decontamination. None is required.

f. Disposal. Dispose of oxygen by commercial sale, if possible, or by venting (para 202).

g. Surveillance. Routine inspection should be made to detect leaks or other defects in valves and accumulation of oil or other combustibles near containers.

h. Physiological Action and First Aid. Oxygen has no harmful physiological action. Normally, first aid is not required.

Section IV. SIMULATED CHEMICAL AGENTS

119. Simulated Mustard (MR)

Molasses residuum (MR) is the standard simulated mustard used for testing and for training purposes. It consists of a 25-percent solution (by volume) in water of the residue obtained in the manufacture of ethyl alcohol from molasses.

a. Storage. MR is stable for at least 6 months when stored in a cool, shaded location and with 0.4-percent cresol added to prevent fermentation.

It has no action on metals. It is shipped in 55 gallon drums.

b. Shipping. There are no DOT restrictions on shipment of MR in commercial shipping containers in the continental United States.

c. Detection. MR is a dark-brown liquid of thin syrupy consistency. It has an odor like that of molasses.

d. Protection. None is required.

e. Decontamination. None is required. Stains on hard surfaces can be removed with cold water.

Stains on clothing can be removed by washing or by dry cleaning.

f. Cleaning Storage Containers. Flush thoroughly with water.

g. Disposal. Because of its commercial value, MR ordinarily is not destroyed. If it becomes necessary to dispose of it, however, it can be poured on or in the ground provided care is taken not to contaminate sources of drinking water.

h. Surveillance (SB 3-30-284). Routine inspection should be made to detect leaks or other defects in containers.

i. Safety. No special precautions are required.

j. Physiological Action and First Aid. MR has no physiological action and, normally, first aid is not required.

Section V. CORROSIVE LIQUIDS

120. General

A corrosive liquid is a strong mineral acid or other corrosive fluid that is likely to cause fire when mixed with chemicals or organic matter, or to corrode or damage matter with which it comes in contact. When corrosive liquids are stored in

containers for any considerable length of time, there is a tendency for the internal pressure to increase. Correct outage (void) must be left in the containers and a schedule of venting followed to prevent rupture of containers that sometimes occurs with explosive violence.

a. First Aid. A supply of water must be readily available to wash off any corrosive liquid spilled on the body. Thorough washing with water is the best treatment for corrosive liquid in the eyes. An eye cup for washing eyes should be available.

b. Surveillance. Containers should be inspected for leaks, breaks, or other defects. Weakened or defective jackets or carboys should be marked when discovered, and immediate corrective action taken to avoid injury during handling of defective containers.

c. Shipping. DA Label 13 (Caution-Acid-Do Not Drop) (fig. 49), DA Label 63 (Caution -Corrosive Liquid-Do Not Drop (Surface Transportation)) (fig. 50), and DA Label 64 (Caution-Alkaline Caustic Liquid (Surface Transportation)) (fig. 51) are required for shipment of acids, corrosive liquids, and alkaline caustic liquids, respectively, by surface transportation in the Continental United States. Containers having inside containers filled with any quantity of corrosive liquid (except carboys not completely boxed) must be marked on top, "THIS SIDE UP." DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

d. Disposal. Corrosive liquids normally can be poured on or in the ground for disposal if care is taken to prevent contamination of sources of drinking water and drainage systems.

121. Storage

Corrosive liquids normally are stored and shipped in glass bottles, in glass carboys of 5- to 13 gallon capacity completely enclosed in strong wooden boxes, in steel drums, or in lined metal drums. Special precautions must be taken in storage, as discussed below.

a. Drums. Drums filled with acid must be stored with bungs up; bungs should be loosened frequently to release pressure that usually accumulates. In releasing this pressure, the bungs should not be removed completely but loosened just enough so that gas can escape slowly through the loosened threads. Drums of acids should be stored in a cool, dry place and should never be exposed to the direct rays of the sun or placed near sources of heat.

b. Carboys. Carboys should be stored on dunnage (lengths of wood) to keep the bottoms of the jackets dry and to prevent rotting. Dunnage also prevents the bottoms of carboys from coming in contact with corrosive material spilled on the floor. Carboys should not be stored in the open or should not otherwise be exposed to the weather. Weakened or broken jackets should never be used. If carboys are to be stored for any length of time, a small section of the gasket should be cut to provide a vent, and the stopper replaced; this allows gases and excess pressure to escape. Carboys should not be stored over two high in tiers. In placing the second tier, care must be taken not to injure the hoods (wood covering for the necks) of carboys in the lower tier. All mechanical shocks should be avoided in handling carboys; carboys must not be allowed to drop or strike other objects. Shaking the contents of carboys should be avoided.

122. Safety

When carboys containing corrosive liquids are handled, personnel should wear rubber aprons (with sleeves), rubber gloves, and rubber boots, with trousers outside of boots (not tucked into them). A face mask or a pair of goggles should also be worn. The following special safety precautions should be observed:

a. In filling or emptying carboys, loosen stoppers carefully so that pressure is reduced slowly.

If the stopper is carelessly removed, pressure in the carboy may cause the contents to spurt out.

b. In emptying carboys, pour the contents out slowly and completely. After completely emptying the carboys, replace and fasten stoppers.

c. Never use compressed air to empty a carboy; it can break a carboy and spatter its contents, and it may leave a small amount of dangerous liquid in a carboy that is supposed to be empty.

d. Before moving carboys, inspect stoppers to make sure that they are in place and securely fastened. Examine the jackets, particularly around the bottom, to see that they are not broken or weakened by the action of spilled acid.

e. Wash empty carboys by turning them upside down over a jet of water.

f. Use large amounts of water to flush acid from the floor. Neutralize the residue with a solution of sodium carbonate (washing soda or soda ash).

g. Install an emergency water shower in the vicinity if possible.

123. Chlorosulfonic Acid

Chlorosulfonic acid is highly corrosive and decomposes with explosive violence on contact with water, forming sulfuric and hydrochloric acids.

a. Storage. Chlorosulfonic acid is stored in carboys and steel drums. It is not a fire hazard but can cause fire by coming in contact with combustible materials. Water must never be allowed in containers of chlorosulfonic acid.

b. Shipping (ch 9). The DOT classification of chlorosulfonic acid is corrosive liquid. DA Label 18 (Caution-Acid-Do Not Drop) (fig. 49) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

c. Detection. Chlorosulfonic acid is normally detected by its characteristic acrid odor.

d. Protection. Protective rubber clothing and goggles are required.

e. Decontamination. None is required. A solution of sodium carbonate (washing soda or soda ash) can be used to neutralize acid spilled on floors or objects.

f. Disposal. Dispose of chlorosulfonic acid by commercial sale, if possible, or by pouring it on or in the ground.

g. Surveillance. Routine inspection should be made to detect leaks, breaks, or other defects in containers.

h. Physiological Action and First Aid. Chlorosulfonic acid produces painful burns on the skin.

Wash affected parts with large amounts of water and then treat as a burn.

124. Hydrochloric (Murliatic) Acid

Hydrochloric acid is corrosive and gives off irritating fumes that are dangerous in high concentrations in enclosed places.

a. Storage. Hydrochloric acid is stored in carboys, stoneware tanks, or wood or steel tanks lined with acid-brick, hard rubber, or pure gum rubber. It is nonexplosive and is not a fire hazard, but should be stored away from nitric acid.

b. Shipping (ch 9). The DOT classification of hydrochloric acid is corrosive liquid. DA Label 13 (Caution-Acid-Do Not Drop) (fig. 49) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

c. Detection. Hydrochloric acid normally is detected by its characteristic pungent odor.

d. Protection. Protective rubber clothing and goggles are required.

e. Decontamination. None is required. A solution of sodium carbonate (washing soda or soda ash) can be used to neutralize acid spilled on floors or objects.

f. Disposal. Dispose of hydrochloric acid by pouring it on or in the ground.

g. Surveillance. Routine inspection should be made to detect leaks, breaks, or other defects in containers.

h. Physiological Action and First Aid. Hydrochloric acid produces painful burns on the skin. Wash affected parts with large amounts of water and then treat as a burn.

125. Hydrogen Peroxide

Hydrogen peroxide has powerful oxidizing properties. It is highly explosive in high concentrations and corrosive in concentrations from 7.4 percent and up.

a. Storage. Concentrated hydrogen peroxide normally is shipped and stored in 30-gallon aluminum containers, 1-gallon glass carboys, or in earthenware carboys. The stoppers must be vented to prevent accumulation of excessive pressure. Hydrogen peroxide must be stored in a cool place, not under direct rays of the sun, because it expands rapidly with increases in temperature. It has a strong corrosive action on steel, lead, and glass. It is considered a fire hazard and should be stored away from flammables because it supports combustion. High concentrations in contact with organic materials will cause spontaneous ignition. Hydrogen peroxide decomposes violently, liberating oxygen under these conditions.

b. Shipping (ch 9). The DOT classification of concentrated hydrogen peroxide is corrosive liquid. For hydrogen peroxide solution in water containing over 8-percent hydrogen peroxide by weight, DA Label 68 (Caution-Corrosive Liquid-Do Not Drop) (fig. 50) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

c. Detection. Hydrogen peroxide is a clear, colorless, fuming, heavy liquid. It has a characteristic pungent odor.

d. Protection. Protective rubber clothing and goggles are required.

e. Decontamination. None is required. Hydrogen peroxide spilled on fibrous or combustible

materials should be washed off with large amounts of water.

f. Cleaning Storage Containers. Rinse thoroughly with water.

g. Disposal. Because of its commercial value, hydrogen peroxide ordinarily is not destroyed. If disposal becomes necessary, however, it can be poured in running water. Do not pour it on combustible materials or in small bodies of still water likely to be used for drinking purposes.

h. Surveillance. Continuous surveillance is required to detect leaks, breaks, or other defects in containers and accumulation of excessive internal pressure.

i. Physiological Action and First Aid. Concentrated liquid peroxide (30 to 95 percent) produces serious burns on the skin and is especially dangerous to the eyes. Wash affected parts with large amounts of water and then treat as a burn.

126. Sulfuric Acid

Sulfuric acid is highly corrosive and develops great heat on contact with water.

a. Storage. Concentrated sulfuric acid is stored in carboys and steel drums. Although it has corrosive action on metals when diluted, sulfuric acid in the concentrations indicated can be stored in containers of the following materials: in cast iron, 85 to 100 percent concentration; in steel, 90 percent to fuming concentration. Any concentration of sulfuric acid can be stored in glass containers. Sulfuric acid is nonexplosive but it may cause fires when in contact with combustible materials. Water must never be allowed in containers of sulfuric acid.

b. Shipping (ch 9). The DOT classification of sulfuric acid is corrosive liquid. DA Label 13 (Caution-Acid-Do Not Drop) (fig. 49) is required for shipment by surface transportation in the continental United States. DA Label 62 (White Label for Corrosive Liquid) (fig. 52) is required for commercial and military air shipments.

c. Detection. Sulfuric acid is normally detected by its characteristic irritating odor.

d. Protection. An acid and organic vapor mask, a rubber apron (with sleeves), and protective rubber clothing are required.

e. Decontamination. None is required. A solution of sodium carbonate (washing soda or soda ash) can be used to neutralize acid spilled on floors or objects.

f. Disposal. Dispose of sulfuric acid by commercial sale, if possible, or by pouring it on or in the ground. Never pour water into or on concentrated sulfuric acid, as high temperatures and/ or an explosion will result.

g. Surveillance. Routine inspection should be made to detect leaks, breaks, or other defects in containers.

h. Physiological Action and First Aid. Sulfuric acid produces painful burns on the skin. Wash affected parts with large amounts of water and then treat as a burn.

i. Fire. Sulfuric acid gives off poisonous fumes in a fire.

Section VI. HAZARDOUS CHEMICALS

127. Potassium Hydroxide (Caustic Potash)

Potassium hydroxide is a corrosive solid in the form of white flakes, powder, or lumps, having a melting point of 8600 C. It attacks clothing wherever it touches it. It readily absorbs moisture from the air.

a. Storage. Potassium hydroxide should be stored in waterproof containers in a dry place.

b. Shipping (ch 9). The DOT classification of potassium hydroxide is less dangerous poison, class B. DA Label 71 (Warning-Poison-Do Not Drop) (fig. 40) is required for shipment by surface transportation in the continental United States. DA Label 67 (Poison Gas Label-Poison) (fig. 38) is required for shipment by commercial)r military air.

c. Detection. Potassium hydroxide consists of white flakes, powder, or lumps.

d. Protection. Protective clothing, goggles, and protective mask or causticproof hoods are required.

e. Decontamination. None is required. Use water or a weak acid solution to wash away any potassium hydroxide spilled on materiel.

f. Cleaning Storage Containers. Flush metal containers thoroughly with water.

g. Disposal. Potassium hydroxide can be disposed of by commercial sale or by burial (para 202). Care must be taken not to contaminate sources of drinking water and drainage systems.

h. Surveillance. Routine inspection is required.

i. Physiological Action and First Aid. Potassium hydroxide attacks the skin wherever it touches it. It does not give off poisonous fumes, but is deadly if taken internally. If particles of potassium hydroxide get on the skin, wash skin with water, and then with a weak acid solution, such as a 2-percent acetic acid solution.

128. Potassium Permanganate

Potassium permanganate is an oxidizing material that stimulates combustion. It comes in the form of purple crystals or powder; it has a metallic sheen. It decomposes below its melting point of 240° C. It is liable to ignite combustible materials by friction, by spontaneous combustion, or if acted upon by corrosive liquid acids. It is known to ignite spontaneously in contact with glycerin (including antifreeze glycerin compounds).

a. Storage. Potassium permanganate is a dangerous fire hazard. It is stored in drums, boxes, barrels, or cans and must be stored in a cool, dry area away from other chemicals, particularly alcohol, ether, flammable gases, and combustible materials. When a container has been opened, it should not be resealed too tightly as the moisture which entered while it was open may cause liberation of oxygen.

b. Shipping (ch 9). The DOT classification of potassium permanganate is oxidizing material. DA Label 57 (Flammable Solids and Oxidizing Materials-Caution-Do Not Drop) (fig. 47) is required for shipment by surface transportation in the continental United States. DA Label 58 (Flammable Solids and Oxidizing Materials Flammable) (fig. 48) is required for commercial and military air shipments.

c. Detection. Potassium permanganate is a rich purple powder or crystal.

d. Protection. Goggles and face mask or field protective mask, rubber gloves, rubber aprons (with sleeves), and rubber boots are required. Potassium permanganate must be kept off the skin as the action of perspiration will cause burns.

e. Disposal. Dispose of potassium permanganate by commercial sale, or by burial away from water table area where it will rapidly deteriorate.

Section VII. UNCLASSIFIED CHEMICALS

129. General

Unclassified chemicals are those not covered by the present DOT regulations; such chemicals include silica gel, sodium carbonate, and others. In most cases, they are not particularly hazardous materials, although a certain amount of care must be taken in storing, handling, packing, and shipping them. Since there are no special storage or shipping problems in connection with the majority of these chemicals, they are not discussed in this manual. When information concerning commercial chemicals is necessary, nonmilitary references such as handbooks of chemistry and physics should be used.

a. Storage. See paragraphs 35 through 40 for information on depot layout.

b. Surveillance. Normal surveillance is necessary to detect leaks, breaks, or other defects in containers.

c. Shipping. Although there are no DOT restrictions on shipping unclassified chemicals, the latest changes to DOT regulations should be reviewed to insure compliance with any requirements pertaining to their shipment by surface transportation in the continental United States. For shipment by military aircraft, see TM 38-250.

CHAPTER 8

TRANSFERRING AND ALLIED PROCEDURES FOR CHEMICAL AGENTS

Section I. TYPES OF EQUIPMENT

130. General

This chapter contains several basic procedures for transferring chemical agents from and to 1-ton containers. These procedures require a knowledge of simple pipe-fitting and the use of pipes, fittings, and plumbing tools; they do not necessitate a high degree of plumbing skill but do necessitate a workable knowledge of the use of equipment. For detailed information pertaining to the plumbing and pipe-fitting tools and equipment discussed in this section, see TM 5-746.

131. Types of Pipe

Two principal types of metal pipe are used in a toxic agent yard-black iron and galvanized. Galvanized pipe is more rust resistant than black iron pipe, but the latter is less expensive and entirely satisfactory for handling toxic agents. A transparent, flexible, and noncorrosive plastic tubing, called Saran, may be used in special transferring operations.

a. Classification. Pipe comes in three weights standard, extra strong, and double extra strong. For a working pressure of about 700 psi, use the standard 1-inch nominal size pipe; for pressure of about 800 psi, the extra strong; and for pressure of approximately 1,000 psi, the double extra strong.

b. Pipe and Thread Size. Pipe is identified by size, such as 1/2-inch pipe and 1-inch pipe, although this identification does not indicate its true size. Pipe is ordinarily threaded with American standard taper threads, having a taper of three-fourths of an inch per foot. Threads are cut either by machine or by hand stock and die.

132. Types of Fittings

The fittings most commonly used in a toxic agent yard are described below.

a Nipple. This is a piece of pipe threaded on both ends. A long nipple is not over 12 inches in length. (Anything over 12 inches is considered a length of pipe.) A close shoulder nipple is threaded from end to end. A shoulder nipple is from 2 to 4 inches long.

b. Coupling. This is a piece of pipe which has female (interior) threads at both ends and is used to connect two other pieces of pipe.

c. Elbow. This is a curved piece of pipe which has female threads at both ends and is used to change the direction of pipe connections. The most common elbow changes direction at a 900 angle. A modification of the elbow is the street elbow that differs only by having a male (exterior) thread at one end and a female thread at the other.

d. Tee. This is a T-shaped fitting having three outlets with female threads.

e. Reducer. This is a coupling used to join two pipes of different size.

f. Bushing. This is an internally and externally threaded fitting used to join two pipes of different size.

g. Plug and Cap. These are fittings used to close off a pipe line or opening. The plug has a male thread and the cap has a female thread.

h. Union. This is a special fitting used to break a piping series for venting, repair, or component replacement with minimum disconnection. When possible, a union is used in place of a coupling because it can be uncoupled without the necessity of tearing down the installed pipework.

133. Types of Valves

Valves are used to regulate the flow of liquids or gases or to shut off the flow entirely. All valves used to regulate the flow of toxic chemical agents should be rising stem brass valves with no fiber disks. After use, they must be completely disassembled and washed, then lightly

oiled and reassembled. The following are the three principal types of valves:

a. Globe Valve. This valve is used when control over the rate of flow of a liquid is desired.

b. Gate or Angle Valve. This valve is used when control over the rate of flow is less important but when the flow must be started or stopped at intervals.

c. Needle Valve. This valve is used to control the flow of filling under high pressure.

134. Types of Tools

The groups of tools most commonly used in handling bulk containers of chemical agents are described below.

a. Wrenches.

(1) *Pipe wrenches* have one rigid jaw and one flexible jaw, both teethed to grip the smooth surface of the pipe. The most common sizes are 24-, 18-, 14-, and 10-inch.

(2) *Monkey wrenches* have smooth jaws and are used for tightening flat-surfaced nuts and brass valves with angular surfaces.

(3) *Open-end adjustable wrenches* are smooth-jawed wrenches with adjustable openings used to disassemble valves and for small nuts and bolts. They are required in sizes from 4 to 18 inches.

(4) *Open-end wrenches* are smooth-jawed wrenches with set openings usually at both ends. They are provided in sets of about six, constituting 12 different sizes of openings.

(5) *Chain tongs* are often used instead of wrenches on larger sizes of pipe.

b. Pipe Cutters. Pipe cutters are tools used for cutting pipe without a hacksaw. They are designed with two rollers and a cutting wheel. By tightening a handle, the cutting wheel is forced deeper and deeper into the pipe as the cutter is rotated around the pipe.

c. Threaders. Threaders are devices used to cut external threads on ends of pipes. The most common type of threader is the stock and die set. The stock has handles that provide leverage for cutting the threads and a seat for holding the dies and guide. The dies are made of tool steel; they are either block type-ll in one piece-or split die type. The split die type has two parts and is adjustable. Guides are used over the pipe being worked on to insure the proper alinement of stock and die during threading. In starting to cut the thread, stock and die must be held straight and care taken to insure that an even pull and plenty of cutting oil are used. The thread should be cut until the end of the pipe protrudes slightly from the end of the stock. To test a thread, a fitting is screwed on by hand and then backed off. As the fitting is backed off, the turns should be counted; if 3 to 8 1/2 turns are required to remove the fitting, then the pipe has a good thread.

d. Pipe Vises. Pipe vises are used to hold the pipe while it is being worked on. Vises either V have toothed jaws or make use of a chain under tension.

e. Pipe Reamers. A pipe reamer is used to clean around the inside end of a pipe that has just been cut, or to grind out obstructions or burrs that have formed inside the end of a pipe.

Section II. TRANSFER OF GROUP A CHEMICAL AGENTS AND ALLIED PROCEDURES

135. General

There are many variations of the procedure for transferring group A chemical agents from and into 1-ton containers. The basic method for transferring liquid agents, using standard equipment and the M3 filling line, is described below. This section also describes the vacuum method of transferring liquid agents to a 1-ton container, a method of venting a 1-ton container, a method of cleaning obstructed eduction tubes of a 1-ton container, and a method of emptying a 1-ton container when its eduction tubes are corroded or detached from the front head. A knowledge of the use of equipment described in chapter 2 is necessary and some improvisation is required.

136. Operations Involving Liquid Agents

The basic operations for transferring liquid agents from a 1-ton container to another container are described in *a* through *h* below. Safety precautions described in paragraphs 45 through 51 must be observed. For adapters for 1-ton containers, see figure 20. Standard tools (fig. 21) should be used to manipulate the valves. The sequence of operations is as follows:

a. Remove the bonnet and roll the container until one of the valves and its companion eduction tube are directly above the other valve and its eduction tube. In this position, hoist the container onto a stand using an appropriate piece of

handling equipment (paras 23 through 27) where it will be sufficiently high to permit gravity flow. If no stand is available, the container may be placed on the edge of a ditch or trench, but it must be kept in a horizontal position.

b. Remove the valve caps from both the top and bottom valves (fig. 22).

c. Attach a vent line assembly to the upper angle valve. Either use the M1 line filling adapter (fig. 23) or improvise an assembly (fig. 25).

d. Attach a filling line assembly to the lower angle valve (fig. 23). This consists of an M1 line filling adapter, an elbow, a short nipple, and the M3 (para 18) or other appropriate filling line. Make sure both valves of the filling line are closed and insert the nozzle of the filling line into the transfer container.

e. Vent the 1-ton container by opening the upper angle valve (E); then slowly open the globe valve (C) on the vent line. The can of decontaminant (B) will neutralize any agent which is forced out of the eduction tube by a positive pressure in the 1-ton container. Do not permit the vent line to extend below the surface of the decontaminant in the can because decontaminant may be drawn into the 1-ton container if the container pressure is less than atmospheric pressure. Leave both valves in the open position. Since agent vapors will be present during the transfer operations, the operators should position themselves upwind of the vent line as much as possible during transfer and should be alert to downwind vapor hazard.

f. Open the lower angle valve (F) and check for leaks between the angle valve and the retaining valve of the filling line. If no leaks occur, open the retaining valve (G) of the filling line and check for leaks along the filling line. If no leaks occur, open the filling valve (J) and carry out the filling operation. If leaks occur during any of the valve opening steps, close the lower angle valve, allow any agent in the filling line system to drain into the transfer container, and replace the faulty equipment. If the mission makes it imperative to continue transfer operations and no equipment is available to repair or replace the leaking items, wrap the leaking area in rags soaked in the appropriate decontaminant. Whenever the nozzle of the filling line is withdrawn from the transfer container, a rag soaked in the appropriate decontaminant should be placed on the end of the nozzle to neutralize any dripping agent. When the filling line nozzle is not in a transfer container, it should rest in a can of decontaminant (1).

g. Once transfer operations are complete, close down the system in the following sequence: close lower angle valve (F), close upper angle valve (E), and close vent line globe valve (C). With the forearms, gently shake the line to drain out any of the agent that may be trapped. Remove the filling line, vent line, and adapters and thoroughly decontaminate them. Also decontaminate the front of the 1-ton container, the top of the transfer container, and all tools.

h. Replace the valve caps and the shipping bonnet.

i. When the level of the liquid in a 1-ton container that is not under pressure falls below the lower angle valve, pressure must be built up in the container to start the flow of liquid. This is done by forcing compressed air into the container through the 1/4-inch globe valve (D, fig.23) on the venting assembly.

Caution: **When transferring G-agents, undried compressed air may be used if the airplane smoke tank or other receptacle is to be used promptly (within 1 or 2 weeks) and if the remaining agent is not to be left in the 1-ton container longer than 2 weeks If longer storage is anticipated, dried compressed air must be used to prevent hydrolysis of the agent with resulting deterioration of the stored agent and the container.**

(1) Close the upper and lower valves on the 1-ton container and close both globe valves (C and D) on the vent line.

(2) Connect a low-pressure source of compressed air to the 1/4-inch globe valve (D).

(3) Open the upper angle valve on the 1 ton container.

(4) Open the 1/4-inch globe valve and pump air into the container until the pressure reaches 3 to 5 pounds per square inch.

(5) Close the upper angle valve and the 1/4-inch globe valve.

(6) The liquid will flow when the lower valve of the 1-ton container is opened.

137. The Vacuum Method of Transferring Liquid Chemical Agents To A 1-Ton Container

The vacuum method of transfer is useful when the container from which the agent is to be transferred is damaged or leaking, or when the valves cannot be opened. The equipment and materials needed for this operation normally are available in depots or storage facilities. With

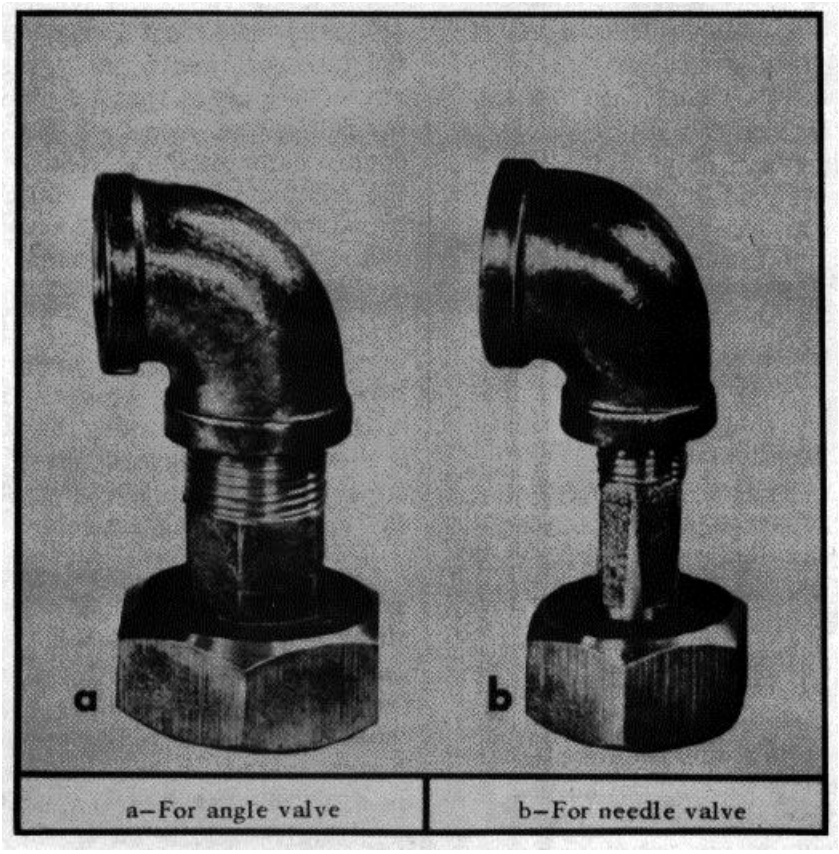


Figure 20. Adapters for 1-ton container.

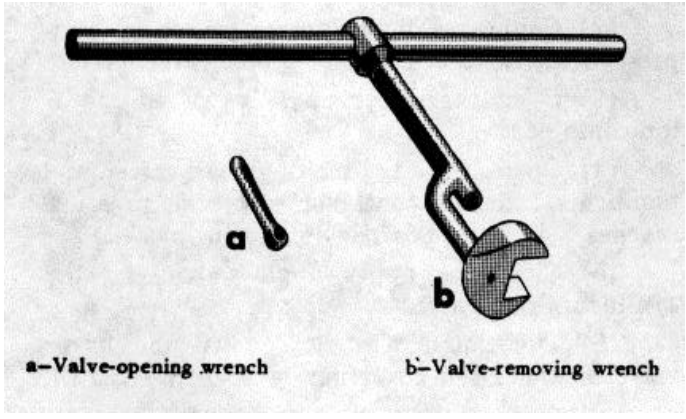


Figure 21. Wrenches for 1-ton container.

reference to figure 24, the following method is based on the action of a vacuum created by the exhaust pump (H) that draws up the liquid agent.

a. Place the damaged container (B) in a box (A) containing a suitable decontaminant, such as bleach mixed with earth

b. Turn the 1-ton container to be filled (E) so that the line (dashed) formed by the two valves is not quite vertical.

c. Hook up an empty 1-ton container (G) to act as a vacuum tank.

d. Use flexible, transparent, noncorrosive Saran tubing (C) where flexible connections are required.

e. Keep an active decontaminant such as caustic soda solution in the first 5-gallon drum (K) and place a check valve (F) on the inlet line. (The check valve prevents caustic soda solution from flowing into the container (G) if the vacuum pump fails to function.) This arrangement neutralizes the toxic vapors that are drawn off through the system.

f. Place a second 55-gallon drum (J) in the system to act as a vacuum tank, with a check valve (I) in the outlet line.

g. Maintain a vacuum in containers (E) and (G) and in drums (J) and (K) at all times during the transferring operations.

Figure 22. Removing and angle valve cap.

h. Use valve (D) to control and regulate the flow of the liquid chemical agent. Open the valve only after the exhaust pump has created a vacuum.

138. Venting A 1-Ton Container Filled With Group A Chemical Agent

The method of venting a 1-ton container filled with liquid chemical agent, described below, permits the operation to take place on the storage rack with personnel working on the ground. This is a procedure used to relieve internal pressure in the 1-ton container, particularly if a valve is to be changed.

a. Rotate the container (fig. 25) until the valve to be changed (B) is on top and the eduction tube is vertical. Use chocks to hold the - container steady.

b. Remove the valve cap and attach an adapter to valve (B). [The adapter consists of the female half of a special pipe union (C) attached to the angle valve, a short nipple (D), and an elbow (E).]

c. Attach an 8-inch length of pipe (F), a valve (G), another length of pipe (H), an elbow (I), and an appropriate length of pipe (J) to the adapter. (All pipe and fittings should be 8/4 inch.)

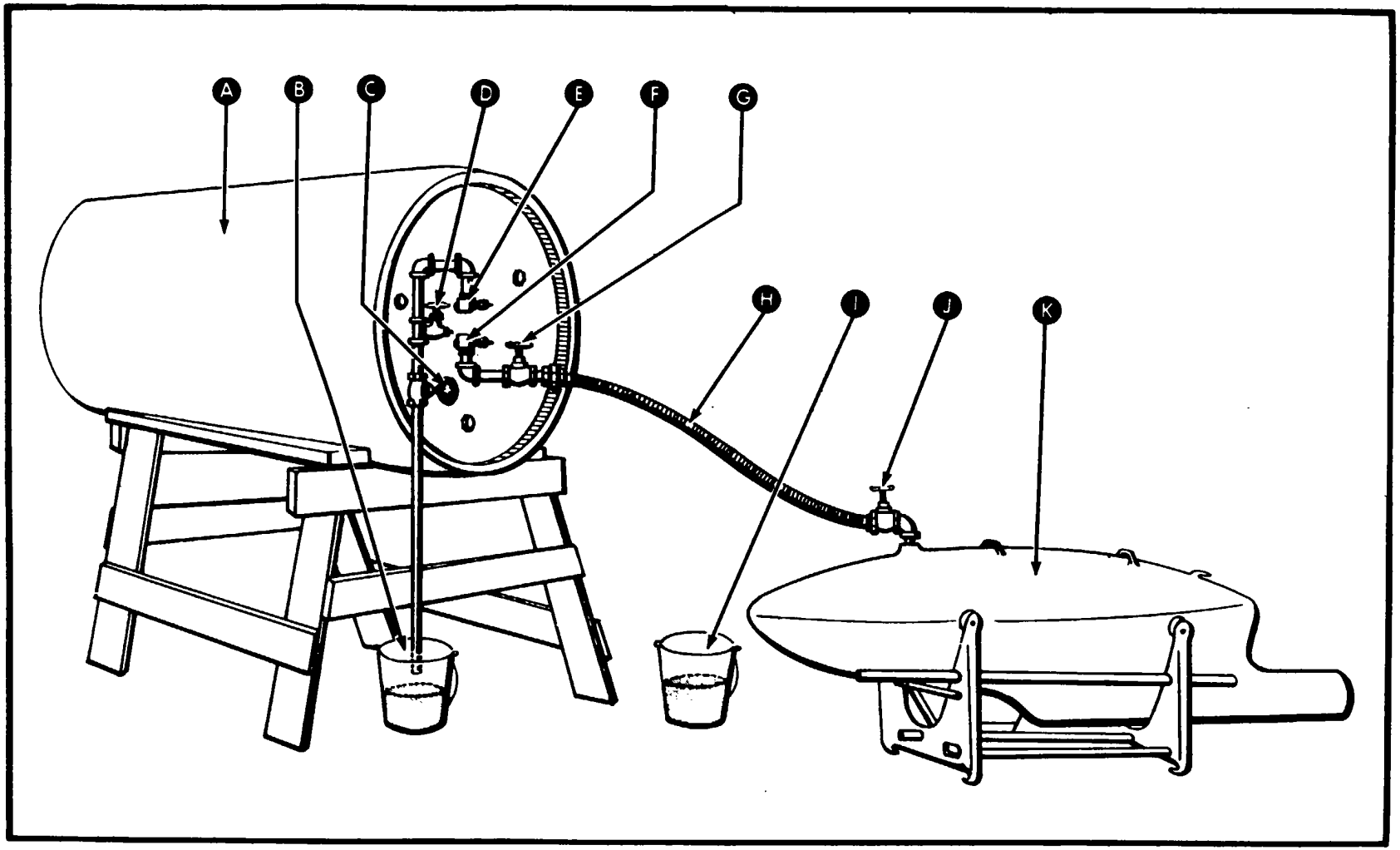
d. Place a bucket (K) partially filled with slurry or other appropriate decontaminant under the open pipe.

e. After slightly opening valve (B), use valve (G) to control the flow from the 1-ton container.

f. See that the lower valve (A) remains closed.

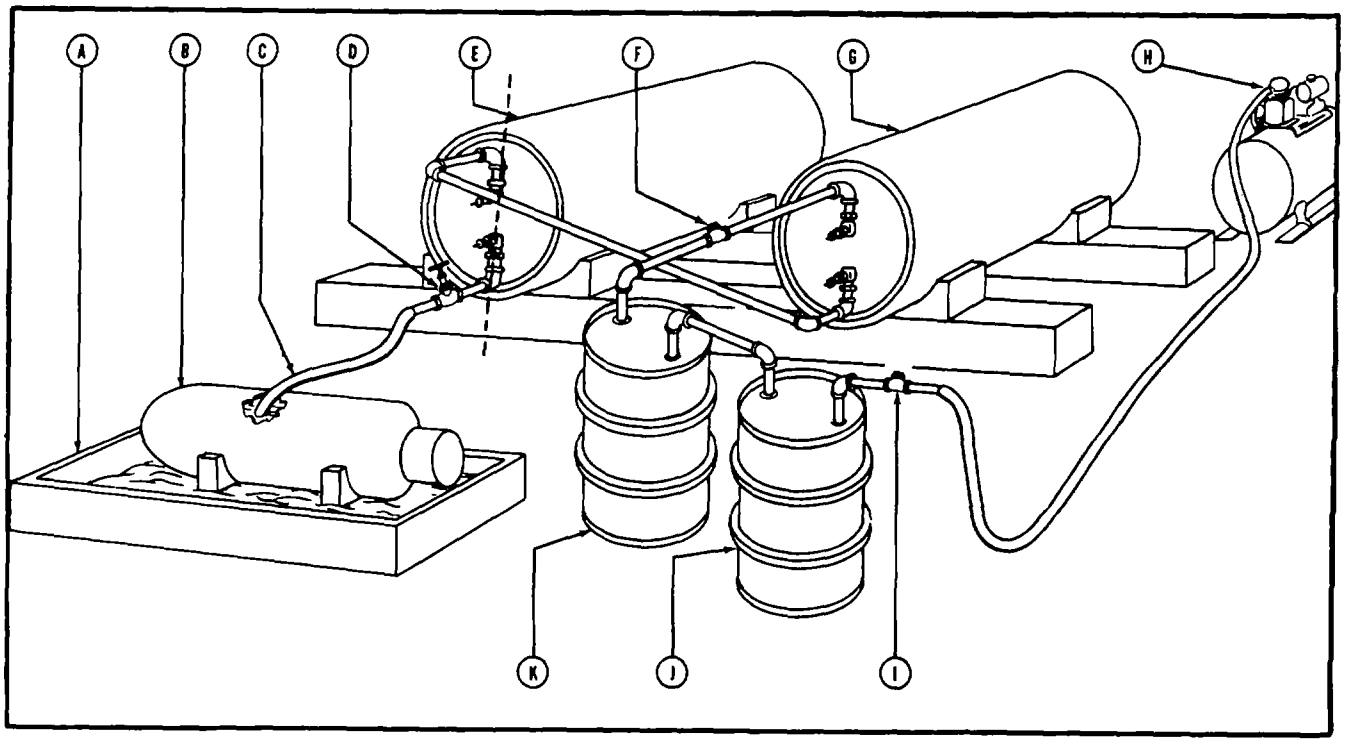
Note. **If the liquid chemical agent is mustard and it is "sick" (polymerized), approximately 1 pint of liquid will drain out before vapor comes off.**

g. When the liquid chemical agent and vapor stop flowing, close valves (G) and (B) and remove the adapter.



A 1-ton container
B Can of decontaminant
C Globe valve
D ¼-inch globe valve
E Upper angle valve
F Lower angle valve
G Retaining valve
H Filling line
I Can of decontaminant
J Filling valve
K Transfer container (M10 smoke tank)

Figure 23. Transfer of liquid chemical agents from a 1-ton container.



A Box
B Damaged container
C Saran tubing
D Valve
E 1-ton container
F Check valve
G 1-ton container
H Exhaust pump
I Check valve
J 55-gallon drum
K 55-gallon drum

Figure 24. Transferring liquid chemical agents by vacuum method to 1-ton container.

139. Cleaning Obstructed Eduction Tube of 1-Ton Container of Group A Chemical Agent

The method described below may be used to clean an eduction tube of a 1-ton container filled with a liquid chemical agent when it is believed that the tube is obstructed. This method is particularly applicable to containers of mustard that may form sludge when stored over a long period of time.

a. Prepare to remove one of the valves from the container head with an M2 valve-removing wrench. (The tube to be cleaned should be at the top.) Slip a length of pipe about 5 feet long over the handle of the wrench to enable it to be worked from a safe distance, and place an ample amount of waste around the valve and the jaws of the wrench to absorb any liquid chemical agent that might spatter. Unscrew and remove the valve slowly.

b. Gradually force a sharp-pointed spring steel wire of appropriate diameter into the eduction tube opening to receive any liquid chemical agent that might be ejected after the obstruction has been cleared.

c. Replace the valve and, if necessary, repeat this process with the other eduction tube.

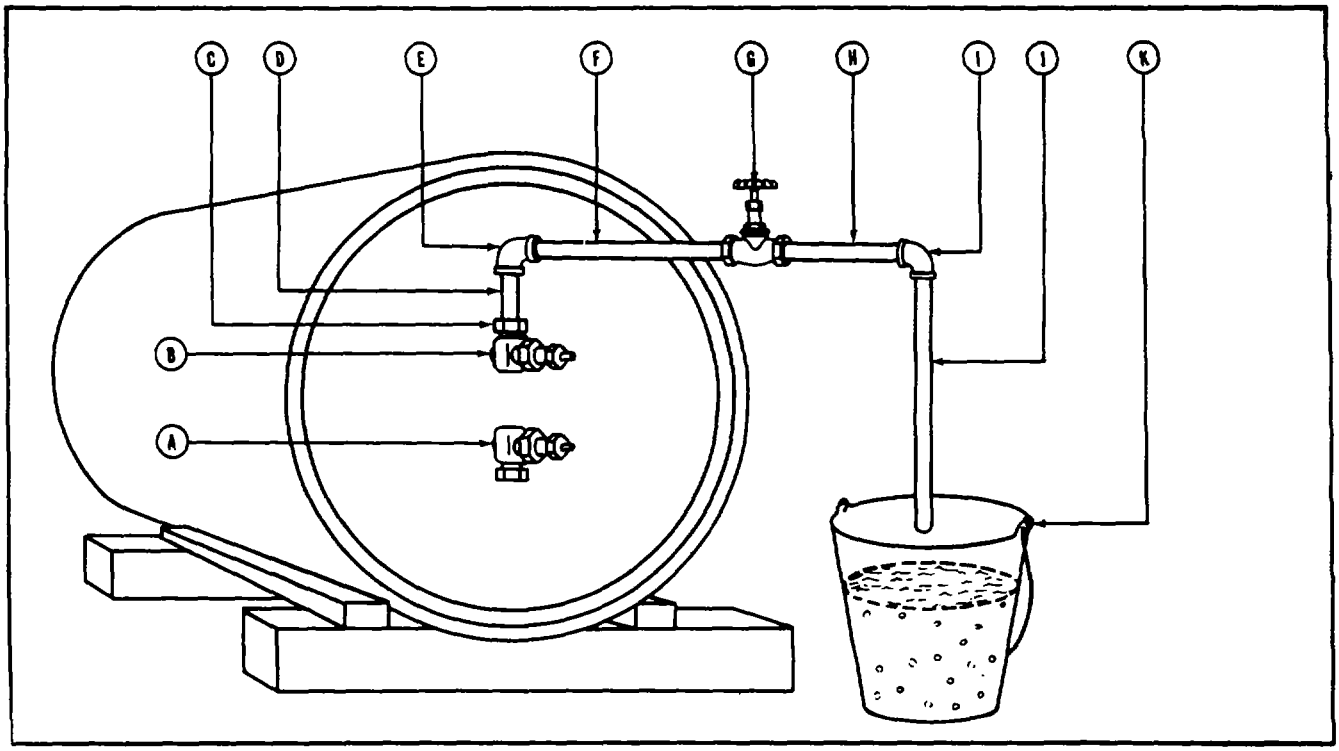
d. If it is found that obstructed eduction tubes cannot be cleared in this manner, remove one of the safety plugs and adapt a filling line to the opening.

140. Emptying 1-Ton Container When Eduction Tubes are Detached or Corroded

The flow of liquid chemical agent may cease when the 1-ton container has been only partially emptied. This usually indicates that the eduction tube to which the draw-off line is attached has been corroded or has become detached inside the container. In this case-

a. Disconnect the draw-off line (filling line) and the vent line assemblies.

b. Roll the container 180° (half way around), and reverse the connection of the draw-off line and the vent line assemblies.



A Lower valve
B Valve
C Female half of special pipe union
D Short nipple
E Elbow
F 8-inch pipe
G Valve
H Pipe
I Elbow
J Pipe
K Bucket

Figure 25. Venting a 1-ton container that contains a liquid chemical agent.

c. With the 1-ton container in its new position, resume the operations. If no liquid flows from the container, there is an indication that both eduction tubes are detached or blocked.

d. To empty a 1-ton container with both eduction tubes detached, remove one of the safety plugs and adapt a filling line to the opening.

Section III. TRANSFER OF GROUP B CHEMICAL AGENTS FROM 1-TON CONTAINERS

141. General

This section explains two methods of transferring group B chemical agents from 1-ton containers to other containers.

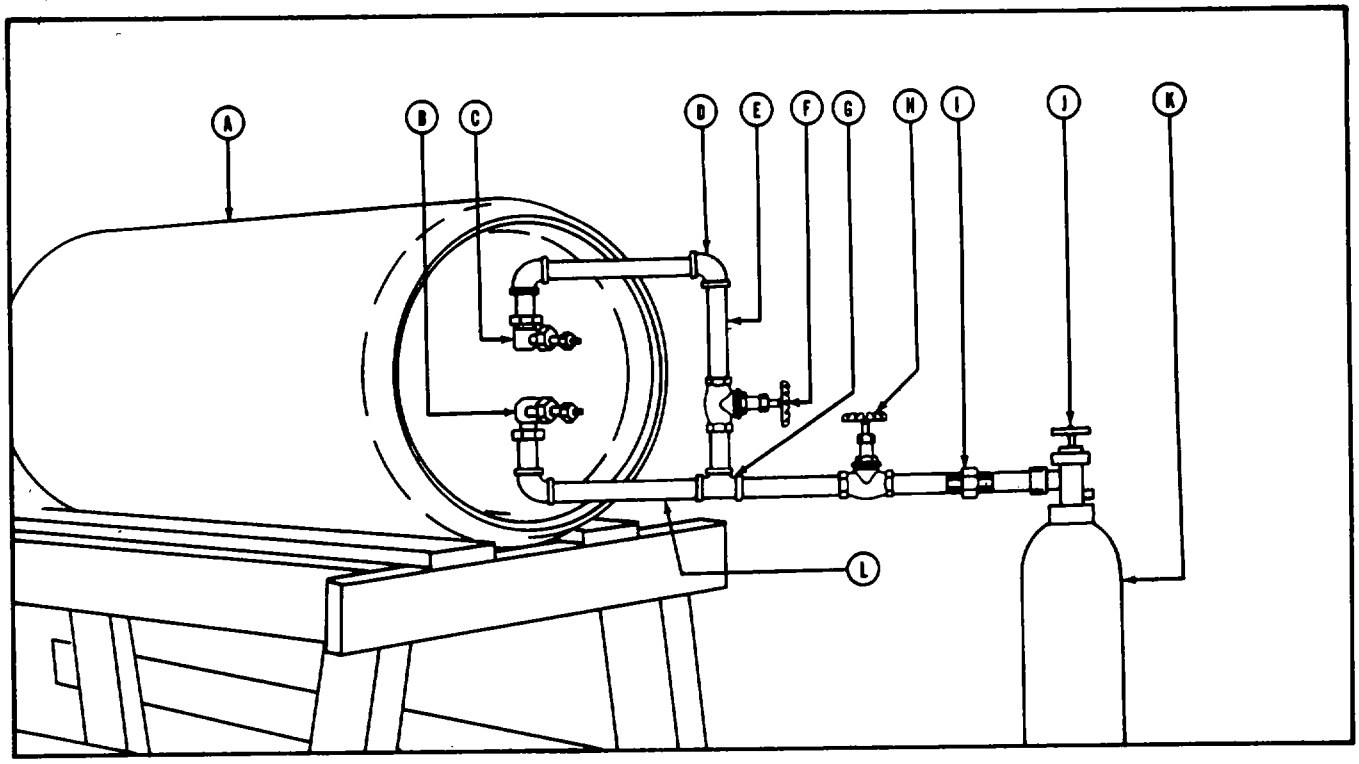
142. Basic Operations Involving Group B Agents

This paragraph describes basic operations for transferring gaseous agents from a l-ton container to a container having no well pipes, such as a portable cylinder. Special transferring operations are described in the following paragraph.

See figure 26 for transferring arrangement for gaseous chemical agents. Caution should be taken in opening globe valve of venting assembly (fig. 27). Standard tools (fig. 21) should be used to manipulate the valves. In this operation (fig. 26), no agent is lost (except between valves H and J) or destroyed by neutralizing agents such as caustic soda solution.

a. Place the 1-ton container (A, fig. 26) on a transfer platform so that one valve is directly above the other and connect pipes.

b. Open valves (B), (H), and (J), allowing the gaseous agent to flow into the portable cylinder (K).



A 1-ton container
B Valve
C Valve
D Elbow
E Pipe
F Valve
G Tee
H Valve
I Union
J Valve
K Portable cylinder
L Pipe

Figure 26. Transferring arrangement for gaseous chemical agents.

c. When the filling ceases to flow, open valves (F) and (C) and vent the cylinder. Repeat this process until the desired amount of filling is in the container. (Measure the filling by placing the cylinder on a platform scale.)

d. Close valves (B), (F), (H), (J), and (C) in that order.

e. Break union (I).

143. Alternate Method of Transferring Gaseous Chemical Agents

a. This paragraph describes another operation in which a "scrubbing" drum is used to neutralize the vented fumes. Containers having well pipes and no vents cannot be filled by this method. No refrigeration has to be used, except in transfer of chlorine gas.

b. With reference to figure 28, container (I) must be partially filled with a 10-percent caustic soda solution to neutralize the vented fumes before they reach the atmosphere. The pipes and fittings must be connected as shown in figure 28. Begin the operation with all valves closed and proceed as follows:

(1) Open valves (B), (D), and (L) in that order. The agent will run from container (A) to (K) until pressure in both containers is the same.

(2) When the agent stops flowing, close valve (D) and open valve (G) slowly, venting the pressure.

(3) After venting has been completed, close valve (G) and open valve (D) until the agent starts flowing into container (K) again.

(4) Repeat this process until the desired amount of chemical agent has been transferred.

(5) Use a platform scale under container (K) to measure the amount of agent transferred.

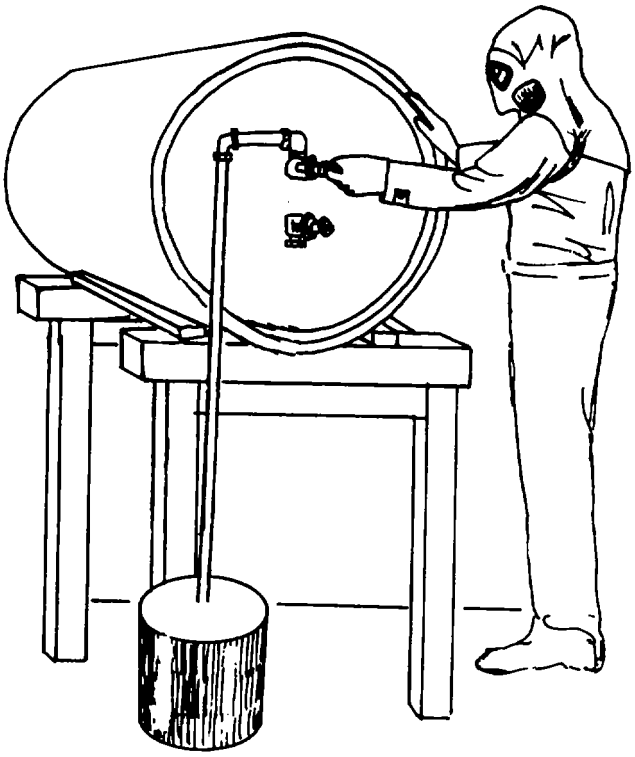
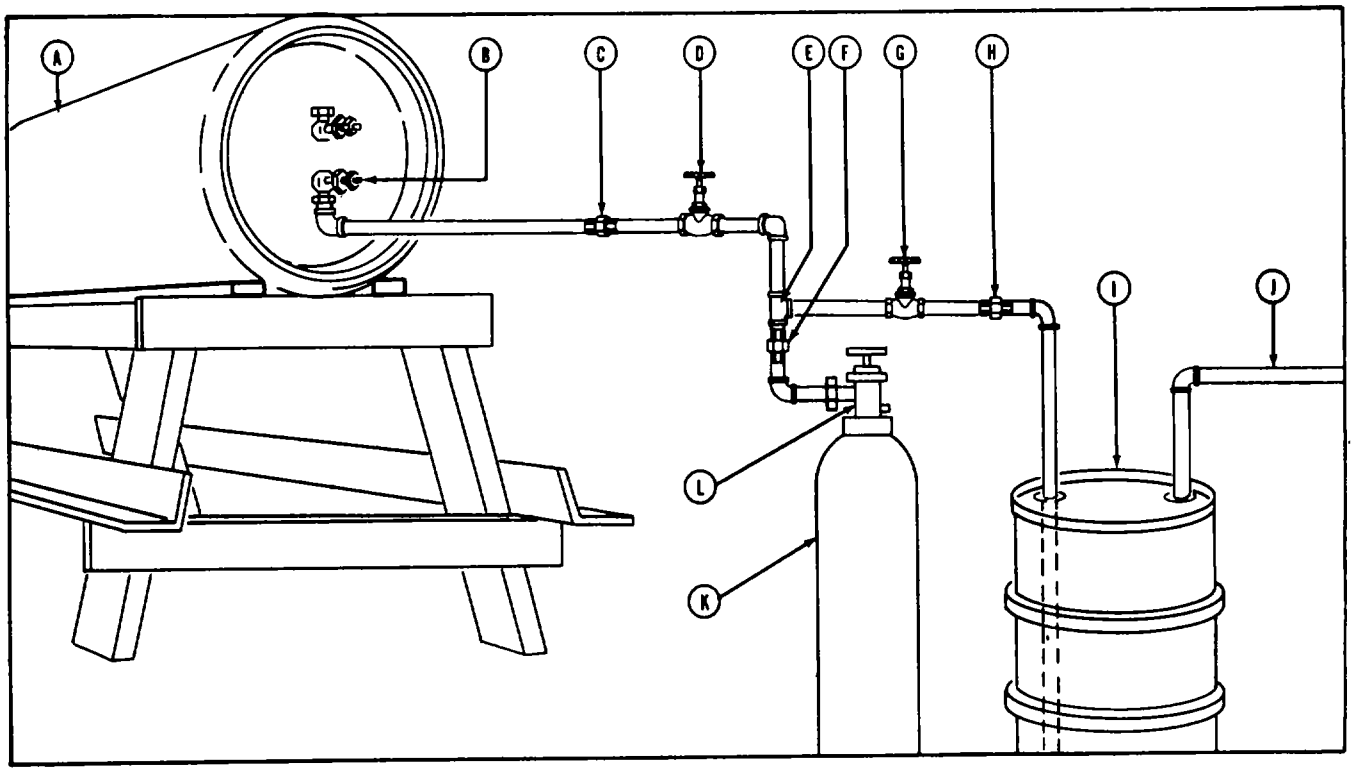


Figure 27. Opening globe valve of venting assembly.



A	1-ton container	G	Valve
B	Valve	H	Union
C	Union	I	Container
D	Valve	J	Vent pipe
E	Tee	K	Container
F	Union	L	Valve

Figure 28. A method of transferring gaseous chemical agents from 1-ton containers.

Section IV. TRANSFER OF GROUP B CHEMICAL AGENTS UNDER PRESSURE TO 1-TON CONTAINERS

144. General

In this method of transferring gaseous chemical agents under pressure from a container, such as a bomb, to a 1-ton container, considerable improvisation is required. It is necessary to construct a manifold panel (para 145) to control the flow of the agent. There are two methods of "scrubbing" the fumes, one using a scrubbing 'tower in the vent line and the other using a scrubbing drum before the fumes reach the vent pipe. Figure 29 is a general view of the arrangements for the transfer operations by use of a scrubbing drum and a specially constructed panel with a "sight" glass (para 145b). Figure 30 is a general view of the arrangements for the transfer operations by use of a vent line.

145. Manifold Panel and Connections

The manifold panel (figs. 31 and 32) is an improvised angle-iron-framed wood stand supporting various valves and fittings required to control the transfer of the gaseous agent from a container to the 1-ton container. The manifold panel can be constructed with a vent line (fig. 31) to which may be attached a scrubbing tower or a scrubbing drum.

a. Figure 31. In this panel arrangement, there is a nitrogen (or compressed air) cylinder (F), located back of the panel, which is connected to the pressure line through a pressure-reducing valve (C) and pressure gages (D), needle valve (B), and flexible copper tubing. The inlet (N) and outlet (K) transfer lines are connected to

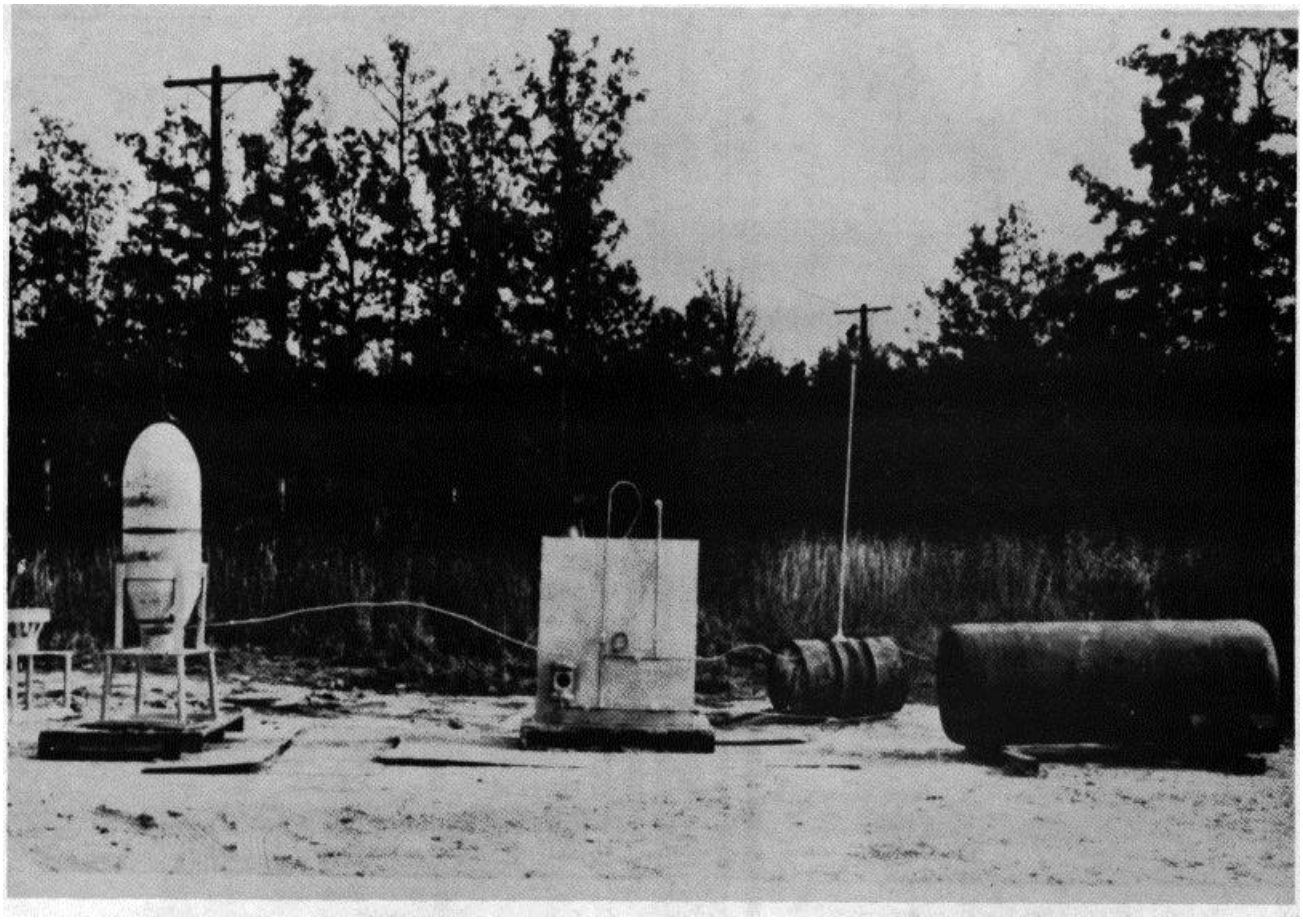


Figure 29. A method of transferring gaseous chemical agents by pressure to 1-ton containers using scrubbing drum.

Merco-Nordstrom valves (L) and (M) by flexible copper tubing. Vent line (H) from the 1-ton container is connected to a metal-seat globe valve (G), with the vent pipe (E) extending at least 20 feet above the panel. Pressure gage (A) is controlled by valves (I) and (J). With reference to figure 30, the inlet line (E) is fitted with an adapter for the threaded opening in the bomb valve (or similar valve on any other container) and a union for quick disconnection from the bombs (C). The outlet line (H) is connected to the valve of the 1-ton container (I) through an adapter. (Sequence and details of operations are covered in the following paragraphs.)

b. Figure 32. In this panel arrangement, the basic manifold panel (a above) has been modified by the addition of a "sight" glass (A) to determine when the flow of liquid agent is completed. A pressure gage (D), with petcocks (C) and (E) on either side and petcocks (B) and (F), is connected to both the filling line (H) and the vent line (G) so that the pressure can be measured during operation by opening and closing petcocks and valves in proper sequence. Figure 33 shows connections in rear of the panel to a 55-gallon drum (A), filled with a 10-percent solution of sodium hydroxide to neutralize agent fumes vented from the 1-ton container (B). The drum is shown connected to the vent line (C), on manifold panel (D).

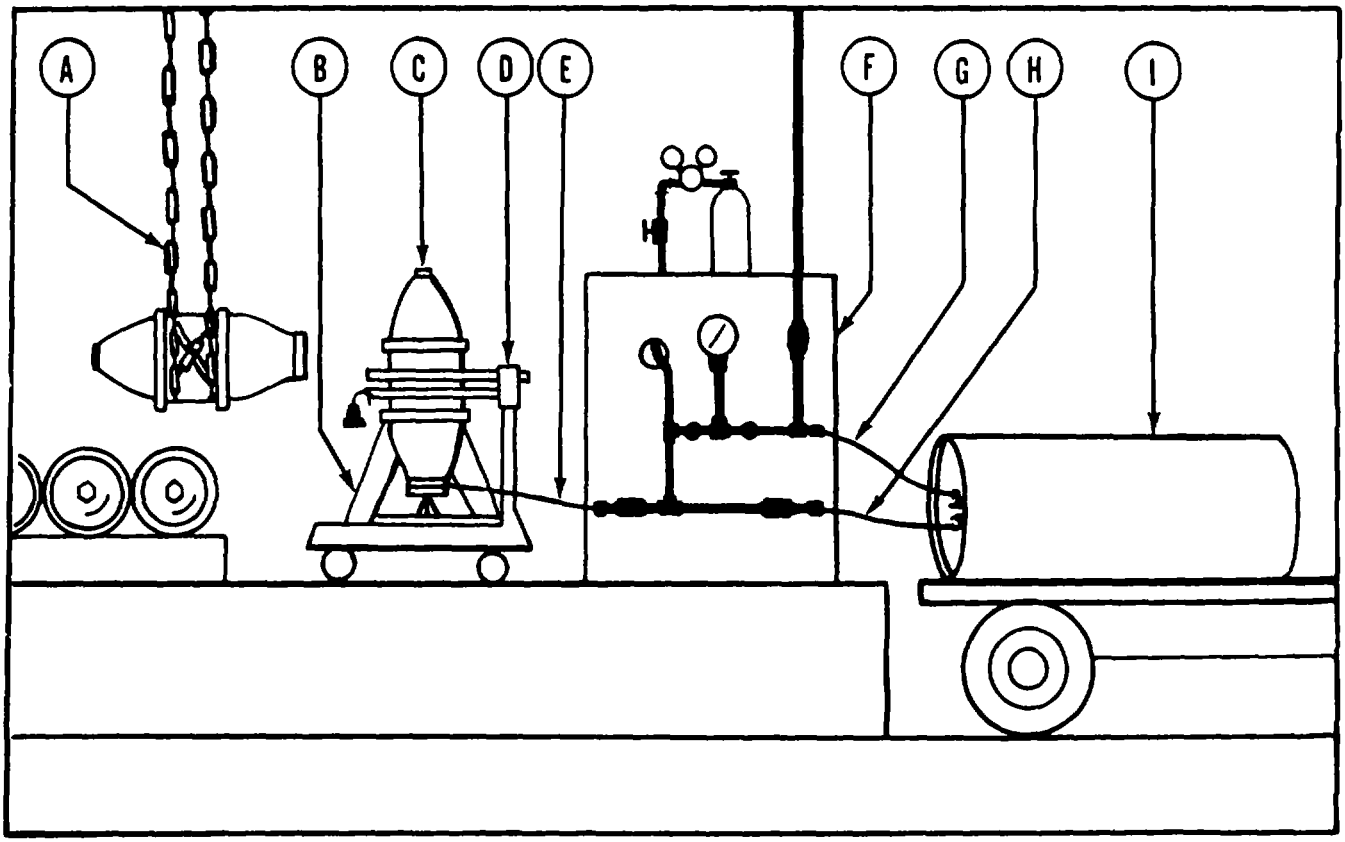
146. Preparing the Bomb or Other Container for Transferring Operations

If the gaseous chemical agent is to be transferred from a bomb or similar container, certain preparatory procedures must be followed; these vary according to the type of container. With reference to figure 30, follow the steps listed below.

a. Remove the nose plug from the bomb to be drained and screw in a handling ring.

b. Raise the bomb with a hoist (A) and remove the fin lock nut and protector.

c. Place the bomb on a pallet (B) located on the platform of a suitable scale (D) and record the weight of the bomb (C).



A Hoist	D Scale	G Vent line
B Pallet	E Inlet line	H Outlet line
C Bombs	F Panel	I 1-ton container

Figure 30. A method of transferring gaseous chemical agents by pressure to 1-ton containers using vent line.

d. Remove the needle valve guard and the pipe plug, and insert a 1/8-inch nipple with half union in place of the pipe plug.

e. Connect the copper tubing (E) from the inlet side of the manifold to the 1/8-inch line from the bomb by means of the second half of the union.

147. Preparing the 1-Ton Container

Before connecting the filling lines to the 1-ton container, inspect the container for cleanliness and dryness by removing safety plugs, inserting a light in one end, and viewing the interior from the opposite end. After inspection, lute the plugs before replacing them. With reference to figure 30, place the 1-ton container (I) in a line with the delivery side of the manifold, and rotate the container to bring the eduction tubes to a vertical position. Connect the delivery line from the manifold to the lower valve of the 1-ton container by means of a container valve adapter and copper tubing (H). Connect the vent line (G) to the upper valve of the 1-ton container by similar fittings.

148. Transferring Operations

With reference to figure 31, and starting with all valves closed, the sequence of operation is as follows:

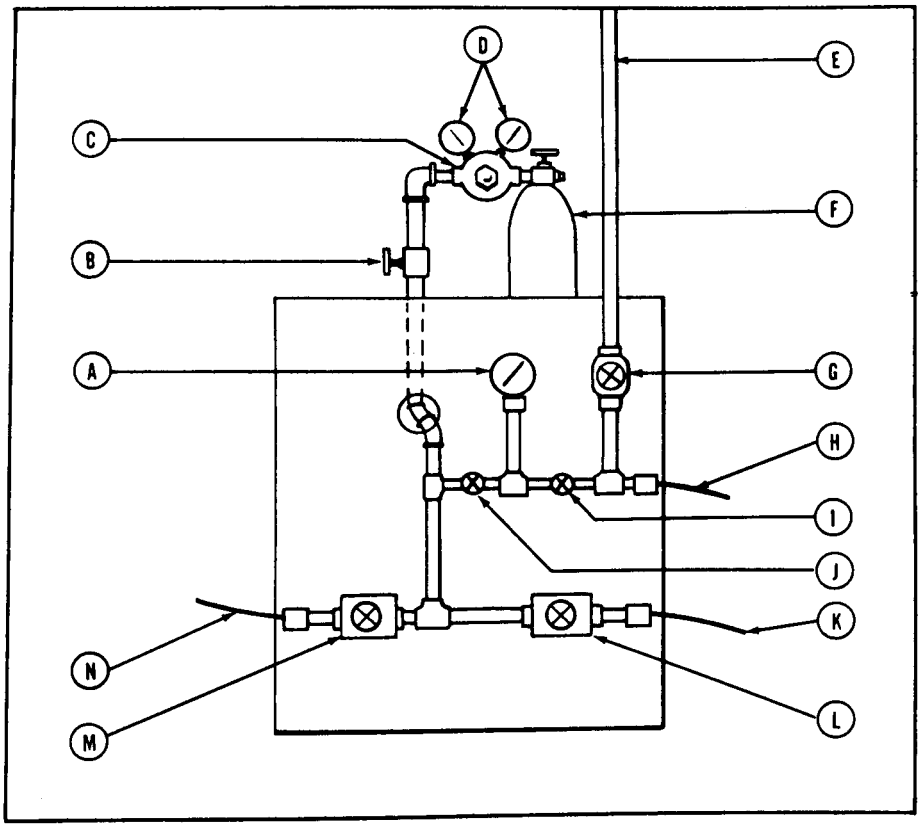
a. Open the main valve on the nitrogen cylinder (F).

b. Adjust the pressure-reducing valve (C) to deliver approximately 75 pounds on the lowpressure side of the line.

c. Open the needle valve (B) on the nitrogen line.

d. Open the petcock (J) between the manifold gage and vent line to the bomb.

e. Open the inlet valve (M) leading to the bomb.



A Pressure gage
B Needle valve
C Pressure-reducing valve
D Pressure gages
E Vent pipe
F Nitrogen (or compressed air) cylinder
G Metal-seat globe valve
H Vent line
I Valve
J Valve
K Outlet
L Merco-Nordstrom valve
M Merco-Nordstrom valve
N Inlet

Figure 31. Details of manifold panel.

f. Open the bomb outlet valve.

g. Allow the pressure to become constant in the bomb as indicated by equal readings on manifold gage (A) and gage (D) on the lowpressure side on the nitrogen line.

h. Close the needle valve (B) on the nitrogen line.

i. Open the outlet valve (L) leading to the 1-ton container.

j. Open the 1-ton container angle valves. (With this action, the pressure inside the bomb will force the liquid chemical agent from the bomb to the 1-ton container. After a time, the flow will diminish as a result of back pressure in the 1-ton container. The extent of this back pressure can be determined by closing the petcock (J) on the line from the manifold gage to tb9 bomb and opening the petcock (I) on the connection between the gage and vent line.) k. When the pressure differential becomes so small as to restrict the transfer of the chemical agent, vent the 1-ton container by opening the vent valve (G) on the manifold.

i. When the flow of the filling is slowed, add nitrogen by closing the outlet valve (L) on the manifold and opening the needle valve (B) on the nitrogen line; let all other valves remain as previously described.

***Caution*: Make certain that both petcocks to the manifold pressure gage are not open at the same time while the bomb is under pressure or when making nitrogen additions If the bomb is under pressure, the bomb filling will be forced out through the vent line (if open); if nitrogen is added, it will be wasted. Make certain that there is sufficient void in the 1-ton container.**

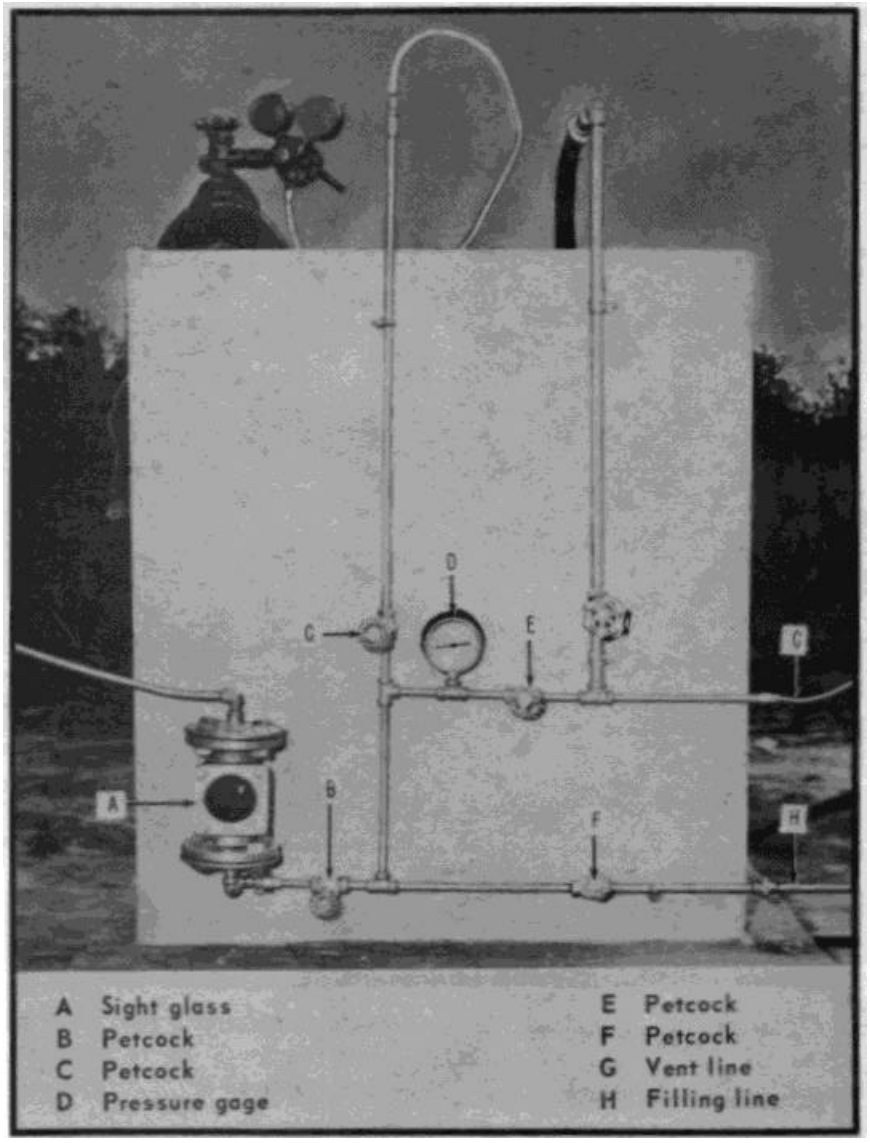


Figure 32. Manifold panel constructed with sight glass.

m. Complete transfer of the filling from the bomb is indicated by a bubbling sound inside the 1-ton container. (Verify this by the rapid equalization of pressure in the bomb and the 1ton container.) If a "sight" glass has been inserted in the transfer line from the bomb on the manifold panel (fig. 32), it is not necessary to depend on the bubbling sound inside the 1-ton container to determine when the filling inside the bomb has been transferred.

n. After the bomb has been emptied, close all manifold valves and the bomb outlet valve. Disconnect the bomb by removing the 1/8-inch line at the union.

o. Unscrew the nipple in the pipe plug opening and reinsert the pipe plug.

p. Reweigh the bomb in the pallet and, from the two weights, compute the amount of chemical agent transferred.

149. Completing the Operations

After a sufficient number of bombs or containers of the chemical agent have been emptied into the 1-ton container to bring the weight of filling to the maximum allowable weight, complete the operations as follows:

a. Turn off the valves in the order given below.

(1) Lower valve of the 1-ton container.

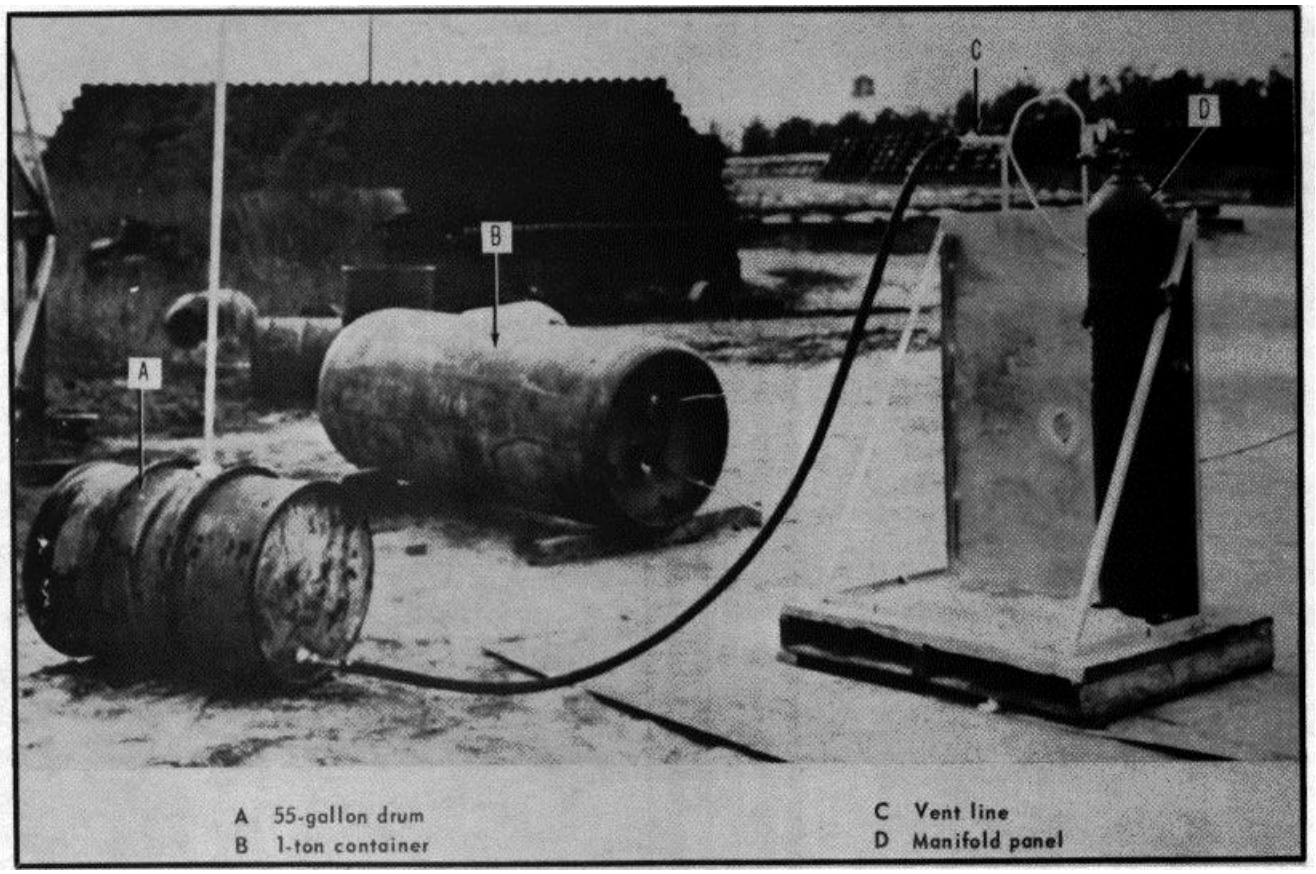


Figure 33. Back of manifold panel, showing connections.

(2) Outlet valve (L) on the manifold.

(3) Upper valves of the 1-ton container, after excess pressure has been released.

b. Disconnect the 1-ton container by unscrewing the angle valve adapters. Replace valve caps and bonnet.

Section V. TRANSFER OF GROUP B CHEMICAL AGENTS BY GRAVITY FLOW TO 1-TON CONTAINERS

150. General

This method of transferring gaseous chemical agents from a bomb or similar container requires a minimum of improvisation. Transfer is accomplished by gravity flow, and this method can be used with captured enemy bombs as well as with our own bombs. The procedure described in the following paragraph may be followed, more or less closely, depending on the type of container from which the chemical agent is to be transferred. Figure 34 shows a German World War II 250-kilogram phosgene bomb for which a valve control adapter must be improvised.

151. Preparatory Steps

With reference to figure 34 and starting at position 1, remove all explosive charge possible (done by EOD personnel) and place the filled bomb (B) on a wooden table (A) with the filler plug (C) pointed upward.

a. Expose the check valve in the appropriate manner. (With captured enemy bombs, it may be necessary to remove the filler plug by hammer and chisel in order to expose the inside check valve.)

b. Screw a check valve control assembly into the bomb body flush with the check valve

through the filler plug (C). [Position 2 shows the adapter assembly, consisting of an apparatus (G) for opening the check valve in the bomb, a valve (F), and a union (E) attached to the bomb (D).]

c. Roll the bomb (H) over (with the check valve assembly attached) one-half turn on the table until the valve control adapter (I) is pointed straight downward as in position 3.

d. Couple the valve and adapter assembly (J) to valve (L) using pipe union (K).

e. Use three "chicksan" swing joints (X) to connect the pipe assembly between the bomb and lower valve (V) of the 1-ton container (M).

f. Connect the following additional parts of the system: valve (W) in pipeline; 1-ton container inlet valve adapters (N); valve (P); 1-ton container vent valve (0); 1-ton container (M); valve (Q); vent pipe (R); rubber hose (S); drum partly filled with 10-percent sodium hydroxide solution (T); and standpipe to caustic soda solution (U).

152. Venting System

To provide a uniform and rapid flow of the liquid chemical agent from the bomb to the 1ton container, install and connect a venting system to the 'l-ton container by means of a flexible rubber hose (S). The vent assembly consists of a metal drum partially filled with a 10-percent solution of sodium hydroxide (T), used as a scrubber for escaping agent fumes. A metal vent pipe (R) and a control valve (Q) are inserted in the metal drum. When the valves are opened as described in the transferring operations (para 153), open valves (P) and (0) to allow air and vapor from the 1-ton container to escape through the rubber hose into the drum containing the sodium hydroxide solution. The air and vapor are neutralized and pass through the vent pipe to be dissipated into the atmosphere.

153. Transferring Operations

Release the liquid chemical agent from the bomb (H) by operating the valve control adapter (I) so as to open the check valve. Open valves (J), (L), (W), and (V) in turn, allowing the liquid agent to drain from the bomb into the 1-ton container.

154. Completing the Operation

After emptying the bomb close all valves, disconnect the pipe union (K), remove the attachments from the bomb, replace the filler plug in the filler hole, and remove the empty bomb from the table. Repeat the transfer process with other bombs until the 1-ton container is filled.

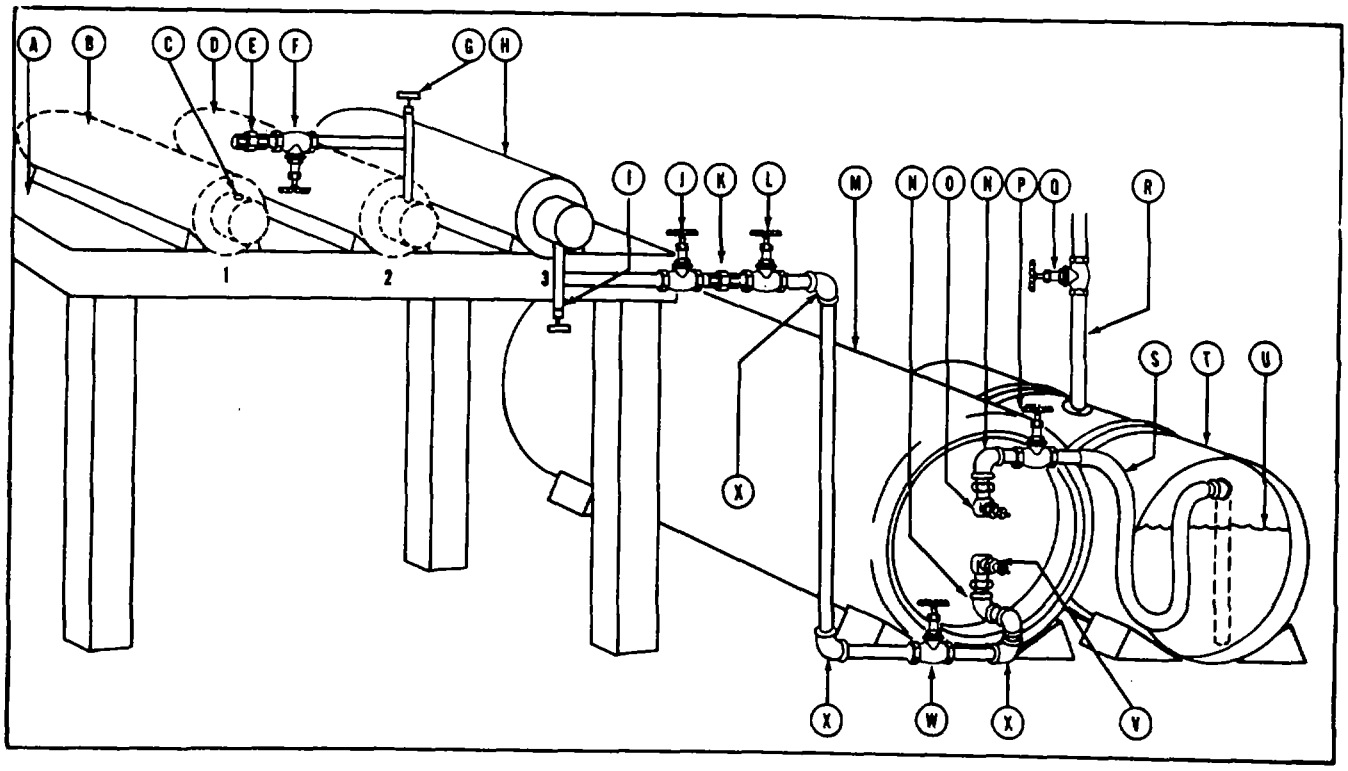
155. Operational Data

As a result of pressure tests conducted on phosgene-filled, 250-kilogram German bombs prior to transferring operations, the following operational data were noted:

a. Low pressure in the bomb retards normal action of the check valve, and the valve action is unpredictable.

b. High pressure of 40 pounds or more in the bomb tends to create normal action of the check valve.

c. Varying pressure, between 19 and 22 pounds, produces irregular action of the check valve and results in vapor blows issuing from the bomb on one out of four bombs when the filler plug is removed.



A Wooden table
B Filled bomb
C Filler plug
D Bomb
E Union
F Valve
G Apparatus
H Bomb
I Valve control adapter
J Valve and adapter assembly
K Pipe union
L Valve
M 1-ton container
N Inlet valve adapters
O Vent valve
P Valve
Q Valve
R Vent pipe
S Rubber hose
T Drum partially filled with 10-percent sodium hydroxide solution
U Standpipe to caustic soda solution
V Lower valve
W Valve
X "Chicksan" swing joints

Figure 34. A method of transferring gaseous chemical agents by gravity flow to 1-ton containers.

Section VI. IMPROVISED METHOD FOR CHANGING VALVES OF 1-TON CONTAINERS FILLED WITH GROUP B CHEMICAL AGENTS

156. General

Valves of 1-ton containers filled with gaseous chemical agents normally are changed by use of the M1 valve replacement mechanism. The improvised method described below may be used to change valves of the type A and D 1-ton containers when the valve replacement mechanism cannot be used.

a. Equipment. The following equipment is required.

(1) Ball peen hammer, 1 1/2 to 2 pounds.
(2) Tapered steel pin.
(3) Litharge and glycerin.
(4) Valve replacement wrench, M1.
(5) Wrenches.
(6) Two extra valves.
(7) Rubber gloves, rubber aprons, rubber boots, impermeable protective clothing, and protective masks.

b. Position of Container. If the eduction tube of the valve of the 1-ton container is intact, the valve can be changed while the container is on its side without loss of the liquid part of the filling. If the eduction tube of the valve to be changed is defective, or has an opening below the surface of the liquid layer, or has become detached from the head of the drum, the container must be placed in an upright position before the

valve is to be changed so that none of the liquid portion of the filling escapes. Paragraph 157 describes the procedure used to determine whether or not the valve can be changed with the 1-ton container in a horizontal position.

c. Cooling the Container. Gaseous chemical agents exert greater pressure at higher than at lower temperatures; consequently, greater pressure must be exerted at higher temperatures to screw a new valve into the container opening. When the agent is cooled, however, a valve can be replaced with little or no loss of the gaseous portion of the filling because there will be little or no pressure exerted by the liquid agent. The container and filling can be cooled as described in paragraph 158.

157. Preliminary Procedure

With the 1-ton container lying in a horizontal position, roll the container so that the valve to be changed is directly over the lower valve. Attach a vent tube to the upper valve, making sure the end of the tube is aimed into a can of decontaminant. Open wide the upper valve. If only gas escapes, the valve may be changed while the container is on its side. (Usually, little or no liquid escapes if the eduction tube is intact and properly secured to the valve connection of the 1-ton container.) If liquid agent escapes and continues to escape when the upper valve is opened, it indicates either the presence of a hole in the eduction tube, as might be caused by corrosion, or the loosening or detachment of the eduction tube from the valve connection. In this case, the 1-ton container must be cooled (para 158) and placed in an upright position before an attempt is made to change valves.

158. Cooling Containers

It is less difficult and dangerous to change valves of a 1-ton container filled with a gaseous agent when the container is cooled. Place the container to be cooled in a tank or vat and surround it with a salt-ice mixture, brine from a refrigerating system, or cold running water. If a salt-ice mixture is used for cooling, leave the container in it for at least 10 hours; or if running water is used, for 20 hours. In case a vat or tank is not available, improvise a temporary one by using a tarpaulin or banked earth.

159. Changing Valves

For changing valves, three men, properly equipped with protective clothing and protective masks, must be available. A fresh-air mask with approximately 50 feet of hose, when available, is preferable to a protective mask. The new valve to be inserted should be carefully inspected to see that it is properly packed and that it is sound. Threads should be inspected and, if they are true, painted with a mixture of litharge and glycerin. (The new valve must be open while it is being inserted.) One man removes the old valve while another stands ready to insert the new one. The third man stands by with a spare valve, ready to give such assistance as may be required. After the new valve has been inserted and given several twists, it should be closed and then tightly seated with a wrench.

160. Valve Breaking Off

There is a possibility that a valve may have deteriorated so much that it will break off when an attempt is made to remove it. If a valve does break off, drive a tapered steel pin securely into the opening with a hammer. Transfer the contents of the container to another container, in the usual manner, through the other valve. If the stem of the second valve should break off when 'an attempt is made to open it, dispose of the container by any approved method.

Section VII. BASIC METHOD OF TRANSFERRING CHEMICAL AGENTS TO OR FROM 55-GALLON DRUMS

161. Operation

The following procedure describes operations involving the standard 2-bung, 55-gallon drum. An adapter (part of the M3 filling line) (para 18) must be used with a drum having only one bung.

a. Prepare the filled drum for transfer operations by placing it on end and removing the 3/4-inch-end plug. Insert the retaining valve of the M3 filling line, with two nipples and one section of the union coupling assembled to it, into the opening (fig. 85). Screw it tightly into the opening, positioning it so that the valve stem will be vertical and the valve in the lowest position when the container is on its side (fig. 86).

b. Place the drum on its side and loosen the side plug just enough to break the seal so that the plug may be removed easily for venting during filling operations.

c. Hoist the drum, with the venting plug on top, to a height sufficient to provide satisfactory gravity flow. Use either a loading stand or other available equipment.

d. Attach the filling hose, with filling valve and nozzle assembled, to the union coupling on the retaining valve assembly by means of the companion section of the union coupling on the filling hose. This connection must be tight, and must be arranged so that the filling nozzle on the other end of the line is pointing downward (fig. 86).

e. See that equipment is clean and dry before filling operations begin. Place the empty container at a proper distance to permit easy insertion of the filling nozzle and a normal gravity flow through the line.

f. Place the nozzle in the filling hole of the container and push it in to its entire length. Open the retaining and filling valves of the filling line carefully to equalize pressure in the drum. Then close the filling valve again and remove the vent plug from the drum. Open the filling valve and adjust it to regulate the flow of the filling, as desired.

g. When the drum has been emptied, or when filling operations have been completed, the filling line should be raised as high as practicable above the container. Open the filling and retaining valves to permit most of the filling entrapped in the filling line to drain back into the drum. Then close the retaining valve and detach the filling line, reversing the procedure that was used for attaching the line.

162. Care and Maintenance

Whenever possible, the drum should be cleaned inside immediately after being emptied (para 12). For thorough cleaning and decontamination of an emptied drum used to store mustards, follow a suitable modification of the steam-underpressure method described in paragraph 10b. In any event, the outside of the drum must be decontaminated, particularly around the bungs. When necessary, the drum should be painted to prevent rusting.

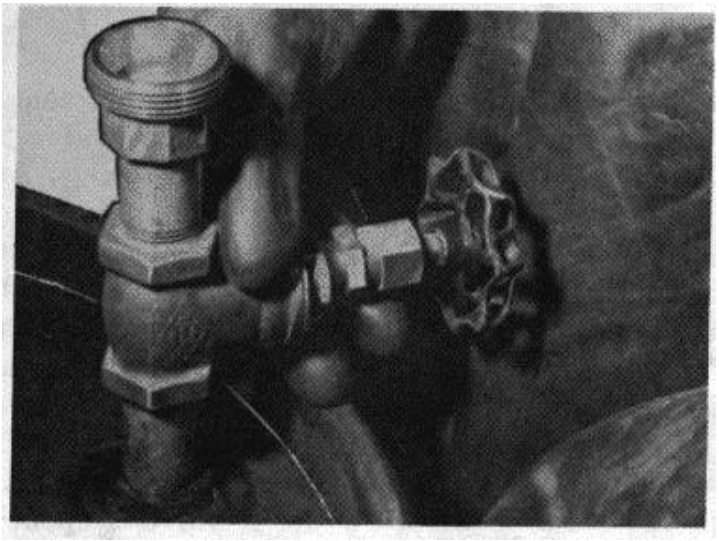


Figure 35. Attaching retaining valve to 3/4 inch opening of 55-gallon drum.

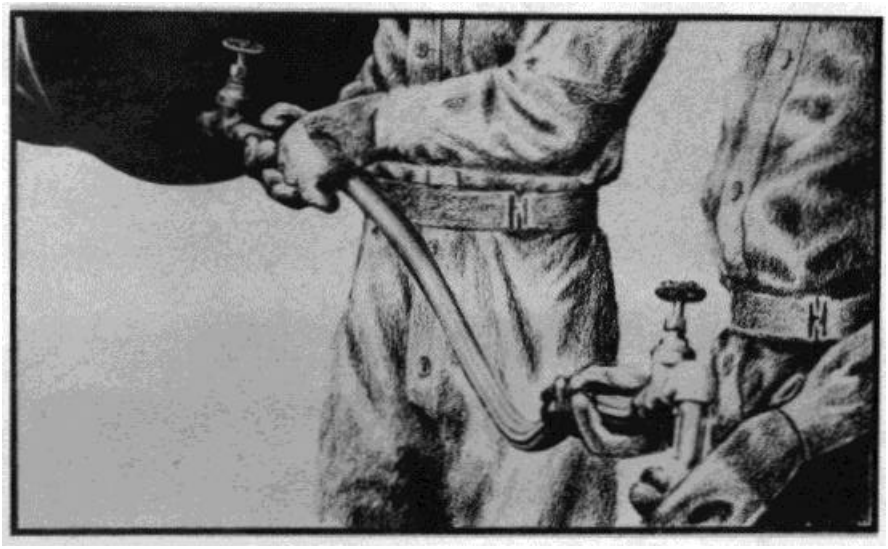


Figure 36. Connecting hose to retaining valve assembly.

CHAPTER 9

SHIPMENT OF CHEMICAL AGENTS AND HAZARDOUS CHEMICALS

Section I. INTRODUCTION

163. General

The transportation of hazardous chemicals and related items within the limits of the continental United States and some areas overseas is regulated by Federal agencies. This chapter is a synopsis of data contained in the regulations published by those Federal agencies. This chapter also describes procedures, methods, and courses of action to be taken under various conditions of shipment.

164. United States Government Shipping Regulations

The United States governmental agencies that regulate the transportation of chemical agents and hazardous chemicals within the limits of the jurisdiction of the United States and the general nature of their regulations are described in a and b below.

a. Department of Transportation (DOT). Under Federal act, this agency formulates the regulations for the safe transportation of explosives, poisonous substances, and other dangerous articles. These regulations are binding upon all common, contract, and private carriers engaged in interstate and/or foreign commerce and on all shippers of these articles by any common, contract, or private carrier. Such regulations are in accordance with the best known practices for assuring safety in transit and cover the packing, marking, loading, and handling of materials in transit, and the precautions necessary to determine whether the materials to be shipped are in proper condition for transport.

(1) *Surface carriers*. Regulations of the DOT governing the safe surface (land) transportation of explosives and other dangerous articles (E&ODA) are binding upon all shippers and all carriers transporting E&ODA by land in interstate or foreign commerce (CFR, Title 49, Parts 171-190 and 297).

(2) *Air carriers*. All commercial air carriers transporting E&ODA are governed by the regulations of the Federal Aviation Administration (CFR, Title 14, Part 103).

(3) *Water carriers*. All commercial water carriers transporting E&ODA are governed by the regulations of the DOT (CFR, Title 46, Parts 146-149).

b. *Military Regulations*. Explosives and other dangerous articles shipped or transported by the military services are subject to the applicable regulations of the military service involved.

(1) *Surface carriers.* AR 55-355 regulates the movement of military cargo within CONUS by commercial vehicle. AR 55-56 deals specifically with the shipment of chemical agents and hazardous chemicals. Other regulations and technical manuals provide guidance specific to the transportation requirements involved.

(2) *Air shipments*. TM 38-250 provides guidance for packaging, handling, and transportation of dangerous articles by military aircraft.

(3) *Water shipments*. AR 55-228 regulates the shipment and transportation of dangerous articles by water in conjunction with Coast Guard Regulations 108, "Rules and Regulations for Military Explosives and Hazardous Munitions."

165. Other Shipping Regulations

Within the continental United States, each state and nearly all municipalities have laws and ordinances that regulate the transportation of dangerous articles over highways and streets. These laws and ordinances have special significance for military vehicular transportation. Allied countries in oversea theaters of operations have similar regulations.

166. Escort of Shipments

The installation transportation officer should be aware of pertinent laws, ordinances, and regulations

of host nation(s) applicable to the movement of dangerous articles within that particular theater of operations. Certain shipments of chemical munitions and agents must be escorted by technically qualified and equipped personnel from the point of origin to the final destination, as explained in AR 740-32 and AR 55-56.

a. U.S. Army Technical Escort Unit. The mission of the U.S. Army Technical Escort Unit, Edgewood Arsenal, Maryland 21010, is as follows:

(1) To provide technical escort for the transfer and shipment of DA radiological material; all Department of Defense chemical, biological, and etiologically agents; and assigned CB munitions and other hazardous items in accordance with technical standards prescribed by the Secretary of Agriculture and The Surgeon General of the U.S. Public Health Service.

(2) To perform EOD procedures on items escorted when required to preclude an unacceptable dissemination of hazardous material.

(3) To provide escort, demolition, demilitarization, decontamination, disposal, and related safety and security functions with respect to chemical agents, biological agents, and radiological material in CONUS and to theaters of operations.

(4) To provide on-site technical escort, demilitarization, disposal, and CBR EOD support at Rocky Mountain Arsenal and Newport Army Ammunition Plant.

(5) To assist U.S. Army Munitions Command in performing its EOD missions when requested. Technical Escort Unit personnel are trained to provide the greatest possible safety to all personnel, military and civilian, who may handle or come in proximity to the cargo during all phases of the shipment.

b. Technical Escort in Theaters of Operations. In theaters of operations, technical escort services are provided by personnel of ammunition units.

167. Shipment by Escort

Technical escorts are required to accompany shipments of the following:

a. Class A poisons (excluding nerve agents and chemical agents under development) except for shipments of quantities per shipment not exceeding in volume the space occupied by 100 pounds of water (1.6 cubic feet or 11 gallons). All oversea shipments of chemical agents and or munitions, class A, regardless of the quantity, will be accompanied by technical escort.

b. Nerve agents and potential chemical agents under development except for separate shipments of one toxic gas identification set (packed as prescribed in paragraph 173.331, DOT regulations in Agent T.C. George's Tariff No. 19) or one laboratory sample (packed in approved container) not exceeding one liter in volume per shipment. When experimental items are to be shipped, the requesting activity will prepare a brief to the escort personnel on any special precautions or procedures, to include provision for any special protection and/or decontamination equipment and/or material that may be required.

c. In cases where an escort is not mandatory by regulation, the commanding officer of the shipping installation may request an escort if he determines such escort would be in the best interest of the Army.

d. Responsibilities of an escort team in connection with escort service generally are as follows:

(1) To guard the shipment throughout the period of transit, with special emphasis on the security and safety of the shipment.

(2) To protect all personnel, both military and civilian, who handle or come in proximity to the shipment.

(3) To effectively repair or expeditiously and safely dispose of leaking munitions or containers during shipment.

(4) To thoroughly and completely decontaminate all objects and/or areas that may be contaminated as a result of a leaking munition or container during shipment.

(5) To assure that the cargo arrives at the proper destination, at the proper time (within the escort team's control), and in the best possible condition.

(6) To inspect the shipment along with the responsible transportation officer or representative prior to movement to detect any potentially unsafe, dangerous, or otherwise unsuitable condition.

168. Request For Technical Escort

The activity originating the shipment is responsible for requesting technical escorts in accordance with the provisions of AR 5-16, AR 55-56, and AR 740-32. When required, a technical escort will be requested, in writing, from the Commanding Officer, U.S. Army Technical Escort Unit, Edgewood Arsenal, Maryland 21010. Requests for CONUS shipments should be received

not later than 7 days prior to the desired shipping date, and requests for oversea shipments not less than 60 days prior to the desired shipping date. The following information must be included in the request:

a. Items and quantities to be shipped, to include-

(1) Agent, if applicable.
(2) Shipping dimensions (length, width, and height).
(3) Weight (gross and net).
(4) Type of container.
(5) Security classification of shipment.

b. Pickup point and destination of shipment.

c. Names, titles, and telephone numbers of individuals to be contacted at the pickup point and the destination.

d. Date shipment will be ready by consignor.

e. Date shipment is desired by consignee.

f. Special requirements placed upon the shipment by the consignee.

g. Fund citation and authority to obligate funds in an amount sufficient for travel and other expenses incident to the services requested.

169. Selection of Mode of Transportation

Generally, the mode of transportation of a shipment of chemical munitions and/or agents is specified by the agency making the request for technical escort services, subject to agreement by the commanding officer of the escorting organization and the installation transportation officer. The following factors should be considered in selecting the mode of transportation:

a. Objective or mission.
b. Quantity to be shipped.
c. Time element.
d. Availability of containers.
e. Directives and regulations restricting certain modes of transportation.

Section II. DEPARTMENT OF TRANSPORTATION (DOT) REGULATIONS

170. General

DOT regulations (Agent T.C. George's Tariff No. 19) define the hazard classifications of chemical agents and chemicals for shipment purposes. These regulations prescribe the types of containers that are acceptable and the specifications for these containers. They also prescribe the types of markings and warning labels that must be used on railroad cars and motor vehicles, as well as certain other safety practices for shipments within the limits of the jurisdiction of the United States. Paragraphs 171 through 179 describe those shipping regulations that are applicable to chemical agents and hazardous chemicals. The transportation officer should be contacted for current information on DOT regulations.

171. Hazard Classification of Poisons

In DOT regulations, poisons are divided into four classes according to the degree of hazard in transportation; chemical agents and other chemicals are contained within the first three divisions:

a. Class A, Extremely Dangerous Poisons. This class includes toxic gases and liquids of such a nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. New compounds are also treated as class A poisons until they are evaluated and their classifications are established.

b. *Class B, Less Hazardous Poisons*. This class includes toxic liquids, semisolids, and solids of such a nature that they are mainly dangerous upon external contact with the body or when taken internally. The vapors of certain chemicals of this class also are offensive or dangerous, but to a much lower extent than are vapors of class A poisons.

c. *Class C, Tear Gases or Irritating Substances*. This class includes liquids and solid substances (exclusive of class A or class B poisons) which, upon contact with fire or when exposed to air, give off dangerous or intensely irritating fumes.

d. *Class D, Radioactive Materials*. This class includes any material or class of material that spontaneously emits ionizing radiation.

172. Explosive Classification of Chemical Ammunition

DOT regulations categorize chemical ammunition into explosive classes according to the degree of hazard in transportation, as follows:

a. Chemical Ammunition, Class "A" Explosives. High Explosives. Any munition having a primary filler of a toxic, riot control, smoke, or incendiary agent, with a high explosive bursting charge (with or without fuzes).

b. Chemical Ammunition, Class "B" Explosives. Low Explosives. Any munition having a

primary filler of a toxic, riot control, smoke, or incendiary agent, with a low explosive, propellant, or expelling charge (with or without ignition devices).

c. Chemical Ammunition, Class "C" Explosives. Relatively Safe Explosives. Any munition having a burning mixture of agents, without an explosive bursting charge (with or without ignition devices).

d. Chemical Ammunition. Less Explosive Components. The items are not classed as explosive hazards and are categorized according to the class of poison that they contain.

173. Hazard Classification of Other Dangerous Chemicals

DOT regulations in Agent T.C. George's Tariff No. 19 define dangerous chemicals as follows:

a. Flammable Solids. A flammable solid is any solid material, other than one classified as an explosive, which, under conditions incident to transportation, is liable to cause fires through friction, absorption of moisture, spontaneous chemical changes, retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation hazard. Examples are certain metallic hydrides, metallic sodium and potassium, and certain oily fabrics, processed meals, and nitrocellulose products. (DOT regulations, Agent T.C. George's Tariff No. 19, paragraph 178.150a.)

b. Oxidizing Materials. An oxidizing material is a substance such as chlorate, permanganate, peroxide, nitrocarbonitrate, or a nitrate that yields oxygen readily to stimulate the combustion of organic matter. (DOT regulations, Agent T.C. George's Tariff No. 19, paragraph 178.151a.)

c. Acids and Other Corrosive Liquids. Corrosive liquids are those acids, alkaline caustic liquids, and other corrosive liquids which, when in contact with living tissue, will cause severe damage of such tissue by chemical action; or in case of leakage, will materially damage or destroy other freight by chemical action; or are liable to cause fire when in contact with organic matter or with certain chemicals. (DOT regulations, Agent T.C. George's Tariff No. 19, paragraph 173.240a.)

d. Compressed Gases. The term "compressed gas" includes any material or mixture having in the container an absolute pressure exceeding 40 psi at 70° F. or, regardless of the pressure at 70° F., having an absolute pressure exceeding 104 psi at 130° F.; or any liquid flammable material having a vapor pressure exceeding 40 psi absolute at 100° F., as determined by the Reid Method of Test for Vapor Pressure of Petroleum Products, the American Society for Testing Materials. (DOT regulations, CFR 49 as published by Agent T.C. George's Tariff No. 19, paragraph 173.300a.)

e. Flammable Liquids. A flammable liquid is any liquid which gives off flammable vapors (as determined by flash point from Tagliabue's open cup tester as used for tests of burning oils) at or below a temperature of 89° F.

174. Types of Containers

Containers used for transportation of chemical agents and hazardous chemicals must conform to or exceed all strength requirements of DOT regulations as specified in Agent T.C. George's Tariff No. 19.

175. Marking and Labeling Containers

This paragraph pertains to containers filled with class A, class B, or class C poisons; and to chemical ammunition containing class A, class B, or class C explosives which also contain toxic chemical agents, vapors, solids, or liquids to be transported by, for, or to the Departments of the Army, the Navy, and the Air Force. Carload or truckload shipments (only) are exempt from DOT labeling requirements when they are loaded and unloaded by the shipper or his duly authorized agent and are accompanied by qualified personnel supplied with equipment to repair leaks or other container failure that would permit escape of contents. When such shipments are not loaded and unloaded by the shipper or his duly authorized agent, each container filled with a chemical agent or a dangerous chemical for shipment must be marked with its proper shipping name, as shown in the commodity list of DOT regulations (Agent T.C. George's Tariff No. 19, section 172.5), and DOT specification container number, if such is prescribed in "Exemptions and Packing" column in section 172.5. Reference should be made to the provisions of MIL-STD-129, "Marking for Shipment and Storage." If chemical agents are sent through the United States mail, reference should be made to 39 CFR, Code of Federal Regulation (Postal Service), for proper markings. In addition, every package or container of class A, B, or C toxic agents and other dangerous chemicals must be conspicuously labeled by the shipper

according to the DOT definitions of degrees of hazard described in a through n below.

a. Class A, Extremely Dangerous Poison. Each outside package must have DA Label 69 (Warning-Beware of Fumes-Poison Gas) (fig. 37) attached. For air shipments, each outside package must have DA Label 67 (Poison Gas Label Poison) (fig. 38) and DD Form 1387-2 (Special Handling Data/Certification) (fig. 89) attached.

b. Class B, Less Dangerous Poison.

(1) Each outside package must have DA Label 71 (Warning-Poison-Do Not Drop) (fig. 40) attached.

(2) For shipment by air, each outside package must have DA Label 67 (Poison Gas Label Poison) (fig. 38) attached. Additionally, each outside package must have DD Form 1387-2 (Special Handling Data/Certification) (fig. 39) attached.

c. Class C, Tear Gas or Irritating Substance.

(1) Each outside package must have DA Label 25 (Caution-Tear Gas or Tear Gas Producing Materials) (fig. 41) attached.

(2) For shipment by air, each outside package must have DA Label 67 (Poison Gas Label Poison) (fig. 38) attached.

Also, each outside package must have DD Form 1887-2 (Special Handling Data/Certification) (fig. 89) attached.

d. Chemical Ammunition, Class A Poison Containing an Explosive. Outside packages must be marked in accordance with the contents. For example, the M55 rocket contains a class A poison and an explosive when shipped. Thus, the M55 rocket would be marked "ROCKET AMMUNITION WITH GAS PROJECTILE," and labeled "POISON GAS." DOT marking must be in letters not less than seven-sixteenths inch in height.

e. Chemical Ammunition, Class B Poison with Explosive Component.

(1) Each outside package must be marked in accordance with the contents. For example, special fireworks (manufactured articles designed primarily to produce visible or audible pyrotechnic effects by combustion or explosion) must be marked "SPECIAL FIREWORKS HANDLE CAREFULLY-KEEP FIRE AWAY," in letters not less than seven-sixteenths inch in height. (Except for freight or motor shipments, each package must have DA Label 88 (Special Fireworks-Handle Carefully-Keep Fire Away) (fig. 42) conspicuously attached.)

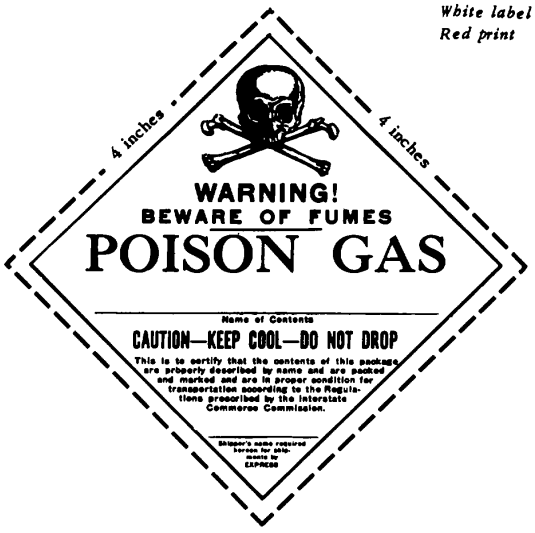


Figure 37. DA Label 69 (Warning-Beware of Fumes-Poison Gas (Surface Transportation)).

White label
Red print

Figure 38. DA Label 67 (Poison Gas Label-Poison (Air Shipment)).

White form

Red print

SPECIAL HANDLING DATA/CERTIFICATION

TRANSPORTATION CONTROL NUMBER	NOMENCLATURE OF ITEM	NET EXPLOSIVE WEIGHT	GROSS WEIGHT
DESTINATION			

HANDLING INSTRUCTIONS

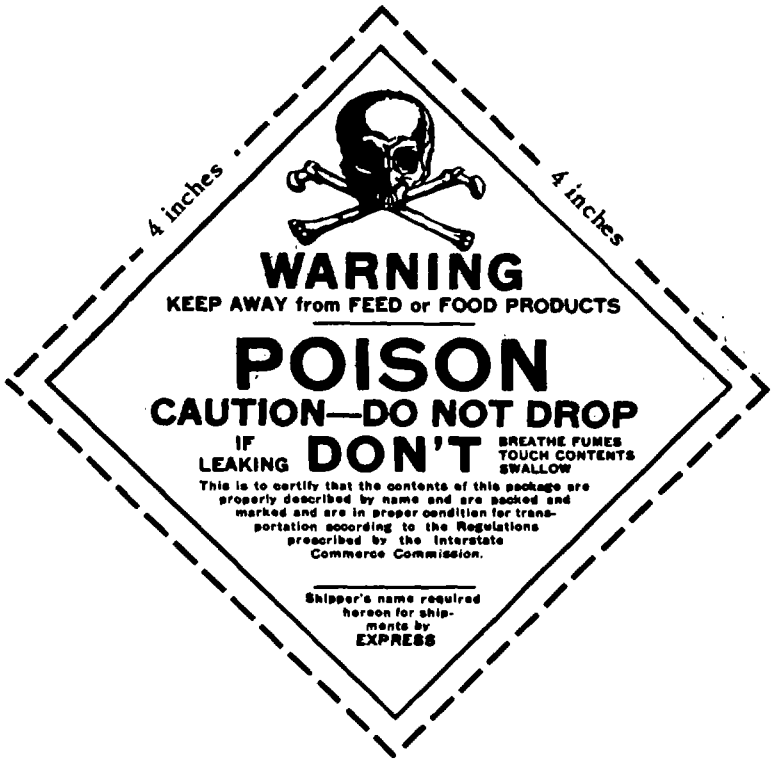
SHIPPER CERTIFICATION: This is to CERTIFY that the contents of the packages in this shipment are properly described by name and are packed, marked, and in proper condition for transportation in accordance with:

- ☐ SUBPARAGRAPH_____, AFM 71-4, TM 38-250, NAVWEPS 16-35-506 AND MCO P4030.19
- ☐ OFFICIAL AIR TRANSPORT RESTRICTED ARTICLES TARIFF 6, CAB NO. 82
- ☐ OTHER (Specify)
- ☐ SHIPMENT WITHIN PASSENGER/CARGO AIRCRAFT LIMITATIONS

SIGNATURE	DATE

DD FORM 1387-2, 1 APR 66 REPLACES EDITION OF 1 APR 63, WHICH MAY BE USED.

Figure 39. DD Form 1387-2 (Special Handling Data /Certification).



White label
Red print

Figure 40. DA Label 71 (Warning-Poison-Do Not Drop (Surface Transportation)).

White label
Red print

Figure 41. DA Label 25 (Caution-Tear Gas or Tear Gas Producing Materials).

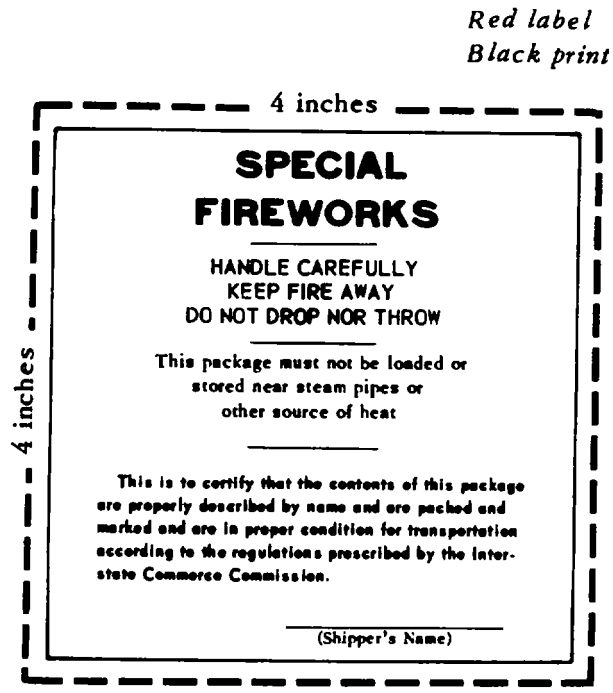


Figure 42. DA Label 88 (Special Fireworks-Handle Carefully-Keep Fire Away).

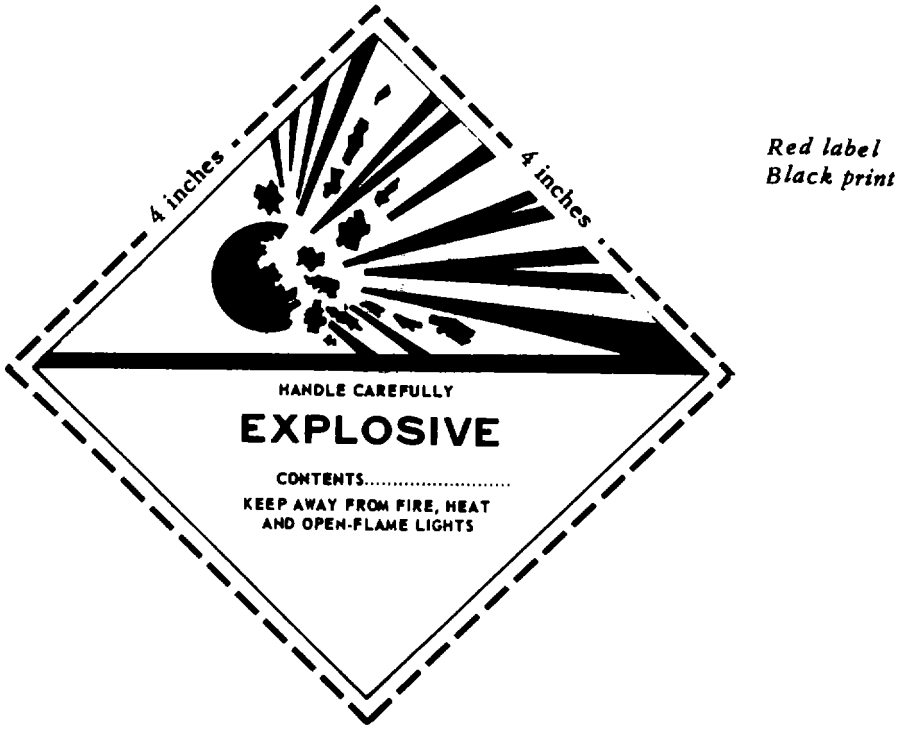
(2) For shipment by air, each outside package must have DA Label 68 (Red Label for Special Fireworks-Explosive) (fig. 43) attached. Also, each outside package must have DD Form 1387-2 (Special Handling Data/Certification) (fig. 39) attached.

f. Chemical Ammunition, Class C Poison with Explosive Component. Each outside package must be marked in accordance with the contents. For example, common fireworks (manufactured articles designed primarily to produce visible effects by combustion) must be marked "COMMON FIRE WORKS-HANDLE CAREFULLY-KEEP FIRE AWAY," in letters not less than seven-sixteenths inch in height.

g. Flammable Liquids.

(1) Each outside package must have DA Label 47 (Caution-Leaking Packages Must Be Removed to a Safe Place) (fig. 44) attached. Flammable liquids shipped in metal drums or barrels, in addition to DA Label 47, must have DA Label 48 (Caution-Unscrew This Bung Slowly) (fig. 45) attached.

(2) For shipment by air, each outside package must have DA Label 56 (Flammable



Red label
Black print

Figure 43. DA Label 68 (Red Label for Special Fireworks-Explosive (Air Shipment)).

Figure 44. DA Label 47 (Caution--Leaking Packages Must Be Removed to a Safe Place).

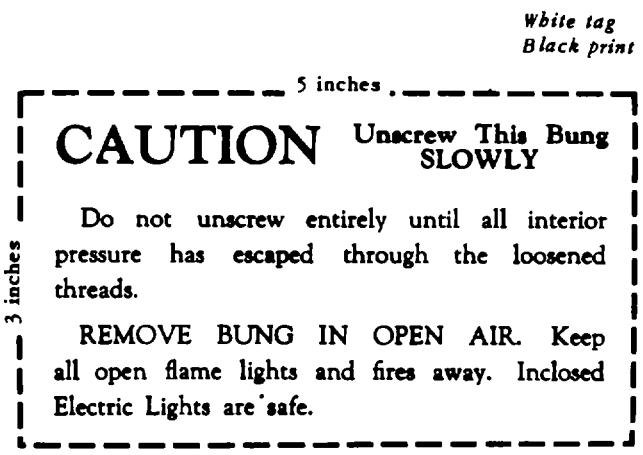


Figure 45. DA Label 48 (Caution-Unscrew This Bung Slowly).

Liquids-Flammable) (fig. 46) attached. Also, each outside package must have DD Form 1387-2 (Special Handling Data/Certification) (fig. 39) attached.

h. Flammable Solids and Oxidizing Materials.

(1) Each outside package must have DA Label 57 (Flammable Solids and Oxidizing Materials-Caution-Do Not Drop) (fig. 47) attached.

(2) For shipment by air, each outside package must have DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable) (fig. 48) attached. Also, each outside package must have DD From 1387-2 (Special Handling Data/Certification) (fig. 39) attached.

i. Acids, Corrosive Liquids, and Alkaline Caustic Liquids.

(1) Each outside package must have DA Label 13 (Caution-Acid-Do Not Drop) (fig. 49) or DA Label 63 (Caution-Corrosive Liquid-Do Not Drop) (fig. 50) or DA Label 64 (Caution-Alkaline Caustic Liquids) (fig. 51) attached.

(2) For shipment by air, each outside package must have DA Label 62 (White Label for Corrosive Liquid) (fig. 52) attached.

j. Compressed Gases.

(1) Each container must have DA Label 31 (Caution-Flammable-Compressed Gas (Red)) (fig. 53) or DA Label 65 (Keep Cool-Caution -Nonflammable-Compressed Gas) (fig. 54) attached.

(2) For shipment by air, each container must have DA Label 56 (Flammable Liquids Flammable) (fig. 46) or DA Label 66 (Nonflammable Compressed Gas) (fig. 55) attached.

Red label
Black print

Figure 46. DA Label 56 (Flammable Liquids-Flammable (Air Shipment)).

Yellow label
Black print

Figure 47. DA Label 57 (Flammable Solids and Oxidizing Mate-Caution-Do Not Drop, (Surface Transportation)).

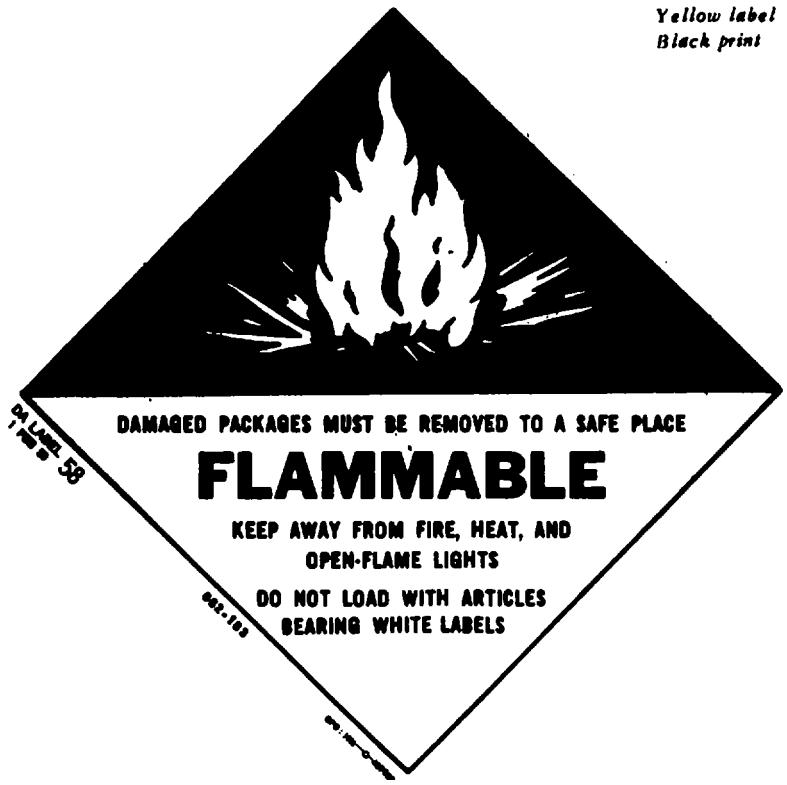


Figure 48. DA Label 58 (Flammable Solids and Oxidizing Materials-Flammable (Air Shipment)).

Figure 49. DA Label 13 (Caution-Acid-Do Not Drop).

White label
Black print

Figure 50. DA Label 63 (Caution-Corrosive Liquid-Do Not Drop (Surface Transportation)).

White label
Black print

Figure 51. DA Label 64 (Caution-Alkaline Caustic Liquids (Surface Transportation)).

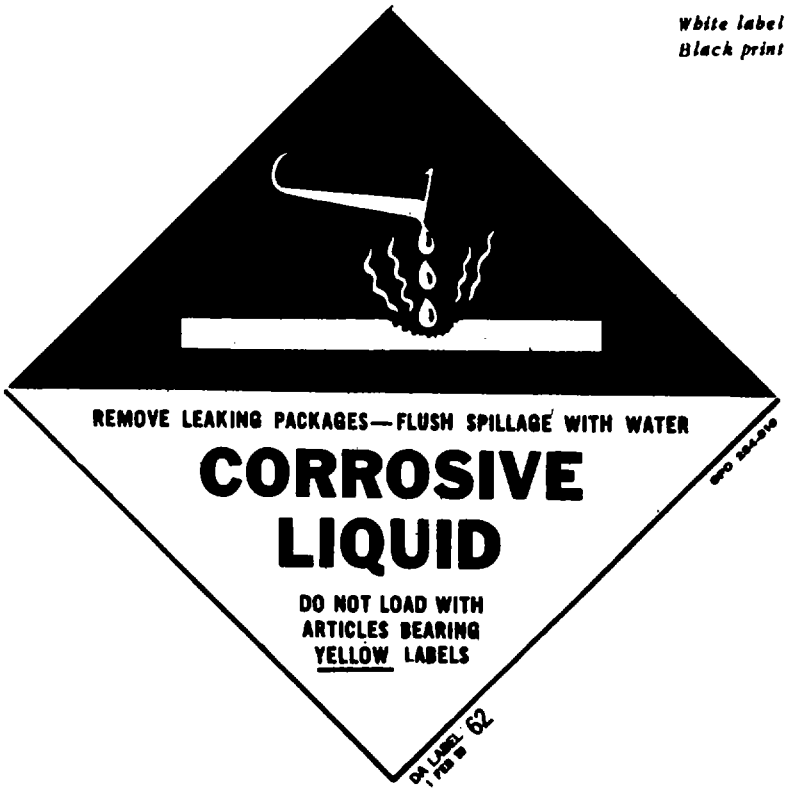


Figure 52. DA Label 62 (White Label for Corrosive Liquid (Air Shipment)).

Also, each outside package must have DD Form 1387-2 (Special Handling Data/Certification) (fig. 89) attached.

k. Empty Containers. DA Label 78 (Empty) (fig. 56) must be applied to each container that has been emptied and from which the old label has not been removed, obliterated, or destroyed. It must be so placed on the container as to completely cover the old label.

l. Labels for Mixed Packing.

(1) Use red label only when red and other labels are prescribed, except when the "POISON GAS" label is prescribed; then both the red and the "POISON GAS" labels must be applied.

(2) Use white "ACID" (alkaline caustic liquid or corrosive liquid) label only when white "ACID" (alkaline caustic liquid or corrosive liquid) and yellow or "POISON" labels are prescribed, except when the "POISON GAS" label is prescribed; then both the white "ACID" label and the "POISON GAS" label must be used.

(3) Use yellow label only when yellow and "POISON" labels are prescribed, except when the "POISON GAS" label is prescribed; then both the yellow label and the "POISON GAS" label must be used.

m. Placarding Freight Cars. See paragraph 181.

n. Marking Motor Vehicles. See paragraph 187.

Red label
Black print

Figure 53. DA Label 31 (Caution-Flammable-Compressed Gas (Red)).

Green label
Black print

Figure 54. DA Label 65 (Keep Cool-Caution-Nonflammable-Compressed Gas (Surface Transportation)).

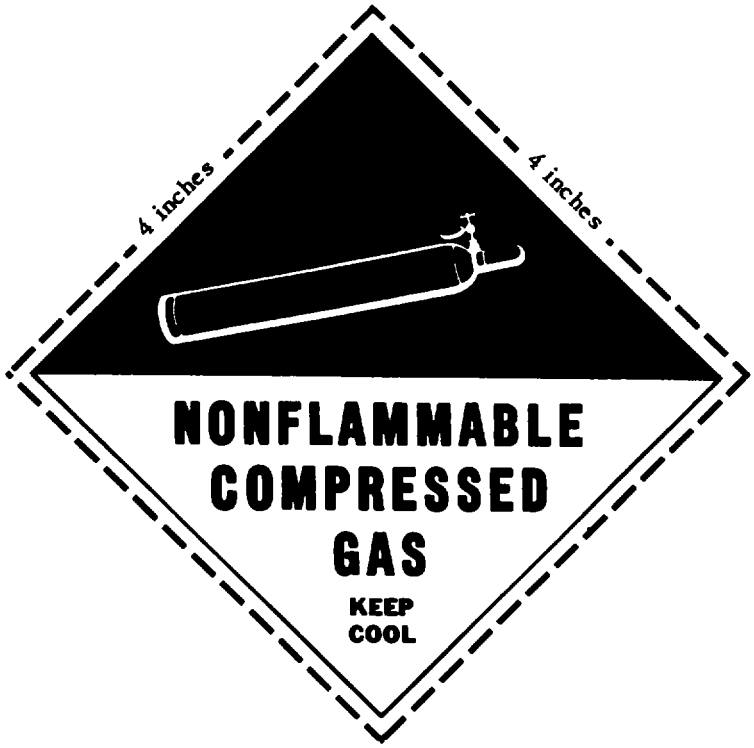


Figure 55. DA Label 66 (Nonflammable Compressed Gas (Air Shipment)).

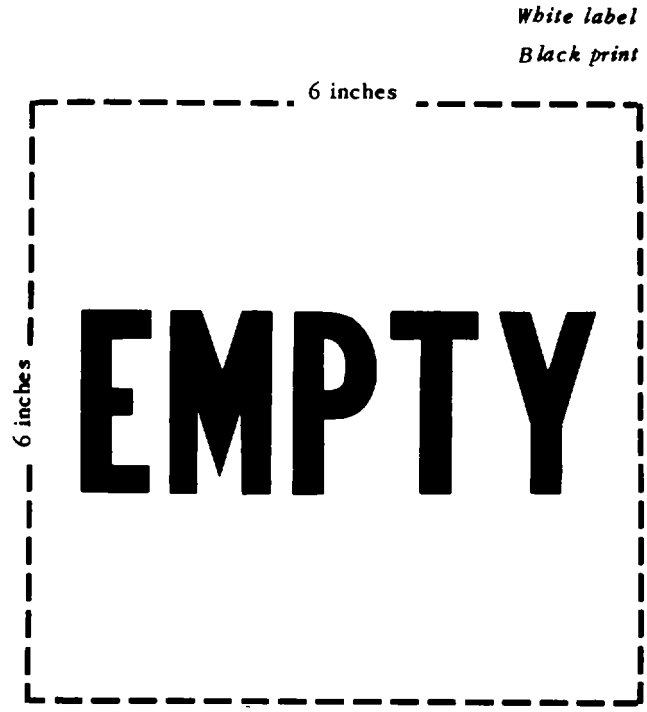


Figure 56. DA Label 73 (Empty).

Section III. RAIL SHIPMENTS

176. General

This section describes procedures and DOT regulations that are applicable to shipments of chemical agents and hazardous chemicals by rail. Such shipments in the continental United States usually are made in separate, certified, closed, and sealed freight cars containing only compatible materiel. A carload shipment of class A poisons must be escorted and guarded by a safety detail, as required by AR 74082, and only authorized personnel may be permitted to handle it. Such shipments are prepared by the shipper in accordance with applicable DOT regulations (paras 170 through 175); cars are placarded in accordance with DOT regulations outlined in paragraph 181.

177. Less-Than-Carload Shipment

When less than a carload of containers of chemical agents and hazardous chemicals is shipped by rail, particular attention should be paid to DOT regulations applicable to marking and labeling containers. Metal drums, tanks, or bombs containing class A poisons cannot be shipped in less-than-carload lots.

178. Inspection of Containers

Containers filled with chemical agents and hazardous chemicals must be inspected for leaks and indications of possible development of excessive internal pressure prior to shipment. If it appears possible that a container can develop excessive internal pressure because of increase in atmospheric temperature during shipment, the container should be vented. The date of the last surveillance should be marked on each container. 1

179. Inspection, Loading, and Bracing of Railroad Cars

The capacity of United States military freight cars varies from 20 to 40 tons; the capacity of United States common carrier freight cars varies from 30 to 50 tons. The capacity of flat cars varies from 40 to 70 tons. For shipment of chemical agents and hazardous chemicals in the continental United States, a joint inspection of each car used or to be used to transport E&ODA must be conducted by a representative of the Transportation Office and a railroad, or a Bureau of Explosives inspector, before the car is released to the carrier.

a. Inspection. Each freight car must be thoroughly inspected prior to loading to locate and correct deficiencies such as protruding nails and bolts in the floor or defective brakes, couplings, or wheel flanges.

b. Loading. Compatibility of items is an important consideration in loading. Shipments must be loaded in accordance with the Loading and Storage Chart in paragraph 174.538 of DOT regulations. This chart refers particularly to E&ODA. See table 4, which is based on this chart.

c. Bracing. Freight cars must be loaded so as to prevent containers from shifting during transit. Containers should be braced with wood so that there is no possibility of one container crushing another. All bracing should be securely nailed in place, but not to the floor of the car.

Table 4. Shipment Chart-Chemical Ammunition and Other Dangerous Materials

Directions: Numbers 1 through 8 in the horizontal columns refer to copy blocks 1 through 8 in the vertical columns. The letter x at an intersection of a vertical and horizontal column denotes that the items in the intersecting columns are not compatible for shipment and must not be loaded together. For example: Acids or corrosive liquids (6) may not be loaded with items 1, 2, 5, or 8.

	1	2	3	4	5	6	7	8
1. Incendiary ammunition: ammunition containing an incendiary charge; WP-loaded ammunition, with or without an explosive charge; and common fireworks.	---	x	---	x	x	x	x	x
2. Complete rounds of shell, rockets, grenades, mines, and so on, having a filler other than incendiary; with or without an explosive charge.	x	---	---	x	x	x	x	x
3. Detonating cord, ignition fuzes, safety fuze, fuze lighters, electric squibs, safety squibs, and nondetonating primers.	---	---	---	---	---	---	---	---
4. Flammable liquids or compressed flammable gases; red label (DA Labels 47 and 31).	x	x	---	---	---	---	---	x
5. Flammable solids or oxidizing materials; yellow label (DA Label 57).	x	x	---	---	---	x	---	x
6. Acids or corrosive liquids; white label (DA Labels 13, 63, and 64).	x	x	---	---	x	---	---	x

(See notes on following page.)

Table 4. Shipment Chart-Chemical Ammunition and Other Dangerous Material--Continued

	1	2	3	4	5	6	7	8
7. Compressed nonflammable gases; green label (DA Label 65).	x	x	---	---	---	---	---	---
8. Poisonous gases or liquids in cylinders, projectiles, or bombs; poison gas label (DA Label 69 or DA Label 71).	x	x	---	x	x	x	---	---

Notes:

1. Cyanides or cyanide mixtures must not be shipped in the same car with acids or corrosive liquids.
2. Smoke pots, smoke candles, and colored grenades are classed as common fireworks.
3. Gas identification sets may be loaded and transported with all articles named above

180. Inspection, Unloading, and Handling of Railroad Cars

All railway cars loaded with chemical agents and hazardous chemicals should receive a complete exterior inspection immediately upon entering a military installation, especially if they have not been under continuous military escort. This inspection should include an examination of the outside and the underside of each car and the checking of individual car numbers and seal numbers against the bill of lading. If sabotage is suspected, the car should be removed to a safe location and inspected. If, upon inspection, dangerous conditions are found, cars should be isolated and rendered safe. An immediate report should then be made by the most expeditious means through command channels to the Commanding Officer, Edgewood Arsenal, Maryland 21010, as well as to other commanders concerned.

a. Unloading. Immediately after the shipment has been unloaded, the installation transportation officer should have each car carefully swept and all placards removed. Sweepings should be placed in metal receptacles for later disposal or should be immediately burned.

b. Inspection and Decontamination. Cars walls and floors should be tested for contamination by the receiving activity and decontaminated if necessary. Before a decontaminated railway car or vehicle is released to the carrier, the installation transportation officer will prepare a statement of certification as to inspection and decontamination of the rail car. Copies of the certification statement will be furnished the escort team leader; the Commanding Officer, Edgewood Arsenal, Maryland 21010; and the carrier.

181. Placarding Railroad Cars

All freight cars loaded with chemical agents or dangerous chemicals for shipment in the continental United States must be placarded in accordance with DOT regulations. Placards must be securely applied, one on each end and one on each side of all loaded freight cars. The placards must be of standard size and color as described in a through e below.

a. Dangerous. The reverse of DA Label 53 is worded "DANGEROUS," as shown in figure 57, and must be fastened to freight cars loaded with one or more containers bearing red, yellow, or white "ACID" (or alkaline caustic liquid or corrosive liquid) labels or white "POISON" (class B) labels and on cars containing explosives, class B.

b. Poison Gas. DA Label 86 (Caution-This Car Contains Poison Gas-Beware of Fumes from Leaking Packages) (fig. 58) is fastened to cars loaded with one or more containers that bear or would bear DA Label 69 (Warning-Beware of Fumes-Poison Gas) (fig. 37). DA Label 86 is also fastened to cars containing ammunition for cannons with toxic agent projectiles or projectiles, bombs, or other containers loaded with toxic agent requiring the "POISON GAS" labels.

c. Explosives. DA Label 11 (Explosives, Handle Carefully-Keep Fire Away) (fig. 59) is fastened to cars loaded with class A explosives, such as chemical bombs shipped assembled with their ignition elements, bursting charges, detonating fuzes, or explosive elements. DA Label 86 (Caution-This Car Contains Poison Gas-Beware of Fumes from Leaking Packages) (fig. 58), in addition to DA Label 11 (Explosives, Handle Carefully-Keep Fire Away), is used when the car is loaded with both explosives and poison, class A.

d. Dangerous-Empty. DA Label 58 (Dangerous-Empty) (fig. 60) is fastened to tank cars that have been emptied and are not completely decontaminated or cleaned of corrosives or flammables. For cars other than tank cars, placards and car certificates must be removed by the party unloading the car.

e. Placards Not Required. Placards are not required for cars loaded with containers that bear

White card
Red and black print

Figure 57. Reverse of DA Label 53.

White card
Red print

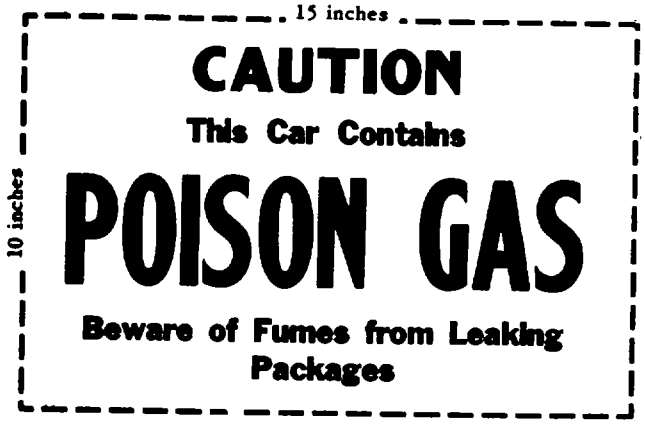


Figure 58. DA Label 86 (Caution-This Car Contains Poison Gas- Beware of Fumes from Leaking Packages)

or would bear only DA Label 65 (Keep Cool-Caution-Nonflammable-Compressed Gas) o DA Label 25 (Caution-Tear Gas or Tear Gas Producing Materials) (Class C tear gases o (irritating substances).

182. Special Precautions

When freight cars are loaded with chemical agents under military supervision, the following special precautions should be observed:

a. Freight car brakes should be set.

b. The sides of the freight car being loaded should be boarded up, when necessary, to obtain an even bearing and proper dunnage arrangement.

c. Protruding nails or bolts in the floor or lining of the freight car should be drawn or repaired.

d. The interior of the freight car should be carefully swept out so that all loose pieces of metal will be removed.

e. Containers must be loaded, blocked, and braced in accordance with Bureau of Explosives regulations, so as to maintain their relative positions during transit.

f. Freight cars loaded with class A poisons should be coupled carefully to avoid excessive shock.

g. Freight cars should not be cut off and allowed to strike the freight cars loaded with class A poisons.

h. Freight cars loaded with class A poisons should never be placed next to cars placarded "EXPLOSIVES" or "DANGEROUS."

Figure 59. DA Label 11 (Explosives-Handle Carefully-Keep Fire Away).

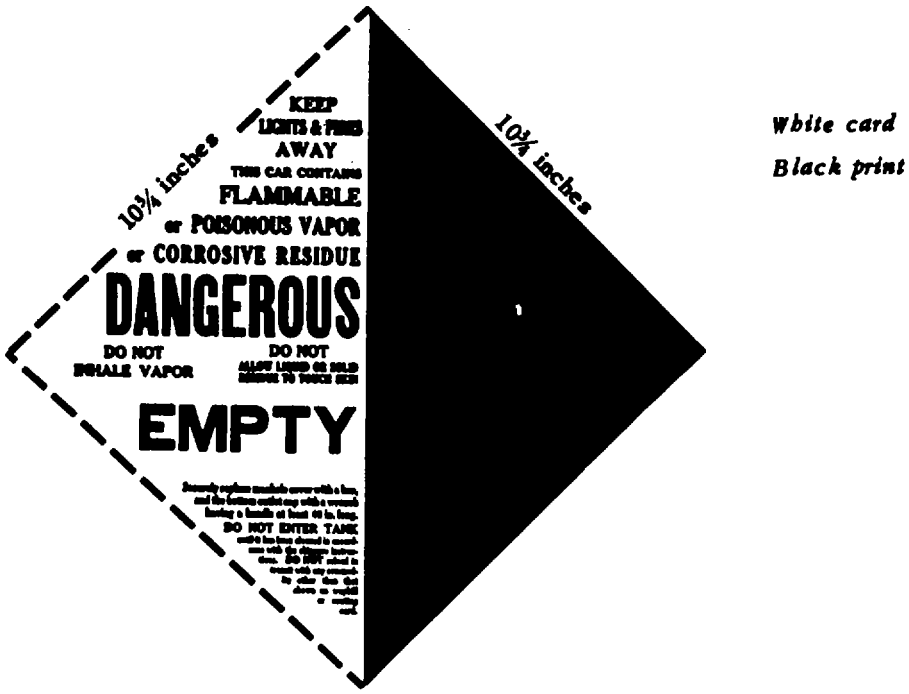


Figure 60. DA Label 53 (Dangerous-Empty).

Section IV. HIGHWAY SHIPMENTS

183. General

This section describes procedures and those DOT regulations that are applicable to shipments of chemical agents and hazardous chemicals over public highways. Such shipments in the continental United States are also subject to local state and municipal laws and ordinances. A shipment

of class A poisons must be escorted and guarded by a safety detail in accordance with AR 740-2, and none other than authorized personnel may be permitted to handle it. When such shipments are made by military convoy, DOT regulations also prevail, particularly those pertaining to markings on motor vehicles.

184. Inspection of Containers

Prior to shipment, containers must be inspected as described in paragraph 178.

185. Inspection, Loading, and Bracing of Motor Vehicles

Each vehicle must be thoroughly inspected prior to loading in order to locate and correct such deficiencies as protruding nails or bolts, or other projections that might damage the shipment.

a. Technical Inspection. Each vehicle must have a physical inspection to show that the vehicle is in first-class operating condition and that a fire hazard (such as oil-soaked electrical wiring) does not exist. The vehicle must have either a closed body or one that is covered with a fireresistant tarpaulin. It must have necessary accessories for use in emergencies, such as red lanterns, red reflectors, red cloths, and fire extinguishers. The above inspection will be completed before the journey commences and will comply with the provisions of DD Form 626, "Motor Vehicle Inspection (Transporting Hazardous Material) ."

b. Loading. Shipments must be loaded in accordance with the DOT loading and storage chart (para 177.848, DOT regulations as condensed in table 4 of this manual) that shows compatibility of items.

c. Bracing. Containers must be so braced in the vehicle as to prevent shifting during transit (para 179c). Containers having valves or fittings must be so loaded as to prevent damage to valves or fittings during transit.

186. Inspection, Unloading, and Decontamination of Motor Vehicles

a. Inspection. All motor vehicles loaded with chemical agents and hazardous chemicals should receive a complete inspection immediately upon entering a military installation.

b. Unloading and Decontamination. After unloading, each motor vehicle will be carefully swept and all placards removed. Walls and floors should be tested for contamination by the receiving authority and decontaminated if necessary. Before a decontaminated vehicle is released to the carrier, the installation transportation officer will prepare a certificate of inspection and decontamination. Copies will be furnished the escort team commander; the Commanding Officer, Edgewood Arsenal, Maryland 21010; and the carrier.

187. Marking and Placarding Motor Vehicles

a. All motor vehicles, other than tank motor vehicles, transporting any quantity of class A poison or class A or class B explosives will be placarded as follows:

(1) Class A explosives (any quantity or a combination of class A and class B explosives). "EXPLOSIVES A" (red letters on a white background).

(2) Class B explosives (any quantity). "EXPLOSIVES B" (red letters on a white background).

(3) Class A poison (any quantity). "POISON" (blue letters on a white background).

b. All motor vehicles transporting more than 1,000 pounds of the following hazardous materials will be placarded as follows:

(1) Class B poison. "POISON" (blue letters on a white background).

(2) Flammable liquid or solid. "FLAMMABLE" (red letters on a white background).

(3) Oxidizing material. "OXIDIZERS" (yellow letters on a black background).

(4) Corrosive liquid. "CORROSIVES" (blue letters on a white background).

(5) Flammable compressed gas. "FLAMMABLE GAS" (red letters on a white background).

(6) Nonflammable compressed gas. "COMPRESSED GAS" (green letters on a white background).

c. When chemical ammunition containing any quantity of a class A poison and class A explosive is transported, both "POISON" and "EXPLOSIVES A" placards will be displayed. When ammunition containing any quantity of a class A poison and class B explosive is transported, both the "POISON" and "EXPLOSIVES B" placards will be displayed.

d. In the event that only one motor vehicle is used to transport more than one type of hazardous material other than class A or class B explosives or class A poison, then the "DANGEROUS" placard will be displayed. This placard has red letters on a white background. Federal and military regulations prohibit transporting mixed loads of dangerous articles except items specifically

authorized by these regulations. Requirements to transport mixed loads not specifically authorized by regulations must be forwarded through military channels to the Department of Transportation for approval.

e. Whenever placards are required, they will be displayed on the front and rear and on the right and left sides of the vehicle. In the event that a trailer is attached to the vehicle, the trailer will also be placarded on the right and left sides and on the rear. Explosives "A" and "B" placards must have letters a minimum of 6 inches in height with a 5/8-inch stroke. All other placards will have letters not less than 4 inches high with a 5/8-inch stroke. A minimum border of 1 inch will be allowed on all placards. All placards will be reflectorized. Placards will be placed on the vehicle immediately prior to loading any type of hazardous material and will not be removed until the entire hazard has been eliminated. Placards will be contained in an area on the vehicle that has no other marking, lettering, or graphic display for at least 3 inches in each direction.

188. Tank Motor Vehicles

Every tank motor vehicle used for the transportation of a class B poison, flammable liquid, corrosive liquid, or any compressed gas, regardless of the quantity being transported (or even if not loaded), must be conspicuously and legibly marked on each side and on the rear as described in paragraph 187 except as provided below. Class A poison will not be loaded or transported in tank motor vehicles.

a. Gasoline. "GAS" or "FLAMMABLE" in the same size and color as required for the "FLAMMABLE LIQUID" described in paragraph 187.

b. Flammable Compressed Gas. "FLAMMABLE GAS" or "FLAMMABLE COMPRESSED GAS" in letters at least 6 inches high; and, in addition, in letters at least 2 inches high with the common name of the containers.

c. Nonflammable Compressed Gas. "COMPRESSED GAS" in letters not less than 6 inches high, and with the common name of the containers in letters at least 2 inches high.

189. Information To Be Given Each Driver of A Motor Vehicle

Each driver of a motor vehicle transporting chemical agents or dangerous chemicals must be given full and complete information concerning the shipment that will assist him in safely delivering his cargo to its destination. When the truck has been loaded and is ready for movement, the driver will be informed verbally and in writing (DD Form 836, Special Instructions for Drivers) of pertinent information about the cargo, and necessary safety precautions. Every motor vehicle driver must have in his possession a valid operator's license for the type of vehicle being driven, together with a Doctor's Certificate of Physical Examination dated within the preceding 36 months.

Section V. WATER SHIPMENTS

190. General

This section describes the procedures and Federal regulations that are applicable to water shipments of chemical agents and dangerous chemicals, Such shipments in common carriers under the jurisdiction of the United States are subject to regulations of the U.S. Coast Guard and those of local ports and harbors. DOT regulations pertaining to labeling (para 175) generally apply.

191. Hazard Classification of Chemical Agents and Dangerous Chemicals

Dangerous chemicals to be transported by ship are classified according to their principal characteristics and properties, in the manner of DOT classifications (para 172 and 173).

192. Inspection of Containers

Prior to shipment, containers must be inspected as described in paragraph 178 and Coast Guard regulations.

193. Inspection, Loading, and Stowing on Board Vessels

United States Coast Guard personnel normally supervise the loading and stowing of dangerous cargo aboard vessels in ports under the jurisdiction of the United States. In all cases where chemical ammunition, class A poisons, and other hazardous chemicals are to be shipped by water, and there are no United States Coast Guard supervisory personnel in attendance, an officer, an enlisted man, or a civilian thoroughly

qualified to advise in the handling of such materials and the means of protection against them must be present to give technical advice.

a. Request for Technical Assistance. Request for technical advisors may be made by the appropriate port commander to the Commanding Officer, Edgewood Arsenal, Maryland 21010. Technical advisors will be attached to the port commander for liaison and assistance if deemed necessary.

b. Inspection. The vessel should be inspected to determine its suitability for transporting chemical agents or dangerous chemicals. Deep tanks are the preferred stowage, if available. Adequate ventilation facilities for the cargo hold are very important. The ideal system provides for mechanical ventilation. Wind scoops and portable ventilating means may be adequate for ventilating the compartments where toxic agents are stored.

c. Loading. Before toxic agents are loaded on board a vessel, the ship's ventilating system should be placed in operation. The chemical cargo should be stowed to permit circulation of air around containers of toxic agents. When shipped in sufficient quantity, toxic munitions should be placed in a hold reserved for the shipment. In any event, toxic munitions should be stowed separately from other cargo. They should be topstowed or so loaded that they can be removed first upon arrival at the destination. Chemical ammunition and explosives must not be loaded in the same hold, nor should they be loaded on a vessel with scrap of any kind.

d. Bracing. Containers must be properly braced to prevent shifting.

194. Inspection and Unloading of Vessels

Immediately after entering a port or harbor, all vessels loaded with chemical agents and hazardous chemicals should receive a complete exterior inspection of the holds where such material are stowed. This examination should be conducted to disclose any evidence of sabotage. If sabotage b suspected, the vessel should be moved to a safe location and given a more thorough inspection.

a. Unloading. Special safety precautions must be taken to insure safety of personnel when they enter holds containing chemical agents-such as, first, checking for leaks by a person dressed in full protective equipment; venting, if necessary, to disperse flammable or toxic fumes; and decontamination, if leaks are found. Each container of chemical agent or dangerous chemicals must be inspected for leakage as it is withdrawn from the hold. Leaking containers of chemical agents must be unloaded as quickly as possible and the hold must be decontaminated before the remainder of the cargo is unloaded.

b. Decontamination. After the entire cargo has been unloaded, the holds must be inspected and decontaminated if necessary.

Section VI. AIR SHIPMENTS

195. General

a. This section describes the procedures and those Federal regulations that are applicable to shipments of chemical agents and hazardous chemicals by air. Such shipments, in commercial air carriers under the jurisdiction of the United States government, are subject to regulations of the Federal Aviation Administration (CFR, Title 14, Part 103). Such shipments by military aircraft are subject to the provisions of TM 38-250. Normally, only high priority shipments of chemical munitions are flown by Military Airlift Command (MAC). Marking and labeling will be in accordance with MIL-STD-129.

b. Commanders of military or contract commercial aircraft will be furnished DD Form 836-1, "Instructions for Aircraft Commanders Transporting Explosives or Other Dangerous Articles by Military or Civilian Aircraft," by the originating Air Freight terminal when shipment includes any item listed in attachments 8 and 4, TM 38-250 (alphabetical item commodity group identification, and commodity groupings: groups I through VI). The aircraft commander will be advised that the DD Form 886-1 must be turned in to the air terminal representative when shipment covered by that form is offloaded at an enroute or transfer station. When a crew change occurs without offloading the cargo, he must transfer the DD Form 886-1 to his replacement or the air terminal representative. The form must be turned in to the air terminal at the terminating station for further processing to final destination. Special attention must be given to the instructions to be followed in case of fire and to the precautions specified on the DD Form 886-1; see attachment 5 to TM 88-250 for example of a completed form.

196. Commercial Aircraft Shipments

The acceptable containers of chemical agents and hazardous chemicals and the conditions under

which they may be shipped by commercial aircraft are generally similar to those given in DOT regulations for shipment by Railway Express. Special FAA regulations state that no class A poison or class A chemical ammunition or article unacceptable for Railway Express (other than laboratory samples) may be carried on commercial aircraft. However, FAA exemptions 672E and 700 permit certain exemptions to these regulations.

197. Military Aircraft Shipments

TM 38-250/AFM 71-4 prescribes packaging and handling of dangerous materials for transportation by military aircraft, contract air carriers, and LOGAIR. Dangerous materials are divided, by hazard, into three categories as follows:

a. Items Designated by Two Daggers. Those items whose properties are considered sufficiently dangerous as to preclude shipment by air. Items so identified will not be offered for shipment by military aircraft under any circumstances.

b. Items Designated by One Dagger. Those items whose physical and chemical properties are considered such as to present definite hazards even under normal shipping safety conditions; and, therefore, shipment by air is permitted only when authorization for shipment, based on operational necessity, is obtained.

c. Items with No Dagger Indicated. Those items of cargo not highly dangerous under normal conditions and that possess a reasonably high safety factor in shipment, but nevertheless require some precaution in packing and handling.

d. Additional Guidance. Chapter 4 of TM 38250 furnishes detailed guidance concerning the categories mentioned in a through c above and should be consulted when offering hazardous chemicals and chemical agents for shipment by military air.

e. Compatibility. Attachment 1 to TM 38-250 should be consulted for guidance on compatibility.

198. Inspection

Prior to loading, containers of chemical agents must be inspected (para 178). Specific attention should be given to any area (seams, valves, burster wells, dents, etc.) that may tend to leak to insure that a possible increase in altitude (decrease in atmospheric pressure) will not cause the container to leak. If possible, containers should be vented before takeoff if such a decrease in atmospheric pressure (increase in relative internal pressure) is expected.

199. Cargo Carrying Capabilities of United States Air Force Aircraft

The aircraft commander is responsible for the determination of actual weight capabilities and operating range of his aircraft. Weight is the controlling factor in the shipping of containers of chemical agents by air transport, carrying capacities varying according to the type of aircraft. For detailed planning on shipment by air, pertinent aircraft operating handbooks should be consulted.

CHAPTER 10

DISPOSAL OF CHEMICAL AGENTS/MUNITIONS AND RELATED ACTIVITIES

200. General

a. This chapter describes the renovation, demilitarization, and disposal procedures for chemical agents and munitions.

b. In addition, appendix C contains information on the uses of the ABC-M2 point source calculator and the ABC-M3 line source calculator which are designed for use by safety personnel concerned with the storage, shipment, handling, and disposal of toxic chemical agents. These calculators provide a rapid, convenient means of determining the maximum extent of the hazard when disposing of chemical agents. Appendix C also contains a nomogram (fig. 88) and acceptable dosages (table 6) for use in the determination of downwind toxic vapor hazard.

c. For additional information, contact Edgewood Arsenal, U.S. Army Materiel Command.

201. Renovation And Demilitarization

a. Renovation. Renovation is the process of restoring unserviceable agents or containers into serviceable condition for return to the supply system. Renovation of chemical agents is a highly technical process that is best carried out in fixed chemical installations. In general, it is not practical in theaters of operations to attempt largescale purification of chemical agents that have deteriorated below the minimum standards of purity or strength. In a theater of operations, renovation is usually limited to the transfer of serviceable chemical agents and chemicals from unserviceable containers to serviceable containers. It may also include the decontamination and repair of damaged containers.

b. Demilitarization. Demilitarization is the mutilation or destruction of materiel, rendering it harmless and ineffectual for military purposes. In the case of chemical munitions, demilitarization of munitions usually occurs during disposal operations (described below) involving burning, venting, or detonating where the techniques of chemical agent disposal also mutilate the munition containing the agent.

202. Disposal

Disposal is the act of getting rid of something (chemical agents or munitions) no longer needed. Demilitarization and disposal are rarely, if ever, contracted to civilian industry. The various methods of disposal are described below.

a. Sale. When chemical agents or munitions have commercial value, every effort is made to dispose of them by sale.

b. Burial at Sea. Chemical agents and munitions will be dumped at sea only if no other means of disposal is practical or feasible. In peacetime, dumping in the sea is employed only with guidance from the Commanding General, U.S. Army Materiel Command. To be feasible, this method requires large quantities, but creates a minimum hazard. Handling costs are high and salvage of containers is not possible. In emergency or wartime situations, a sea dump may be made in waters farther than 10 miles from shore and deeper than 1,000 fathoms. The location of such dumps must be carefully charted and recorded for later reporting. All agents and munitions can be disposed of in this manner except WP and PWP, which, if washed ashore, could cause a serious fire hazard.

c. Land Burial. This method of disposal *will not* be used if disposal is possible by other means, since underground water sources may become contaminated or the land area may become the site of future construction. Land burial is usually considered only a stopgap or holding measure to reduce or contain vapor hazards until another method of permanent disposal can be arranged. Burial of toxic agents on nongovernment-owned property could have serious legal implications. This method of disposal *will not* be used in peacetime without the specific approval of the Commanding General, U.S. Army Materiel Command.

d. Burning. Burning can be employed to dispose of blister (except arsenicals such as L, ED, and MD which leave a highly toxic residue when burned), nerve, riot control, incapacitating, incendiary, and smoke agents. Burning is best accomplished in an open pit or trench.

(1) The pit should be deep enough to allow a minimum depth of 0.6 meter (2 feet) of combustible material, such as wood, to be placed under the item to be destroyed, and a minimum distance of 0.3 meter (1 foot) from the item to the top edge of the pit. Deeper pits should be used for larger quantities of agent, thus permitting additional burning material to be used and, consequently, longer and hotter burning. Deeper pits will also provide a form of barricade which will reduce the fragmentation hazard from heavy cased ordnance.

(2) The pit must be wide enough to permit the use of a minimum of 1 meter (3 feet) of combustible material on each side of the items being destroyed.

(3) In order to aid in rapid ignition and to assist the combustion, used motor oil, thickened flame fuel, or diesel fuel should be spread over the combustible material.

Note. Gasoline is not recommended for this purpose because of its low flash point and susceptibility to premature ignition from a small spark.

(4) Heavy cased munitions must be opened with a small explosive charge simultaneously with the ignition of the burning pit. This is done to permit a slow release of the agent into the flame. If the munition is not opened or vented, a mechanical explosion (due to the buildup of agent pressure) may occur, resulting in a sudden release of the agent and incomplete destruction "f the toxic properties by the fire. Some puncturing and cutting shaped charge systems are shown in figures 61 through 63.

(5) The explosive detonation and pit ignition must be done remotely. Gasoline in small, closed containers (plastic jugs or cans) may be exploded in the pit to provide an excellent means of assuring rapid and complete ignition. These containers are easily integrated with the explosive train used to open the munition as indicated in figures 64 and 65. The two major considerations are to open the munition with a small, puncturing charge that will not propel the munition out of the burning pit, and to release the smallest amount of agent possible until the pit is completely ignited and high temperatures eventually develop. A pit prepared for a burning operation is shown in figures 65 and 66. When disposing of agent from 1-ton containers, it may be slowly fed into the fire by using a system of pipes, valves, and fittings adapted to the lower valve of the container. The container should be placed out of the fire on the upwind side of the pit. After the contents have been destroyed, the container should be burned prior to salvage or cleaned prior to refilling.

(6) The disposal of nerve and blister agents by burning will create a significant downwind hazard to unprotected personnel. The extent of the actual hazard cannot be accurately computed since it will depend on the efficiency of the burning pit and the surrounding weather conditions. By using the ABC-M2 downwind hazard calculator or the point source nomogram, however, the maximum potential downwind hazard distance and cloud width may be calculated by assuming a total release of all the agent. If the disposal operation is successful, i.e., the munition is properly opened and the pit burns vigorously, a highpercentage of the agent will quickly be destroyed and the actual hazard area will be much less than the maximum calculated. If the operation is not completely successful, the computed downwind hazard area will have provided an adequate exclusion area for unprotected personnel downwind.

(7) After the fire has burned out and the pit has cooled for a minimum of 12 hours, the pit, its contents, and the surrounding area must be checked for residual contamination. Further burning or decontamination operations may be required if contamination is detected.

(8) Whenever nerve agents are burned in peacetime, guidance should be obtained from the Commanding General, U.S. Army Materiel Command before burning large quantities.

(9) Riot control, incendiary, and smoke agents may also be disposed of by open pit burning. Small amounts of riot control, incendiary, and smoke munitions may be disposed of in a small trench or depression in the ground with minimum dunnage and a less elaborate ignition system. These munitions normally contain pyrotechnic materials which will support combustion and merely need to be opened and ignited. The quantity that can be destroyed in a single operation is generally limited only by the type of agent and the downwind travel of the agent cloud. However, burning large stacks of incendiaries should be avoided, since explosions And scattering of incompletely destroyed munitions may result.

(10) The advantages of burning as a method of disposal are that the bulk agent containers can be salvaged, the hazard to operating personnel

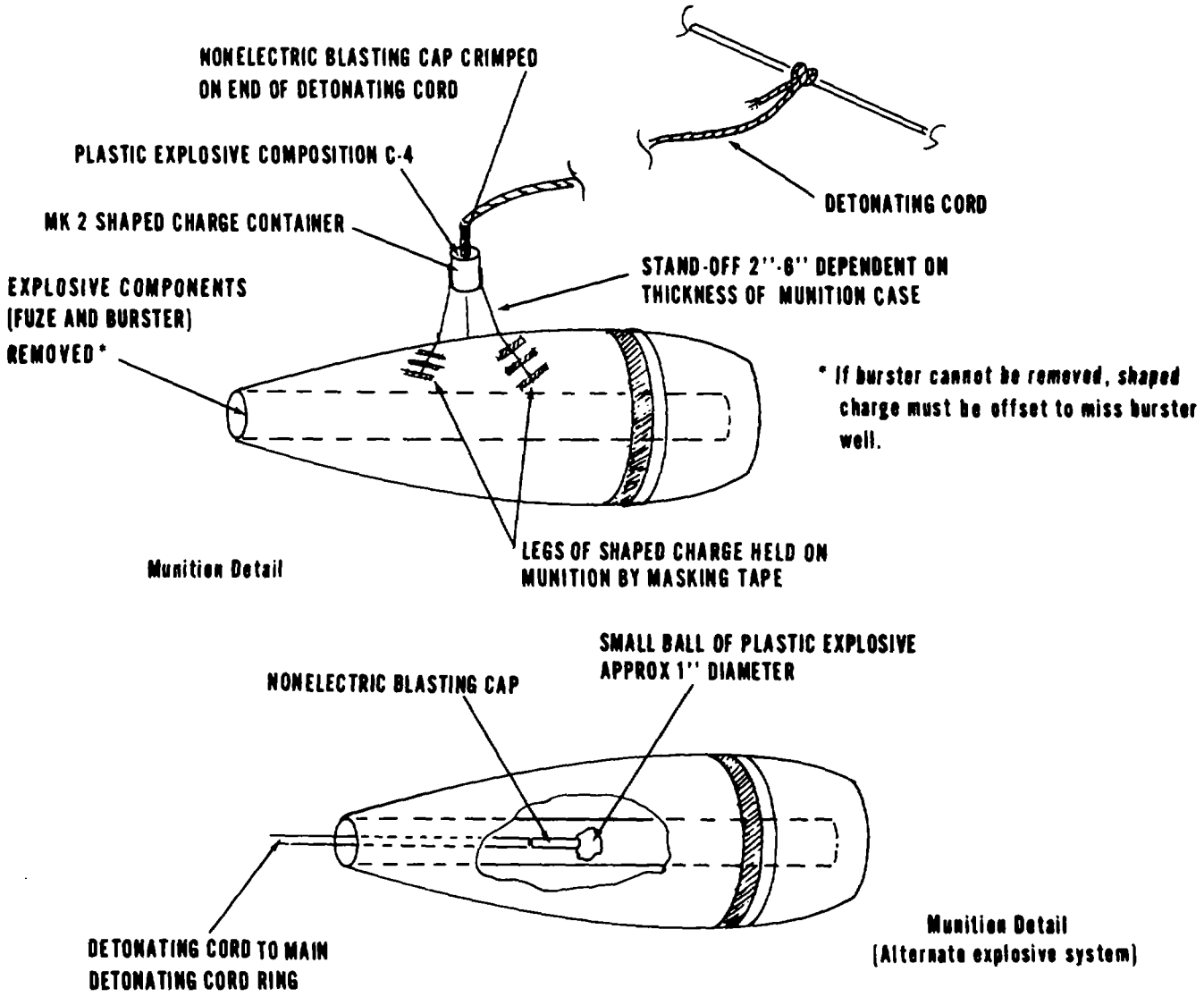


Figure 61. Venting charges for heavy cased munitions.

is small, and large quantities can be disposed of economically.

e. Venting. Venting, or release to the atmosphere, is used to dispose of agents or hazardous chemicals with a high volatility (normal physical state is a gas) such as CG, CK, and AC.

(1) Venting normally will be limited to small quantities of agents or large quantities under controlled release conditions. When the venting site is very distant from inhabited areas, greater quantities may be released, provided that safe downwind area requirements are met as determined by the ABC-M2 calculator or the point source nomogram.

(2) Venting may be accomplished by puncturing the munition with an explosive shaped charge, by opening filler plugs or venting valves, or by drilling a hole in the munition. Prior to drilling a hole, it is recommended that the munition be cooled to as low a temperature as possible. Dry ice is very effective as a refrigerant and can be obtained by discharging a CO, fire extinguisher into a bucket covered with a rag. Water, ice, and salt mixtures are also effective. Cooling will significantly reduce the vapor pressure, and the drill operator will not be subjected to high concentrations of toxic vapor when he penetrates the munition casing. The munition should be packed in the coolant material for about an hour prior to drilling.

(3) The advantages of venting are that it permits maximum salvage of agent containers

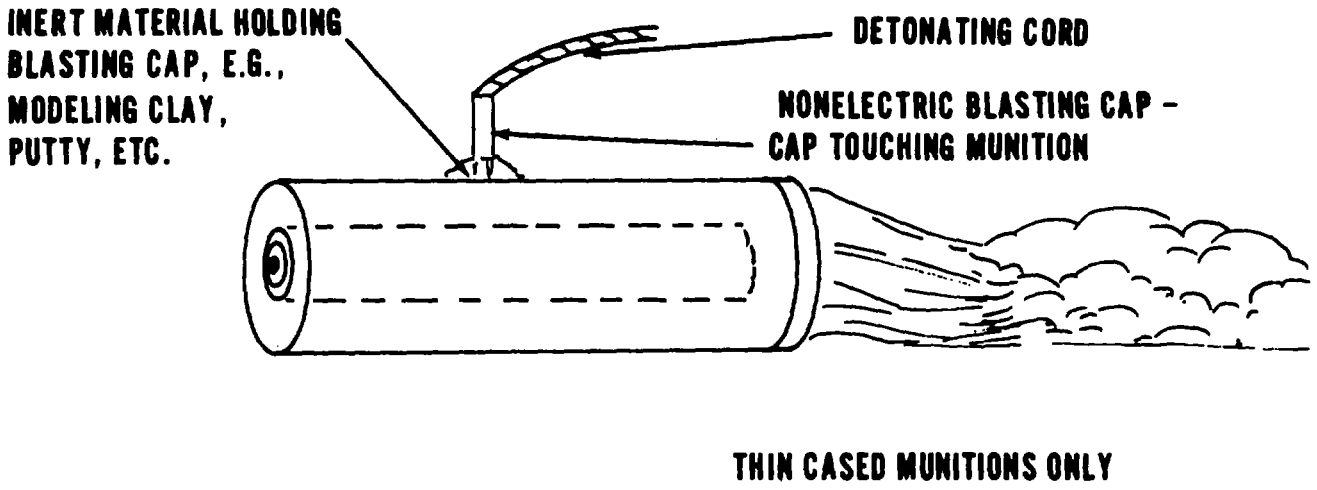


Figure 62. Venting changes for thin cased munitions.

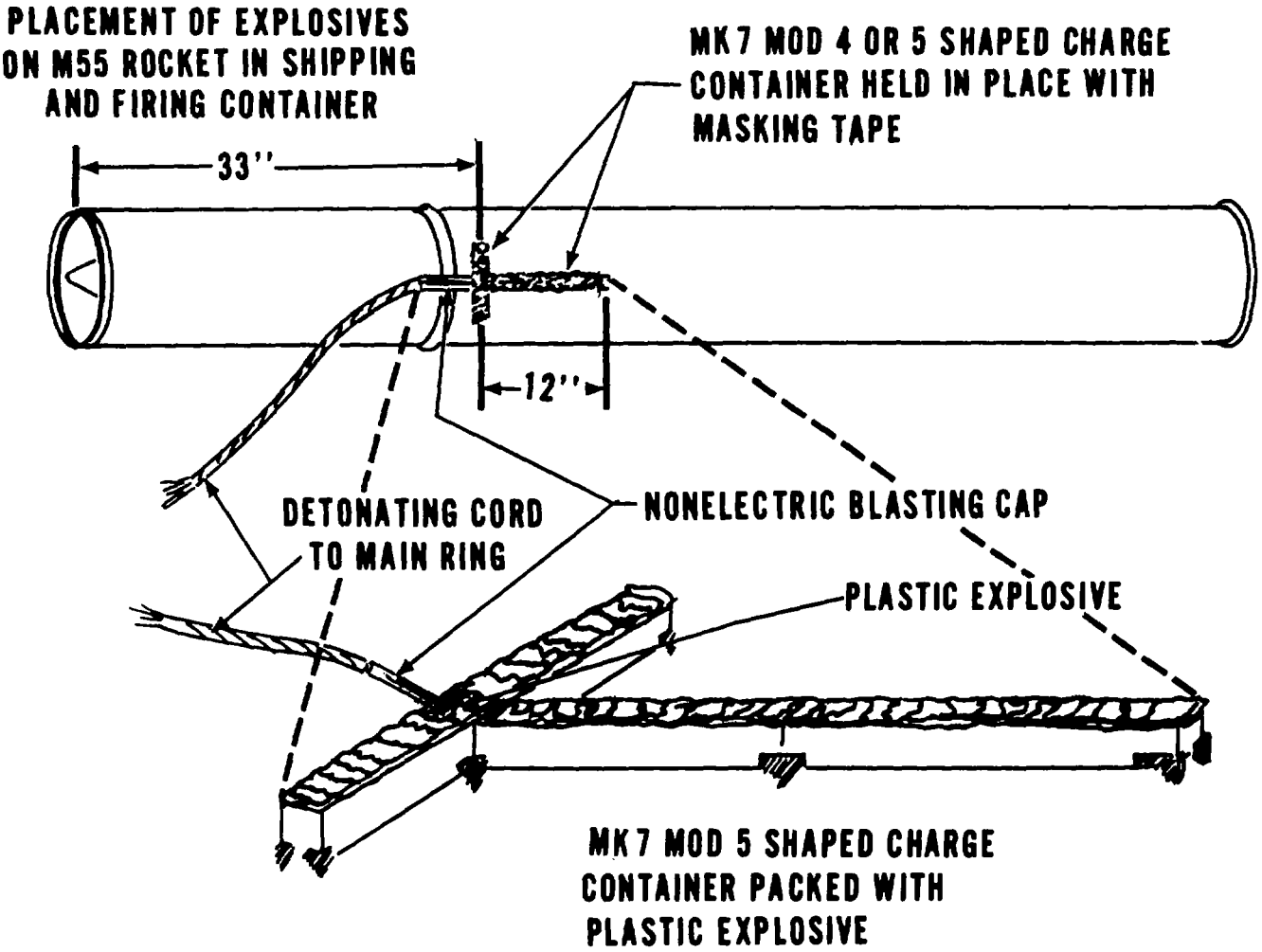
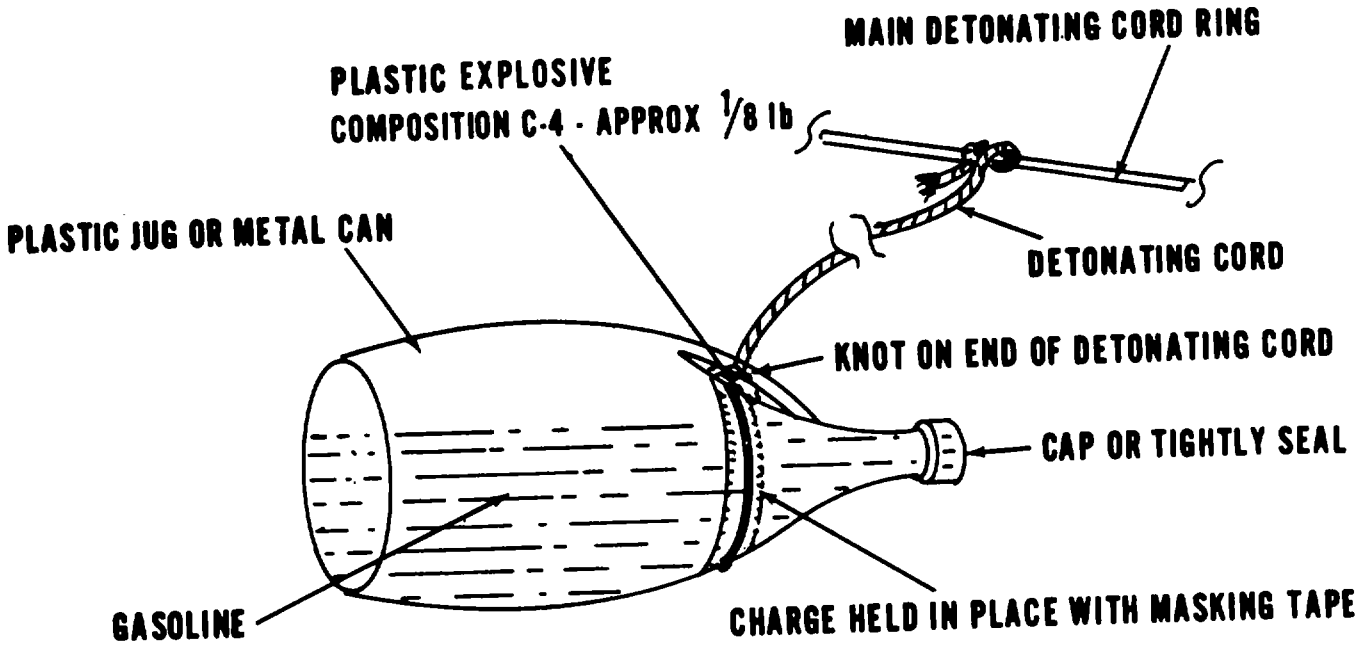
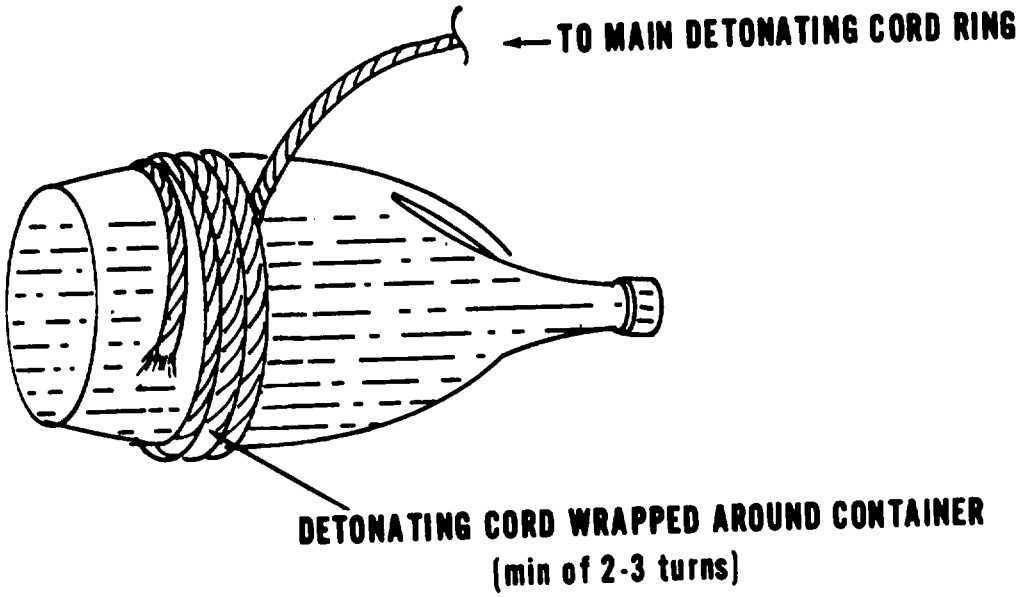


Figure 63. Venting charges for M55 rocket.



Igniter Detail



Igniter Detail
(alternate explosive system)

Figure 64. Pit igniter.

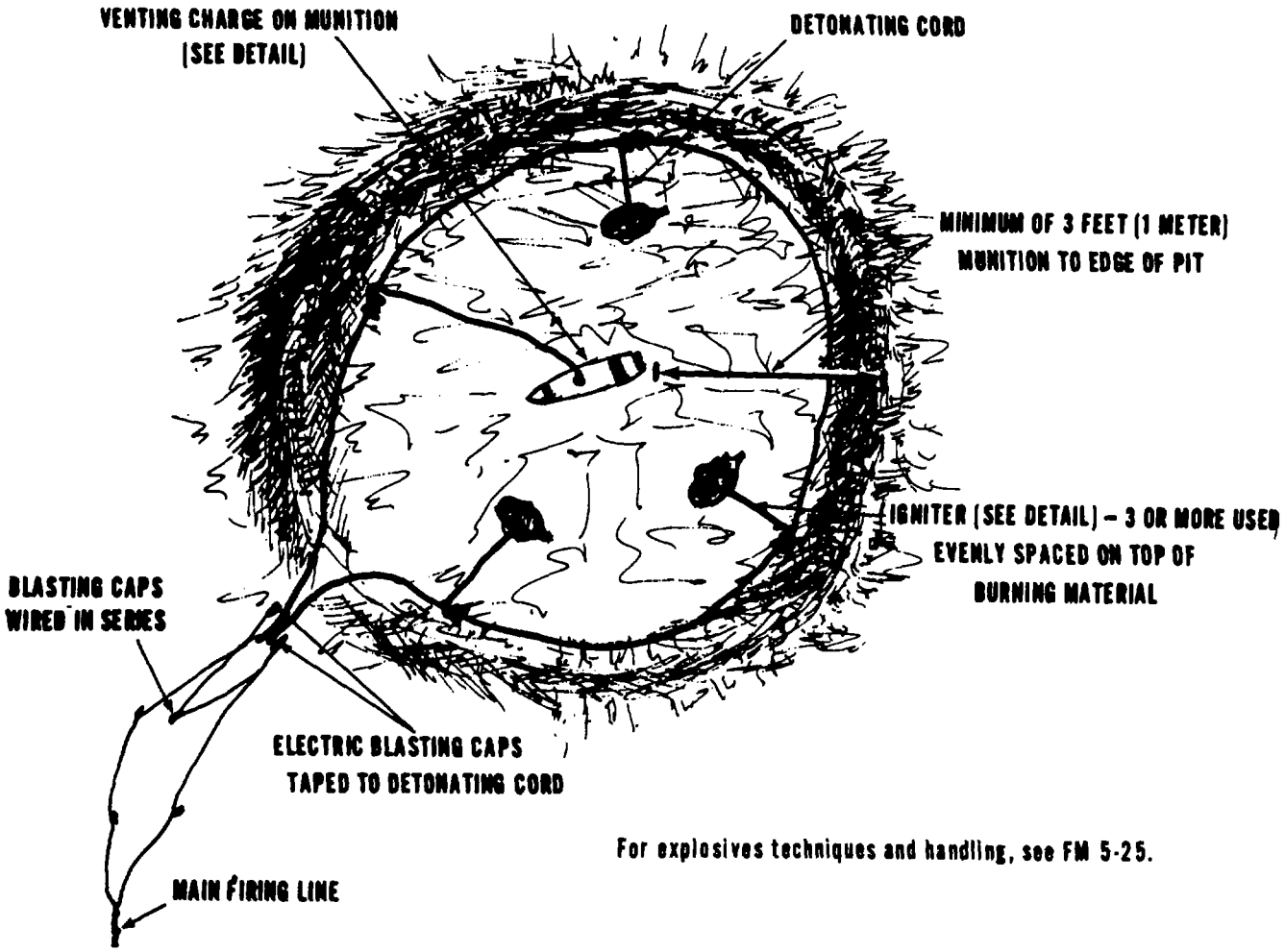


Figure 65. Top view of burning pit ready for ignition.

and it is economical. Its major disadvantage is the limitation of quantity because of the large downwind hazard area created. Only small quantities of agent may be disposed of at a time, and ideal weather conditions for disposal must exist.

f. Chemical Neutralization. Neutralizing chemical agents with a strong decontaminant is an excellent disposal method for small quantities of agent (approximately 25 pounds or less).

(1) At least 2 gallons of 10-percent neutralizing solution should be used for each pound of agent. Caustic soda solutions are effective on GB and CK. Calcium hypochlorite solutions are most effective on nerve agent VX, blister agents such as HD, and vomiting agents such as DM. Alcohol caustic solutions should be used for neutralizing BZ, CN, and CS.

(2) When conducting neutralizing operations, it is usually best to place the appropriate amount of neutralizing solution in a clean, heavy-gaged steel container such as a 55-gallon drum. Regulate the flow of agent into the container through a valve and pipe system or by slow pouring. Stir the solution as the agent flows into the container so as to mix the agent rapidly with the neutralizing solution. When the agent is contained in a munition, it may be opened by removing the filling plug, by drilling a hole in the munition, or by explosively puncturing a small hole. As in venting, the munition should be cooled prior to drilling. The agent should always be poured slowly into the neutralizing solution to avoid the development of excessive heat from the chemical reaction. The solution could become agitated enough to splatter. The agent/neutralizing solution mixture should be allowed to react for 24 hours before spilling on the ground. When BZ is neutralized with a 10-percent caustic alcohol solution, it is best to burn the agent/ neutralizing solution after the 24-hour period.

(3) A small downwind hazard area will exist during neutralizing operations. The maximum

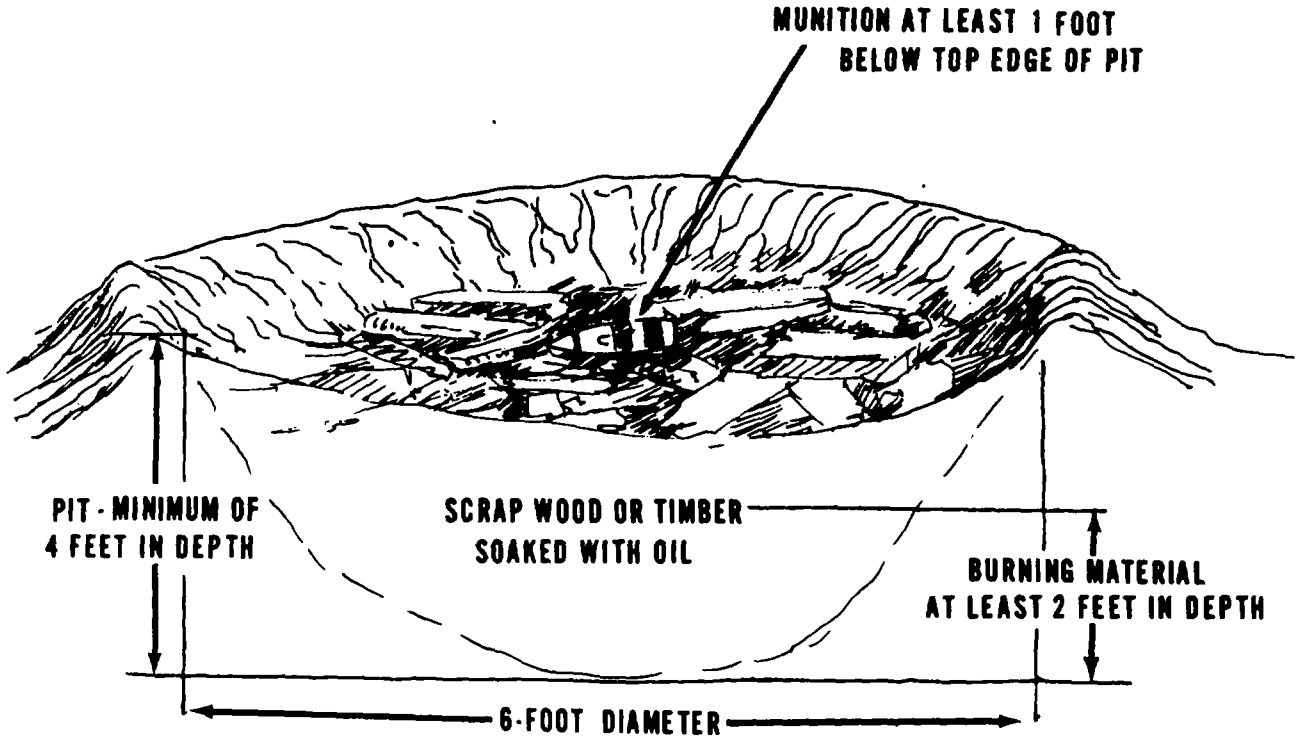


Figure 66. Cross section of a disposal pit for burning chemical munition.

mum potential downwind hazard area should be calculated by assuming a total release of the agent. If the neutralizing operation is successful, the actual hazard area will be much less than that calculated. If an accident should occur, however, the computed downwind hazard area will have provided an adequate exclusion area for unprotected personnel downwind.

g. Detonation. Some smoke and incendiary-filled munitions may be disposed of by detonation in a manner similar to that used for high-explosive items. This method is particularly practical for disposing of white phosphorus-filled munitions. In some remote locations toxic chemical munitions may be detonated where they are found, but the downwind hazard restrictions as calculated by the ABC-M2 calculator or the point source nomogram must be observed. The detonation method may also be used in conjunction with the venting of small munitions containing CG or CK. Sufficient explosives may be placed on or under the munition to fragment it completely, rather than puncturing the casing as described in e above. This may be appropriate when the integral explosive components cannot be removed.

203. Weather Conditions Affecting Disposal

Weather conditions are very important factors in determining the appropriate disposal procedure and are of paramount importance in burning, venting, or detonation operations. Local weather reports and forecasts are instrumental in the planning and conduct of chemical disposal operations. The weather conditions favorable for disposal generally are opposite to those desired for the offensive employment of chemical agents. It must be recognized that weather factors are interdependent. For example, while high wind speeds tend to reduce the downwind hazard distance, they will also destroy strong lapse temperature gradient conditions. The combined effect may result in an extension of the downwind hazard. Therefore, in order to evaluate the weather conditions for a specific disposal operation, the weather factors must be considered collectively. Accurate weather data are used when available; otherwise, estimations discussed below may be used to predict the downwind hazard. See appendix C for discussion and examples of determination of downwind toxic vapor hazard by the use of the nomogram or the ABC-M2 or ABC-M3 calculator.

a. Temperature Gradient. A strong lapse temperature gradient is always preferred for chemical agent disposal. Weak lapse and neutral gradient conditions may be acceptable for some disposal operations. Inversion conditions are undesirable because of the extensive downwind hazard distance produced.

(1) *Measurement of temperature gradient*. The temperature gradient is defined as the change in temperature with altitude and is determined by subtracting the air temperature at 0.5 meter above the ground from the air temperature at 4 meters above the ground. For accurate prediction of the downwind hazard from a disposal operation using either calculator or the nomogram, the average temperature gradient existing throughout the area must be used. The measured gradient at specific points will often vary widely depending on instrument accuracy, type of ground surface, and the degree of sunlight at the point of measurement. Therefore, several points over a large area must be measured, or an estimation must be made.

(2) *Estimation of temperature gradient*. Estimation of the general temperature gradient in a disposal area is often a more reliable determination than specific measurements and is much easier to perform.

(*a*) Strong lapse conditions (temperature gradient -2° to -3° F.) will occur near midday when the sky is clear of clouds, the sun is bright, and the wind speed is low.

(*b*) Weak lapse conditions (temperature gradient 0° to -1° F.) will occur during midmorning and midafternoon provided that the sky is clear, the sun is bright, and the wind speed is low. They will also occur on partly cloudy days and when the wind speed is moderate.

(*c*) Neutral conditions (temperature gradient 0^{o} F.) generally will occur at sunrise and sunset on clear days and will exist throughout the day whenever the sky is overcase or anytime that there are strong winds.

(*d*) Inversion conditions (temperature gradient 0° F. to $+3^{o}$ F.) generally will occur throughout the night when the sky is clear and the wind speed is low.

b. Wind Speed. Wind speeds of 3 to 15 knots are preferred for disposal operations. With wind speeds less than 3 knots, wind direction fluctuates widely, thereby decreasing the accuracy in predicting the downwind hazard area. Higher wind speeds (10 to 15 knots) provide increased air mixing which will tend to dissipate the agent cloud more rapidly. Strong winds (over 15 knots) will produce neutral temperature gradient conditions and consequently will increase the downwind hazard distance. When wind speed indicators are not available, wind speed should be estimated by use of the Beaufort scale (table 5).

c. Wind Direction. Wind direction is important in determining where the toxic vapor cloud will travel. The prevailing wind direction is important in determining a good location for the disposal site relative to surrounding inhabited areas.

d. Precipitation. Precipitation will have a minor influence on the downwind hazard distance. However, weather conditions which produce precipitation generally are unfavorable for disposal operations.

e. Temperature. Moderate temperatures have little influence on disposal operations. In general, high temperatures will assist in vaporizing agents that may be spilled or splashed at the disposal site, ultimately reducing the amount of decontamination required. Low temperatures may cause freezing of some agents, thus preventing the use of some disposal methods.

Table 5. Beaufort Scale

Beaufort Number	Name	Miles per Hour	Description
0	Calm	Less than 1	Calm; smoke rises vertically.
1	Light air	1-3	Direction of wind shown by smoke but not by wind vanes.
2	Light breeze	4-7	Wind felt on face; leaves rustle; ordinary vane moved by wind.
3	Gentle breeze	8-12	Leaves and small twigs in constant motion; wind extends light flag.
4	Moderate breeze	15-18	Raises dust and loose paper; small branches are moved.
5	Fresh breeze	19-24	Small trees in leaf begin to sway; crested wavelets form on island waters.
6	Strong breeze	25-31	Large branches in motion; telegraph wires whistle; umbrellas used with difficulty.
7	Moderate gale	82-88	Whole trees in motion; in convenience in walking against wind.
8	Fresh gale	39-46	Breaks twigs off trees; generally impedes progress.
9	Strong gale	47-54	Slight structural damage occurs; chimney pots and slates removed.
10	Whole gale	5688	Trees uprooted; considerable structural damage occurs.
11	Storm	64-72	Very rarely experienced; accompanied by widespread damage.
12-17	Hurricane	78186	Devastation occurs.

204. Disposal Site

When selecting a site for disposal operations such as burning, venting, neutralizing, and detonating, the site should be located as far away as possible from magazines, inhabited buildings, towns, cities, public roads, railroads, and navigable streams. Inhabited areas should be especially distant from the disposal site in the downwind direction of the prevailing winds. Where possible, natural barricades such as hill masses should be utilized between the disposal area and storage magazines or populated areas. The disposal site must be a clear area, preferably on high terrain rather than in a valley where agent clouds can be trapped. All dry grass and other combustible materials must be removed within a radius of 60 meters of the site. The ground must be free of deep cracks in which agents or explosives may lodge. Prior to disposal operations, all personnel not directly connected with the operation must leave the area. However, in no case will the number of persons at the site be less than two. Before a disposal operation, all entrances to the area will be closed by barricades, gates, or guards. A red range flag will be flown during the disposal operation. An instrument to indicate wind direction and wind speed should be provided, as well as a klaxon or a siren for audible warning. Communications in the form of telephones or radios will be necessary within the disposal area. Communications with surrounding inhabited areas should also be available in case of an emergency or a sudden change in wind direction.

205. Safety Considerations

Prior to beginning any disposal operation involving chemical agents, the following safety precautions must be observed.

a. The proper protective clothing must be worn. Decontamination equipment (PDDA when available) and first-aid supplies must be available. When the disposal method involves a potential fire hazard, fire-fighting equipment must be at hand.

b. The number of people engaged in any disposal operation should be kept at a minimum consistent with safety and the amount of work to be done, but in no case should there be less than two people conducting the operation.

c. Explosive elements should be removed from munitions, if possible and practical, prior to disposal, unless the explosive components are to be utilized in the disposal.

d. EOD personnel will render safe and/or dispose of munitions which have become hazardous or unserviceable through damage or deterioration when the disposal of such munitions is beyond the capabilities of personnel normally assigned the responsibility for disposal. Chemical munitions which have failed to function (dud fired) must also be rendered safe by EOD personnel prior to disposal.

206. Leaking Chemical Munitions

a. General. During normal inspection and surveillance operations, leaking chemical munitions or bulk containers may be discovered. Leaks in 1-ton containers most often occur around the valves or the safety plugs. These leaks can easily be stopped by tightening or replacing the faulty valve or plug. The following information deals with the steps required to reduce the hazards and contain the limits of contamination developing from leaking munitions.

b. Immediate Action. The storage unit SOP prescribes certain immediate steps to be taken once a leaking munition has been discovered. Such steps include rendering first aid when necessary, notifying the officer in charge, and alerting activities downwind of the storage area. A hot line and emergency personnel decontamination station (PDS) (fig. 67) should be established upwind of the leaking munitions and will be the control point for limiting the extend of contamination to the area of the leakers. The distance between the hot line and the leaking munitions is dependent on such factors as the potential missile hazard resulting from munition explosive components, the existence of a fire in the area of the leakers, and the intermediate terrain features. The hot line must always be placed in an area known to be free of contamination and as close to the leakers as safety considerations will permit. It is preferable to locate the hot line within sight of the leaking munitions. All personnel working in the contaminated area and all equipment used in the operation must enter and leave through the control point or PDS on the hot line. The number of persons working in the contaminated area should be kept at a minimum consistent with safety and the amount of work to be accomplished, but in no case should there be less than two people. Al' personnel working in the immediate area must wear the protective clothing required for *complete protection* from the specific leaking chemical agent.

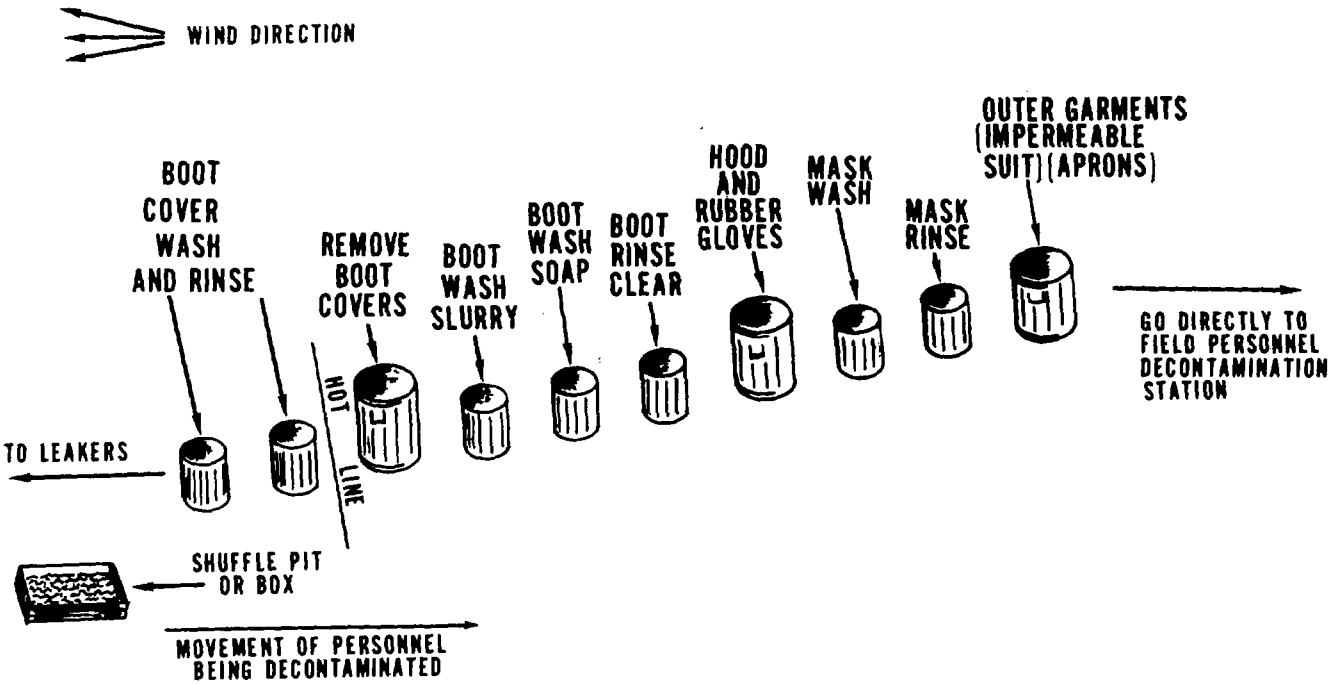


Figure 67. Hot line and emergency personnel decontamination station.

c. Determining the Extent of Hazard. The leaking munitions should be separated from the nonleaking munitions to determine the extent of the hazard. Before a munition containing explosive components is handled, however, it should be examined to determine if damage or fire has caused a potential explosive hazard requiring render safe procedures by EOD personnel. The munition should be decontaminated to neutralize the gross contamination so that the handler comes in contact with as little agent as possible. The immediate ground or igloo floor area may also require some spot decontamination to reduce the amount of agent tracked from the site. When the munition is handled, the leaking point should be held uppermost so that agent is not spilled. Once the leaking munitions have been separated from the nonleakers, a determination of the downwind hazard area can be made. By using the ABC-M2 or the ABC-M3 downwind hazard calculator or the point source nomogram and by assuming a total release of the agent in all the leaking munitions, the maximum potential downwind hazard area can be calculated.

d. Leak Sealing. When the source of the leak is a puncture or a crack which can be plugged, an effort should be made to seal the leaking area to contain the liquid and vapor which is escaping. Techniques for sealing will vary, depending on the type of agent and the size of the holes. If the hole is very large and most of the agent has leaked out, final agent disposal can be effected at the site by neutralizing or decontaminating the remaining agent. This may be the most rapid method of reducing the overall hazard and will eliminate the need for extensive packing.

(1) The application of a freezing compound will result in lowering the temperature and vapor pressure of all liquid and gaseous agents. This technique will significantly reduce the actual downwind vapor hazard from the munition. Freezing compounds can be made by discharging a carbon dioxide fire extinguisher as described in paragraph 202*e*. The solid carbon dioxide can then be mixed with alcohol or acetone and applied to the leaker as a paste. Temperatures as low as -100° F. can be obtained with this method. Water, ice, and salt mixtures can reduce temperatures to about 0° F. These freezing techniques are particularly useful in attempting to seal leaks in ordnance containing nonpersistent (high vapor pressure) agents such as CG, CK, and AC and are also practical in reducing the vapor hazards from agents such as GB and HD.

(2) Plug smaller holes physically with a wooden plug cut from a stick and shaped to the hole. Large holes can be stuffed with rags or covered with tape. Plaster of paris impregnated casting bandages can be soaked in water and

wrapped around the munition. This material will set fairly hard in 10 minutes and will prevent further liquid agent leakage. Quick setting epoxy resins (most often used as automotive body repair fillers) can be applied to leaks on some items. Figures 68 through 70 demonstrate the use of some of the sealants discussed above.

(3) After plugging or patching the hole, decontaminate the surface, taking care not to remove the sealant. Encase the munition in a plastic bag and tie, wire, or tape the bag closed.

e. Packaging. Once the leaking munition has been placed in the plastic bag, it should be packed in a sturdy container that will provide some type of vapor-tight seal. Figure 71 shows examples of such expedient packing containers. A small amount of loose dirt or sand is placed in the bottom of the container, the munition placed inside with the damaged portion uppermost, and loose dirt or sand is packed around the munition to hold it in position. The upper portion of the container should then be filled with water, leaving a 10-percent void space for expansion. Decontaminant may be used in place of the water if all explosive components have been removed and provided the munition is heavy cased. (Many chemical munitions are light cased, and a reaction between the decontaminant and the metal could erode the munition. Heat generated by the reaction of the chemical agent and the decontaminant may be sufficient to detonate explosive components in the munition.) Seal the container as

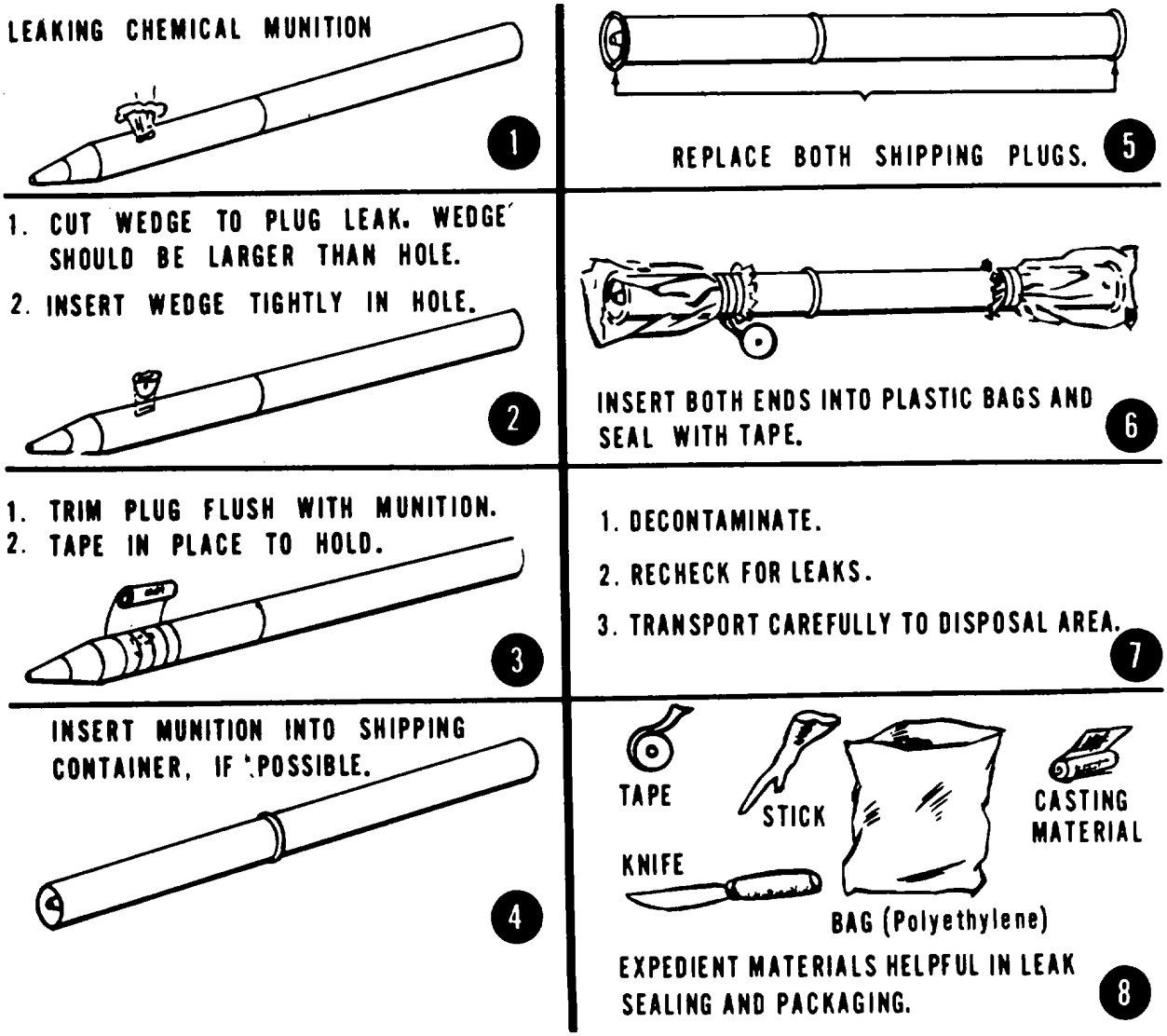
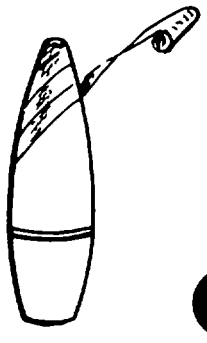
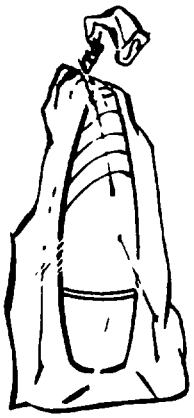


Figure 68. Typical leaking and packaging procedure (M55 rocket).



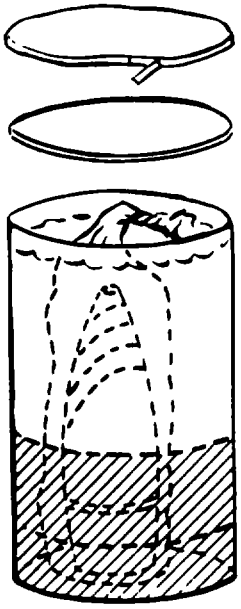
1

SEAL LEAK WITH GAUZE STRIPS, PLASTER OF PARIS IMPREGNATED



2

CONFINE ENTIRE UNIT INSIDE POLYETHYLENE PLASTIC BAG



3

1. PLACE PACKAGE IN SUITABLE CONTAINER.
2. STABILIZE MUNITION.
3. FILL VOID WITH WATER OR DECONTAMINANT.
4. SEAL AND DECONTAMINATE CONTAINER.
5. CHECK FOR LEAKS.

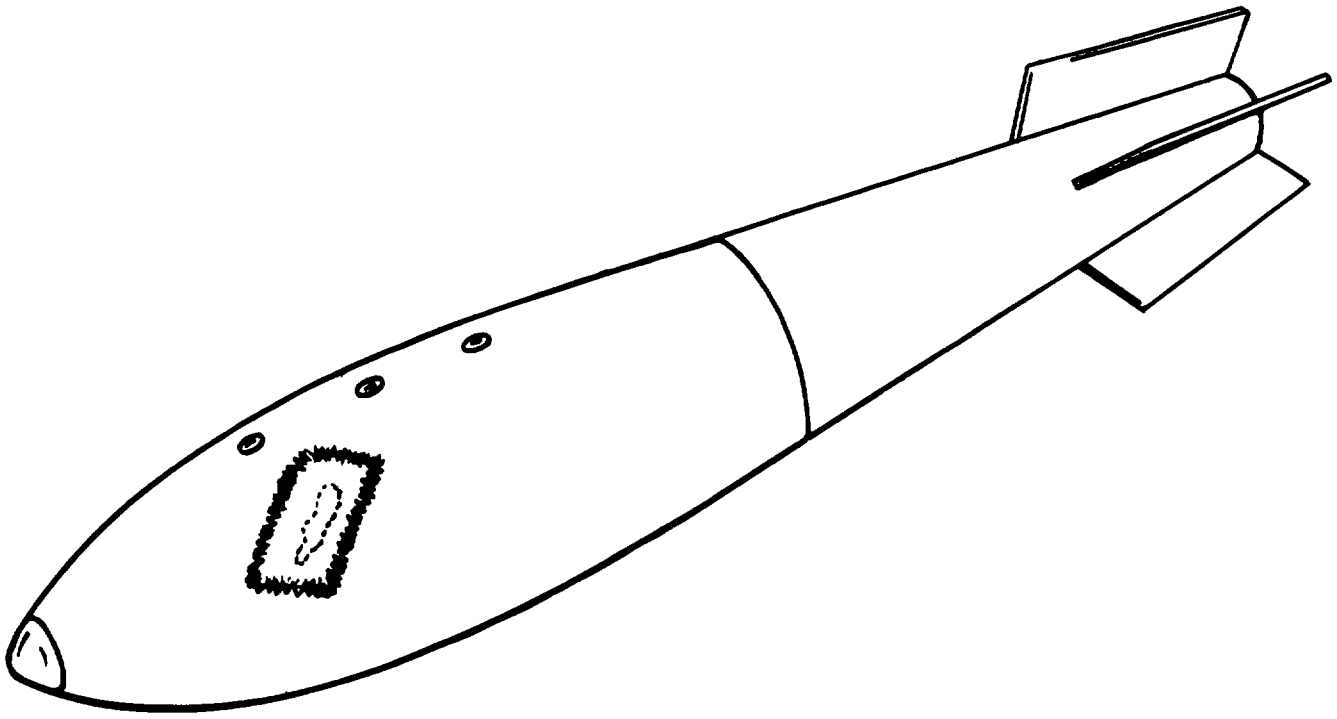
4

EXPEDIENT MATERIALS HELPFUL IN LEAK SEALING AND PACKAGING

Figure 69. Typical leak sealing and packaging procedures (artillery projectile).

tightly as possible to prevent vapor leakage, decontaminate, and check the container for leakage. This final decontamination and checking should be accomplished at the hot line, immediately prior to removing it from the "hot" area. The container can then be transported to a holding area or to the disposal area. Every effort should be made to dispose of the agent and munitions as soon as possible after the area of the leakers has been thoroughly decontaminated.

f. Decontamination of the Area and Personnel. The immediate area around the leaking munitions must be decontaminated. The path from the



1. PATCH HOLES.

2. SEAL EDGES OF PATCH.

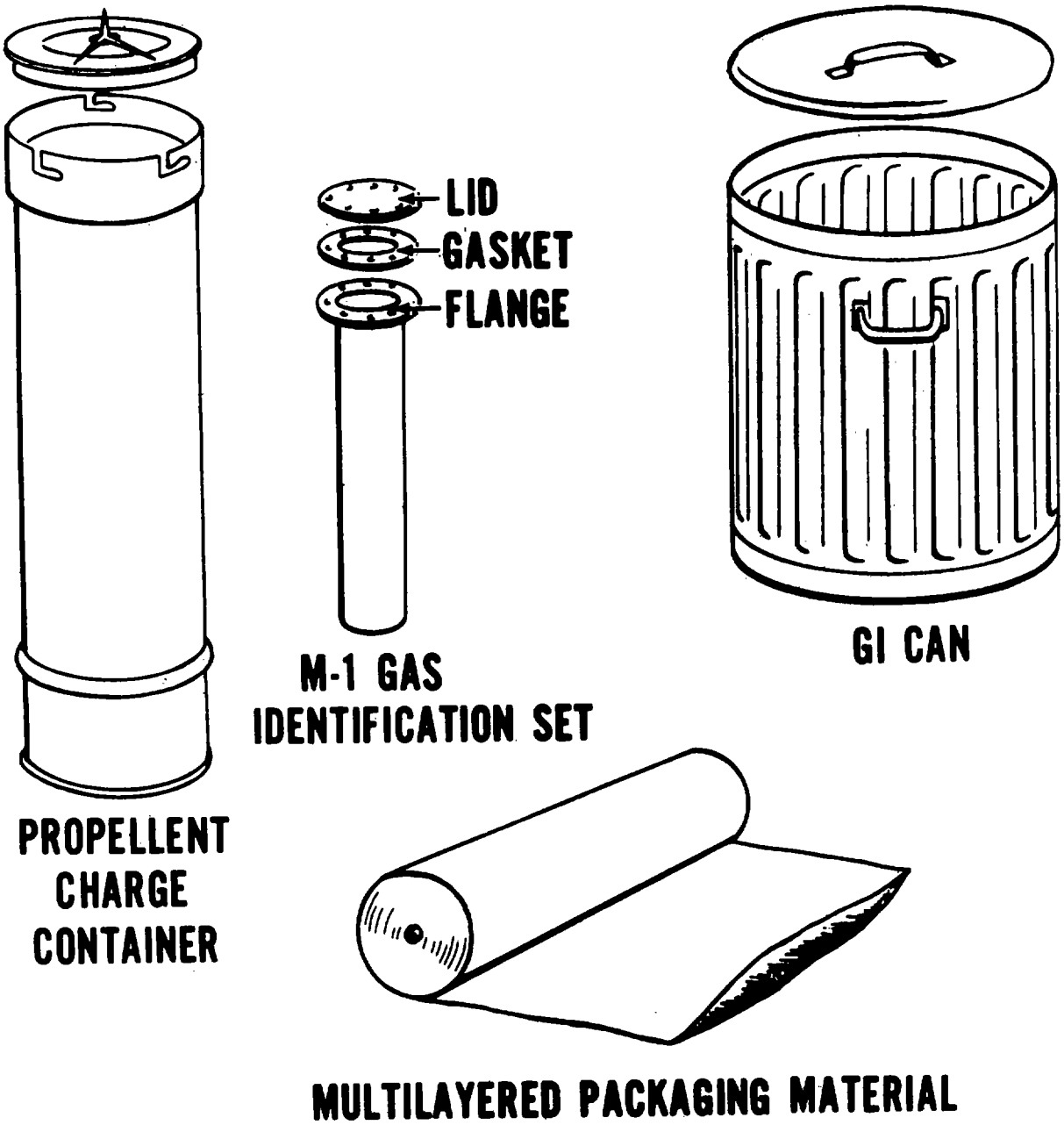
3. PACKAGE IN AGENT-PROOF CONTAINER.

Figure 70. Typical sealing procedure-large munitions.

hot line to the leakers must be carefully checked and decontaminated if necessary. All personnel in the working party who have been in the "hot" area must decontaminate themselves and their equipment at the emergency PDS at the hot line. Outer clothing such as boot covers, rubber gloves, and rubber aprons is removed and the hood and mask are washed. Contaminated spots on impermeable clothing are decontaminated. Personnel then pass through the shuffle pit and move directly to the permanent PDS of the storage facility, where they follow the fixed undressing procedure (as explained in TM 3-220) and shower. If rigid hot line discipline has been followed, no contamination will have spread beyond the immediate area of the leaking munitions.

g. Leaking WP and PWP Munitions. A puncture, crack, or other opening in a munition which exposes WP or PWP to air will cause the agent to burn spontaneously. The heat of burning will explode the burster if the agent is not smothered.

The recommended emergency action is to immerse the munition in a can of water or hose down the munition with water to cool it and reduce the explosive hazard. If large amounts of water are used, the burning agent will be extinguished momentarily, and the opening can be rapidly sealed with mud or other expedient material. A more effective sealing material should be used on the opening after the munition has cooled. The munition may then be disposed of, preferably by the detonation method.



*h. Recommended Disposal Method*s. A summary chart of recommended disposal methods is provided 'in figure 72. Explanations of each of them method are included in paragraph 202.

LARGE QUANTITIES (over 25 lbs of agent)	SMALL QUANTITIES (less than 25 lbs of agent)		
BURN (Open Pit)	NEUTRALIZE	GB-VX	NERVE
BURN (Open Pit) BURIAL AT SEA (Lewisite and other Arsenicals)	NEUTRALIZE	HD	BLISTER
CONTROLLED VENTING	VENT DETONATE	CG-AC-CK	BLOOD & CHOKING
NEUTRALIZE (Burn Solution)	NEUTRALIZE (Burn Solution)	BZ	INCAP
BURN (Open Pit)	NEUTRALIZE	CN-CS	RIOT CONTROL
DETONATE	DETONATE	WP-PWP	SMOKES
DETONATE	DETONATE NEUTRALIZE	FS-FM	SMOKES
BURN	BURN	BURNING	SMOKES
BURN DETONATE	DETONATE BURN	NP-PTI	INCENDIARIES
BURN	BURN	THI-MG	INCENDIARIES

Figure 72. Summary chart-disposal methods.

APPENDIX A
REFERENCES

Section I. ARMY PUBLICATIONS REFERENCES

AR 55-16	Movement of Cargo by Air and Surface-Including Less Than Release Unit and Parcel Post Shipment.
AR 55-56	Transportation of Chemical Ammunition, Chemical Agents, and Other Dangerous Chemicals.
AR 55-162	Permit for Oversize, Overweight, or Other Special Military Movements on Public Highways in the Contiguous States and the District of Columbia of the United States.
AR 55-228	Transportation by Water of Explosives and Hazardous Cargo.
AR 55-355	Military Traffic Management Regulation.
AR 75-14	Responsibilities for Explosive Ordnance Disposal.
AR 75-15	Responsibilities and Procedures for Explosive Ordnance Disposal.
AR 75-85	Authority to Waive Ammunition and Explosives Quantity-Distance Safety Standards.
AR 1903	Physical Security Standards for Storage of Chemical and Biological Agents and Munitions.
AR 320-5	Dictionary of United States Army Terms.
AR 320-50	Authorized Abbreviations and Brevity Codes.
AR 385-10	Army Safety Program.
AR 385-14	Accident Reporting Procedures, Army-Shipped NonNuclear Explosives and Dangerous Articles Transported by Commercial Carriers.
AR 385-0	Safety Color Code Markings and Signs.
AR 385-40	Accident Reporting and Records.
AR 385-65	Identification of Inert Ammunition and Ammunition Components.
AR 420-47	Refuse Collection and Disposal.
AR 420-90	Fire Prevention and Protection.
AR 606-5	Identification Cards, Tags, and Badges.
AR 700-15	Preservation, Packaging, Packing, and Marking of Items of Supply.
AR 700-68	Safe Handling, Storing, Shipping, Use, and Disposal of Compressed Gas Cylinders.
AR 725-50	Requisitioning, Receipt, and Issue System.
AR 740-22	Care of Supplies in Storage, Inspection and Reporting.
AR 74032	Responsibilities for Technical Escorts of Chemical, Biological, and Etiological Agents.
AR 742-Series	Inspection of Supplies and Equipment.
AR 755-21	Excess, Surplus, and Foreign Excess Personal Property at Disposal Activities.
FM 3-8	Chemical Reference Handbook.
FM 5-15	Field Fortifications.
FM 5-25	Explosives and Demolitions.
FM 9-15	Explosive Ordnance Disposal Unit Operations.
FM 21-11	First Aid for Soldiers.
FM 21-40	Chemical, Biological, Radiological, and Nuclear Defense.

FM 21-41	Soldier's Handbook for Defense Against Chemical and Biological Operations and Nuclear Warfare.
FM 81-45	Explosive Ordnance Disposal Service.
FM 31-70	Basic Cold Weather Manual.
TM 3-215	Military Chemistry and Chemical Agents.
TM 3-220	Chemical, Biological, and Radiological (SBR) Decontamination.
TM 3-240	Field Behavior of Chemical, Biological, and Radiological Agents.
TM 3400	Chemical Bombs and Clusters.
TM 3-522-15	Mask, Protective, Field, M9, and Mask, Protective, Field, M9A1.
TM 8-662-16	Beam, Hoisting, Liquid Gas Tank, M1.
TM 3-663-15	Hoisting Unit, Tripod, Drum, M1.
TM 3-1040-222-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Apparatus, Filling, Field, Land Mine, M2.
TM 3-1040-223-15	Operator, Organizational, Field and Depot Maintenance Manual: Dispensing Pumps, Hand Driven, M2 and M2A1.
TM 3-4230-200-12	Organizational Maintenance Manual: Decontaminating Apparatus, Power, Driven, Truck-Mounted, M8A8.
TM 3-4230-203-12	Organizational Maintenance Manual: Decontaminating Apparatus, Power-Driven, Truck-Mounted, 400-Gallon, M9.
TM 3-4230-204-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tools List: Decontaminating Apparatus, Portable, DS2, 1-1/2 Quart, ABC-M11.
TM 3-4240-202-14	Operator, Organizational, Direct Support, and General Support Maintenance Manual: Mask, CBR: Field, ABC-M17 and Accessories.
TM 34240-230-12	Operator and Organizational Maintenance Manual: Mask, Gas, Acid, and Organic Vapors, M10.
TM 3-4240-231-12	Operator and Organizational Maintenance Manual: Mask, Gas, All-Purpose, A11A1.
TM 3-4240-232-12	Operator and Organizational Maintenance Manual: Mask, Gas, Ammonia, M12.
TM 3-4240-258-14	Operator, Organizational, DS, and GS Maintenance Manual: Mask, CBR: Field, M17A1 and Accessories.
TM 3-4730-200-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Adapter, Line Filling, 1-Ton Container, M1.
TM 34940-200-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Mechanism, Valve Replacement, M1.
TM 3-6665-254-12	Operator and Organizational Maintenance Manual: Detector Kit, Chemical Agent, ABC-M182A2.
TM 5-311	Military Protective Construction (Nuclear Warfare and Chemical and Biological Operations).
TM 5-746	Plumbing and Pipefitting.
TM 8-285	Treatment of Chemical Agent Casualties.
TM 9-1300-206	Care, Handling, Preservation, and Destruction of Ammunition.
TM 9-1900	Ammunition, General.
TM 10-277	Protection Clothing, Chemical Operations.
TM 10-1619	Quartermaster Materials Handling Equipment.
TM 83250	Packaging and Materials Handling; Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft.
TM 55-602	Movement of Special Freight.
TM 748-200	Storage and Materials Handling.
TM 743-200-1	Storage and Materials Handling.
(0) TM 750-5	Photographic Equipment Data Sheets.
TM 75015	Army Equipment Data Sheets, Chemical Weapons and Defense Equipment.

TM -Series and TB CML-Series	Chemical Munitions and Equipment.
TB 9-1300-246/1	Identification of Ammunition Employing the New Color Coding Standard.
DA Pam 108-1	Index of Army Films, Transparencies, GTA Charts, and Recordings.
DA Pam 810-1	Index of Administrative Publications.
DA Pam 810-2	Index of Blank Forms.
DA Pam 810-8	Index of Doctrinal, Training, and Organizational Publications.
DA Pam 810-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Form 984	Materiel Serviceability Report.
DA Form 985	Data Sheet for Grand Lots, Miscellaneous Lots, or Depot Lots.
DA Form 986	Test Data Sheet, Serviceability of Burning-Type Munitions.
DA Form 987	Test Data Sheet, Serviceability of Materiel Other Than Burning-Type Munitions.
DA Form 988	Visual Inspection Sheet, Serviceability of Materiel.
SB -30-Series	Serviceability Standard for CB Materiel.
SB 8-1365-2	Thickener, Incendiary Oil, M1, M2, and M4; Storage Serviceability Standard.
DD Form 626	Motor Vehicle Inspection (Transporting Hazardous Material).
DD Form 886	Special Instructions for Motor Vehicle Drivers.
DD Form 836-1	Instructions for Aircraft Commanders Transporting Explosives or Other Dangerous Articles by Military or Civilian Aircraft.
MIL-STD-101	Color Code for Pipelines and Compressed Gas Cylinders.
MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-709A	Ammunition Color Coding.

Agent T. C. George's Tariff No. 19 Publishing Hazardous Materials Regulations of the Department of Transportation Including Specifications for Shipping Containers (2 Pennsylvania Plaza, New York, N.Y. 10001).

Army Materiel Command Regulations of the 885-Series.

Section II. COMPARABLE PUBLICATIONS OF DEPARTMENT OF THE ARMY AND OEPARTMENT OF THE ASR FOR

Comparable Department of the Army and Department of the Air Force publications are listed below.

Army Publication	Comparable Air Force Publication	Army Publication	Comparable Air Force Publication
AR 55-56	AFM 127-100	TM 8-4240-202-12	TO. 14P4-9-1
	AFR 136-4		T.O. 14P4-9-3-1
AR 566-228	AFM 127-100	TM 3-4240-281-12	AFM 127-100
AR 55665	AFM 75-2	TM 8-286	AFM 160-12
AR 740-82	AFR 1864	TM 9-1300-206	AFM 127-100
	T.O. 11C-1-8		AFR 127-4
FM 21-40	AFM 160-12	AFM 855-7	
	AFR 85-16	TM 10-77	T.O. 14P8-1-7
	AFR 855-17	T.O. 14P8-1-9	
	AFM 8566-7	TM 88-250	AFM 71-4
TM 3-215	T.O. 11C2-6-7	SB -80-Serle	T.O. 11A-1-10
	T.O. 11C15-3-2-7		
	T.O. 00-110	DA Label	AF Form
	T.O. 00-110-1	18	1598
	T.O. 110-1-1-1	25	1606
TM 3-220	T.O. 11D1-1-1	31	1591
	T.O. 11H2-1-2	47	1600
	T.O. 11H2	48	168
	T.O. 14P4-1-144	56	1601

DA Label	AF Form	DA Label	AF Form.
57	1602	67	1605
68	141	68	1607
62	1608	69	1596
68	1598	71	1594
64	1604	78	1595
65	1592	88	1597
66	1542		

APPENDIX B
SIGNS AND MARKINGS FOR STORAGE OF CHEMICAL MUNITIONS

1. Classification

To simplify the problems of safety and fire fighting, explosives and chemicals are divided into various groups according to their nature.

a. *Explosives.* Chemical ammunition items and explosive components are divided into 12 explosive hazard classes. (See tables in Army Materiel Command Regulation 385-224.)

b. *Chemicals.* There are four chemical storage groups as already discussed. (See para 8, this manual, and table 2902, AMCR S85-224.)

2. Signs on Buildings and Storage Areas

As a guide and warning to personnel working around areas where dangerous bulk chemical agents or munitions are stored, appropriate signs will be used to caution all concerned. Whenever practicable, signs similar to those described below will be posted near entrances to storage areas.

a. For Group A (Excluding Nerve Agents) Ammunition or Agents. THIS MAGAZINE (OR STORAGE AREA) CONTAINS GROUP A CHEMICAL MUNITIONS REQUIRING THE CARRYING OF A PROTECTIVE MASK. IF LEAKING MUNITIONS OR ODOR IS PRESENT, WEAR PROTECTIVE MASK AND COMPLETE PROTECTIVE CLOTHING.

b. For Group B Ammunition or Agents.
THIS MAGAZINE (OR STORAGE AREA) CONTAINS GROUP B (TOXIC, RIOT CONTROL, OR SMOKE) CHEMICAL MUNITIONS REQUIRING THE CARRYING OF A PROTECTIVE MASK. IF LEAKING MUNITIONS OR ODOR IS PRESENT, WEAR PROTECTIVE MASK.

c. For Group C Ammunition or Agents. THIS MAGAZINE (OR STORAGE AREA) CONTAINS GROUP C (SPONTANEOUSLY FLAMMABLE) CHEMICAL MUNITIONS.

d. For Group D Ammunition or Agents. THIS MAGAZINE (OR STORAGE AREA) CONTAINS GROUP D (INCENDIARY AND READILY FLAMMABLE) CHEMICAL MUNITIONS. DO NOT USE WATER ON FIRES.

e. For Special Hazard (Nerve Agents) Ammunition or Agents. THIS MAGAZINE (OR STORAGE AREA) CONTAINS NERVE AGENTS (SPECIAL HAZARD), AGAINST WHICH COMPLETE IMPERMEABLE PROTECTIVE CLOTHING PLUS PROTECTIVE MASK ARE REQUIRED. IF ANY PERSON IS SPLASHED BY LIQUID AGENT, WASH IMMEDIATELY WITH LARGE AMOUNTS OF WATER. INJECT ATROPINE FROM FIRST-AID PACKET IMMEDIATELY IF SYMPTOMS OF NERVE AGENT POISONING APPEAR. IF BREATHING STOPS, ADMINISTER ARTIFICIAL RESPIRATION. EVACUATE TO HOSPITAL IMMEDIATELY.

3. Hazard Markers

To provide a guide for fire-fighting personnel and others during emergencies, storage areas (warehouses, bunkers, open areas, etc.), with the exception of earth-covered magazines or outdoor revetted areas in which storage is limited to symbol 4 explosives, will be marked to indicate the primary degree of heat, missile, and concussion hazard (a below) and the degree of primary hazard of the chemical agents stored there (b below). The markers are removable plaques at least 24 inches high and 20 inches wide and visible from all approaches of fire fighters. Lettering or stripes will be on a yellow background. Signs made from reflectorized or luminous materials are preferred.

a. Explosive Markers. To aid in identification of the markers at long distances, each has a characteristic shape.

(1) *Marker 1.* The background plaque is rectangular (fig. 78). Included in this group are explosive classes i and 8 and solvents, oils, paint, gasoline, solid propellants, compressed gases, and metallic powders when packed in

closed shipping containers approved by the DOT. Enter the area with care.

(2) *Marker 2.* The background plaque is square (fig. 74). Class 3 ammunition and explosives are placed in this group. These items usually explode progressively with not more than a box or two exploding at a time. Missiles are small and light in weight, usually falling within 800 feet.

(3) *Marker 3.* Th background plaque is diamond-shaped (fig. 75). All class 2 and 2A explosives are in this group. There is an intense radiant heat hazard. Fire-fighting operations should be confined to preventing the spread of the fire. The danger from concussion is practically negligible, and except for WP-filled items and smokeless powder, the missile hazard is limited to about 100 feet. In the case of WP-filled items and smokeless powder, it can be expected that molten WP, parts of containers, and whole containers will be scattered over distances up to 500 feet.

(4) *Marker 4.* The background plaque is octagonal-shaped (fig. 76). Explosive classes 5, 6, and 7 are in this group. There is a severe missile and concussion hazard, marking fire fighting impossible after a fire has gained headway. Keep 1,000 feet away until clearance is granted to enter the area.

b. Chemicals. The chemical grouping of ammunition items and bulk chemicals is governed by table 2902, AMCR 885-224. A yellow disk with a diameter of at least 24 inches is the standard hazard marker for chemical ammunition and agents (except nerve agents).

(1) *Group A.* These are toxic chemical agents against which complete protective clothing and protective masks are required. Work upwind. The hazard marker bears two parallel black bands

Yellow rectangular plaque with black numbering

INDICATES

Explosive classes 1 and 8 and solvents, oils, paint, gasoline, solid propellants, compressed gases, and metallic powders when packed in closed shipping containers approved by the Department of Transportation. Diagonal lines indicating persistency may be superimposed over fire hazard symbols.

PRECAUTION

Enter with care.

Figure 73. Hazard marker 1.

Yellow square plaque with black numbering

INDICATES

All class 3 ammunition and explosives. Diagonal lines indicating persistency may be superimposed over fire hazard symbols.

HAZARD

Limited explosive hazard.

Figure 74. Hazard marker 2.

4 inches wide, running from upper right to lower left across the disk. See figure 77.

(2) *Group B except BZ.* These are toxic chemical agents for which protective masks are required, nonburning screening smokes, and nonburning mixtures of riot control agents. Work upwind. The hazard marker bears one diagonal black band. See figure 78.

Yellow diamond-shaped plaque with black numbering

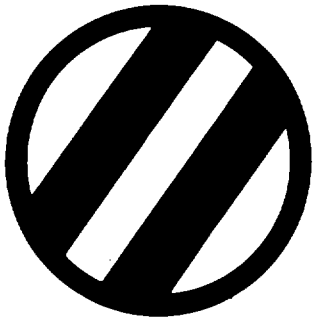
INDICATES	HAZARD OR PRECAUTION
All class 2 and 2A explosives. Diagonal lines indicating persistency may be superimposed over fire hazard symbols.	Intense radiant heat. Confine fire-fighting operations to prevent spread of fire.

Figure 75. Hazard marker 3.

Yellow octagonal-shaped plaque with black numbering

INDICATES	PRECAUTION
Explosive classes 4, 5, 6 , 7, and 8. Diagonal lines indicating persistency may be superimposed over fire hazard symbols.	Keep 1,000 feet away until clearance is granted to enter the area. When the question of safety is in doubt, no effort will be made to extinguish the fire. If safe to enter, protect adjacent buildings and attempt to extinguish the fire.

Figure 76. Hazard marker 4.



Yellow disk with 2 parallel black bands

INDICATES	PRECAUTION
Group A (except nerve agents).	Wear complete protective clothing and protective mask. Work upwind.

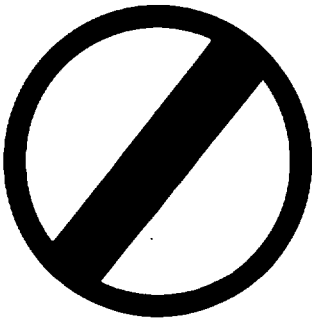
Figure 77. Hazard marker for group A.

(3) *BZ.* Because of the special nature of the incapacitating agent BZ, it is identified by a separate hazard marker bearing the black letter "Z" on a circular yellow disk. See figure 79.

(4) *Group C.* These are spontaneously flammable chemical agents. It is dangerous to enter the storage area without lifeline and protective mask. See figure 80.

(5) *Group D.* These are incendiary and readily flammable chemical agents. There is an intense radiant heat hazard. Do not use water to extinguish fires as there is a danger of explosion. See figure 81.

(6) All nerve agents. Because of their special hazard, the nerve agents are placed in a separate category. Complete protective clothing and protective mask must be worn. Do not enter until clearance is granted. See figures 82 and 83.



Yellow disk with diagonal black band

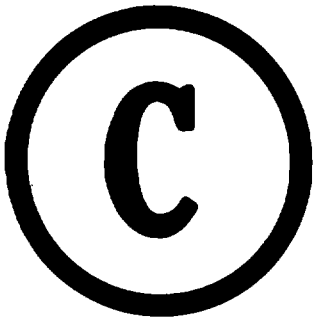
INDICATES	PRECAUTION
Group B toxic chemical agents, nonburning screening smokes, and nonburning mixtures of riot control agents.	Use protective mask. Work upwind. Enter with care.

Figure 78. Hazard marker for group B (except BZ)

Yellow disk with black letter Z

INDICATES	PRECAUTION
Special chemical hazard. Incapacitating agent BZ.	Use protective mask. Work upwind. Enter with care.

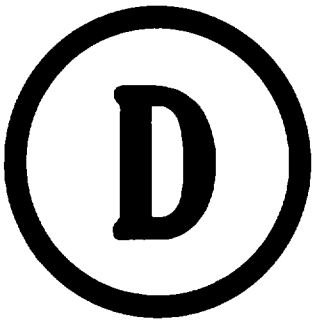
Figure 79. Hazard marker for agent BZ



Yellow disk with black letter C

INDICATES	HAZARD
Group C spontaneously flammable chemical agents.	Dangerous to enter without lifeline and protective mask.

Figure 80. Hazard marker for group C.



Yellow disk with black letter D

INDICATES	HAZARD
Group D incendiary and readily flammable chemical agents.	Intense radiant heat. Danger of explosion if water is used to attempt to extinguish fire.

Figure 81. hazard marker for group D.

Yellow disk with black letter G

INDICATES	PRECAUTION
Special chemical hazard. G-type nerve agents.	Wear complete protective clothing and protective mask. Do not enter until clearance is granted.

Figure 82. Hazard marker for G-type nerve agents.

Yellow disk with black letter V

INDICATES	PRECAUTION
Special chemical hazard. V-type nerve agents.	Wear complete protective clothing and protective mask. Do not enter until clearance is granted.

Figure 83. Hazard marker for V-type nerve agents.

c. Examples. Examples of typical hazard markings are given below:

APPENDIX C
DETERMINATION OF DOWNWIND TOXIC VAPOR HAZARD

1. General

This appendix contains information on the uses of the ABC-M2 point source downwind toxic vapor hazard calculator (FSN-666598-986), the ABC-MS line source downwind toxic vapor hazard calculator (FSN-6665-898-0985), and the point source downwind toxic vapor hazard nomogram (fig. 88). Both calculators are available through normal supply channels. The nomogram is included in paragraph 6 of this appendix. A description of the calculators and the nomogram, definitions of terms used with the calculators and the nomogram, and typical calculations are included in this appendix.

2. Use

The ABC-M2 point source and the ABC-MS line source downwind toxic vapor hazard calculators and the point source nomogram are designed for use by safety personnel concerned with the storage, shipment, handling, and disposal of toxic chemical agents. The ABC-M2 calculator and the point source nomogram provide tools for the rapid determination of the distance downwind that a toxic vapor cloud of a given dosage may be expected to exist when a toxic chemical agent is released from a point source. The determination can be made either when the release is instantaneous, as when a munition exploded, or when the release is continuous, as when a container leaks. The ABC-M8 calculator provides a tool for the rapid determination of the distance downwind that a toxic vapor cloud of a given dosage may be expected to exist from a true line source release of a toxic chemical agent. The ABC-M2 calculator and the ABC-M3 calculator also may be used in target analyses.

Note.

When using the calculators, all weights, distances, and rate of speed must be converted to the metric system. Use the conversion factors on the calculators for these conversions. Use the conversion factors on the calculators for the conversions.

3. Definitions of Terms

For the purposes of this appendix, the following definitions apply:

a. Downwind Toxic Vapor Hazard Distance. The downwind toxic vapor hazard distance is the distance downwind from a point source release or a line source release of a toxic chemical agent where a cloud with a given level of agent toxicity can be expected.

b. Dosage. Dosage is the concentration of a toxic vapor in the air multiplied by the time (minutes) that the concentration exists or the time that an individual is exposed to a given concentration of toxic vapor. Dosage is expressed in milligram-minutes per cubic meter (mg-min/ m').

Note

Since dosage is dependent upon concentration and time, the same dosage can be obtained by a short exposure to a high concentration or by a long exposure to a low concentration..

c. Concentration. Concentration is the amount of toxic vapor contained in a unit volume of air. Concentration is expressed in milligrams per cubic meter (mg/m^3).

d. Source Strength. Source strength is the weight of a toxic chemical agent that has been released as a vapor. Source strength is expressed in kilograms (kg) for an instantaneous point source. Source strength is expressed in kilograms per minute (kg/min) for a continuous point source. Source strength is expressed in kilograms per meter (kg/m) for a line source.

e. Wind Speed. Wind speed is the speed of the wind at the time of release of the source. Wind speed is expressed in meters per minute (m/min).

f. Vertical Temperature Gradient. Vertical temperature gradient is the change in temperature with altitude. It is obtained by subtracting the air temperature at 0.5 meter above the ground from the air temperature at 4 meters above the ground. Vertical temperature gradient is expressed in degrees Fahrenheit (°F.). See TM 3-240 for further information on vertical temperature gradients.

g. Line Source Length. Line source length is the actual distance over which the toxic chemical

agent is released. Line source length is expressed in kilometers (km).

h. Reference K. Reference K is a constant computed from a known set of values (b-g above). K is used to determine downwind distance with the ABC-M3 line source downwind toxic vapor hazard calculator.

i. Cloud Width. Cloud width is the width of the toxic vapor cloud at the downwind toxic vapor hazard distance. Cloud width is expressed in meters (m).

j. Point Source. Point source is the actual point where the toxic chemical agent is released.

4. ABC-M2 Point Source Downwind Toxic Vapor Hazard Calculator

a. Description. The ABC-M2 point source downwind toxic vapor hazard calculator is issued in a plastic protective envelope. The calculator consists of an inner disk and an outer disk with a swing scale superimposed on the two disks. The disks and the swing scale are affixed concentrically by a center rivet which permits the rotation of the inner disk and the swing scale over the stationary outer disk.

(1) *Inner disk.* The inner disk is made of laminated white plastic. A dosage (D) scale is imprinted in red on the outer edge of the disk.
A cloud width-meters scale and two sets of vertical temperature gradient curves are imprinted in black on the inner surface of the disk.

(2) *Outer disk.* The outer disk is made of laminated white plastic. A wind speed (U) scale is imprinted in red and a source strength (Q) scale is imprinted in black on the edge of the outer disk. Brief instructions on the use of the calculator and a list of conversion factors are imprinted in black on the back of the calculator.

(3*) Swing scale.* The swing scale is made of transparent plastic and is imprinted in black with a downwind distance-km scale.

b. Limitations. The ABC-M2 point source downwind toxic vapor hazard calculator can be used only for toxic chemical agents capable of being vaporized and only when four values are known. These values are dosage, wind speed, source strength, and vertical temperature gradient.

(1) *Dosage.* An acceptable dosage must be determined. Acceptable dosages of military toxic chemical agents listed in table 6 can be used as guides.

(2*) Wind speed.* The wind speed must be determined at the point of release by use of an accurate anemometer (TM 3-240).

(3) *Source strength.* The -actual weight of toxic agent released must be known.

(4) *Vertical temperature gradient.* Vertical temperature gradient must be determined in the area of the release at the time the release occurs.

Note.
Utmost care must be exercised to obtain an accurate temperature gradient. An error of 1° in the temperature gradient can produce a significant error in the downwind toxic vapor hazard distance.

c. Instantaneous Point Source Calculations.

(1) Problem 1. Ten pounds of toxic chemical agent are released at a given point. At what distance downwind can a toxic vapor cloud having a dosage of 2 mg-min/m' be expected to exist and how wide will the toxic cloud be at that distance?

Table 6. Acceptable Dosage for Computing Downwind Hazard

(For use with ABC-M2 or ABC-M3 calculator or nomogram, fig. 88)

	chemical agent	Acceptable dosage $\frac{\text{mg-min}}{M^3}$
	GA	80
Nerve	GB	2
	GD	2
	GD	26
	HD, HN.....	25
	AC.....	100
Blood	CK.....	700
Choking	CG, DP	150
Riot	CS.....	1*'
Control	CN.....	10*
	DM	10*
Incapaci-tating	BZ	10*

*The calculators and nomogramn are designed for calculation of vapor hazards, but either calculator or the nomogram will indicate approximate range of effects of these agents if the figure for acceptable dosage is used for the computation.

(2*) Solution to problem 1.* The following meteorological conditions were found to exist:

(a) Wind speed - 2 miles per hour (53.6 meters per minute).

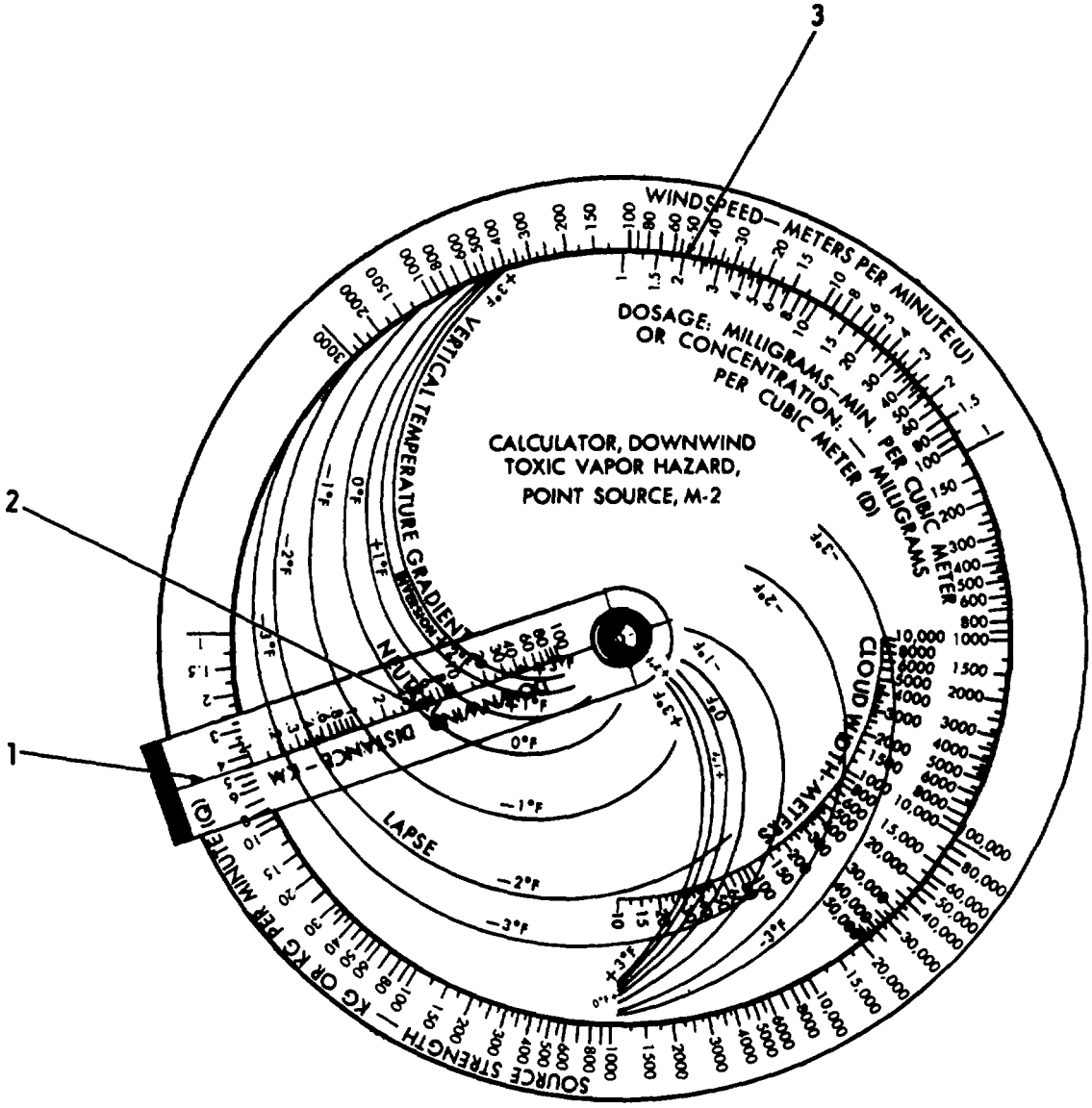
(b) Temperature gradient - 0° F.

Step 1. Aline the dosage (2 mg-min/ m') on scale D with the wind speed (58.6 meters per minute) on scale U. Hold this setting (3, fig. 84).

Step 2. Swing the swing scale so that the base line of the swing scale alines with 10 pounds (4.5 kg) on scale Q. Hold this setting 1, fig. 84).

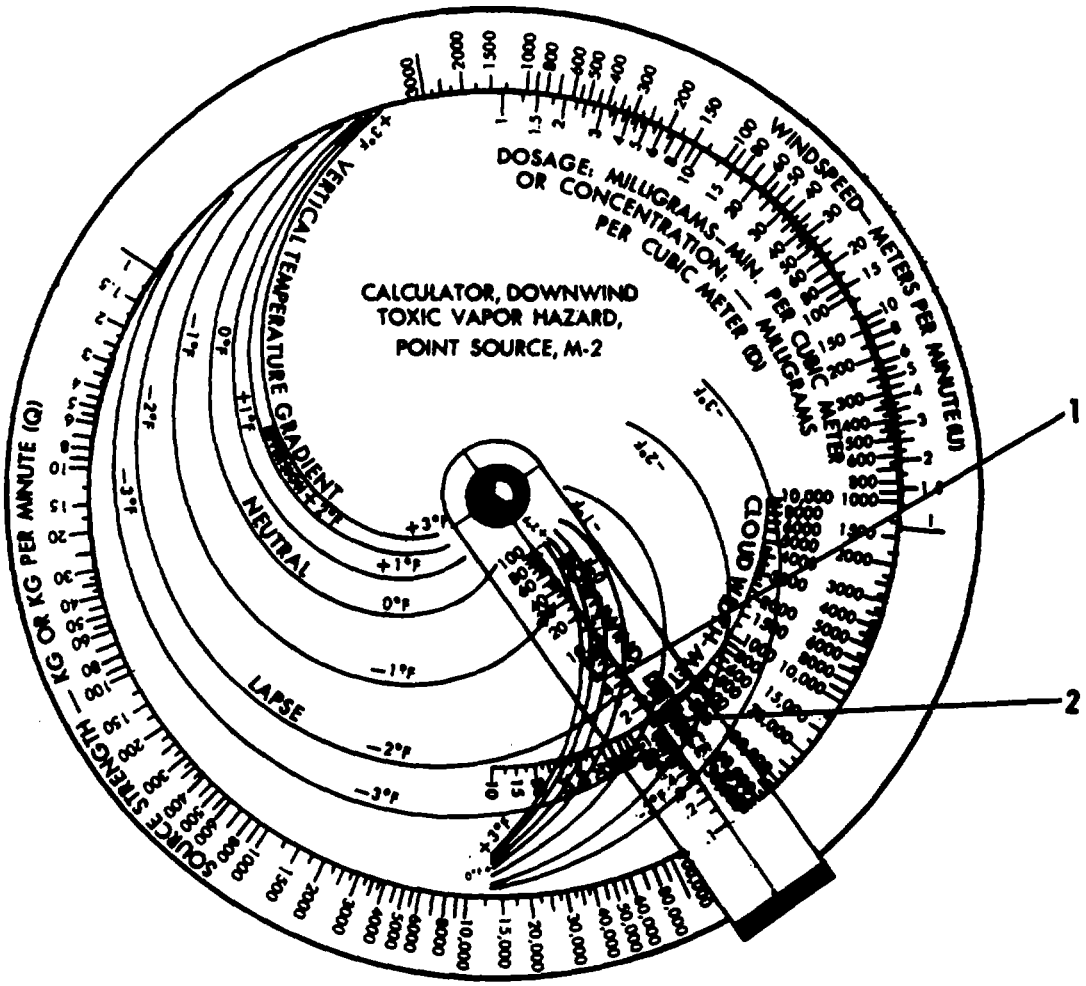
Step 3. Read the distance on the swing scale at the point where the 0° F. temperature gradient curve intersects the base line of the swing scale. This is the downwind toxic vapor hazard distance, which is approximately 4.5 kilometers (2, fig. 84).

Step 4. Swing the swing scale over into the cloud width-meters scale so that 4.5 kilometers (toxic vapor hazard distance, step 3) on the swing scale intersects the 0° F. temperature gradient curve in that area (1, fig. 85). Hold this setting and read the cloud width where the base line on the swing scale alines with the cloud width-meters scale. This is the cloud width at 4.5 kilometers downwind, which is approximately 150 meters (2, fig. 85).



1. Swing scale alined with source strength
2. Swing scale alined with vertical temperature gradient curve
3. Dosage alined with wind speed

Figure 84. Determining downwind toxic vapor hazard distance (instantaneous point source), ABC-M2 calculator.



1. Swing scale intersected by vertical temperature gradient curve
2. Swing scale alined with cloud width-meters scale

Figure 85. Determining downwind toxic vapor hazard distance (instantaneous point source), ABC-M2 calculator.

(3) *Problem 2.* A toxic chemical agent is to be released at a given point. What amount of toxic agent can be released in order that a dosage of not more than 2 mg-min/m' will be received at a downwind distance of 5 kilometers from the point of release?

(4) *Solution to problem 2*. The following meteorological conditions were found to exist:

(a) Wind speed - 10 miles per hour (268 meters per minute).

(b) Temperature gradient - 80 F.

Step 1. Aline the dosage (2 mg-min/m') on scale D with the wind speed (268 meters per minute) on scale U. Hold this setting.

Step 2. Swing the swing scale so that 5 kilometers on the base line of the swing scale intersects the 80 F. temperature gradient curve. Hold this setting.

Caution:
Do not es the temperature gradient curve in the cloud width-meters area.

Step 3. Read the source strength where the base line of the swing scale intersect scale C This is the amount of toxic chemical agent that will produce a dosage of 2 mg-min/m' at a downwind distance of 5 kilometers, which is 2 kilograms.

d. Continuous Point Source Calculations. Steps in continuous point source calculations are the same as steps for instantaneous point source calculations. Source strength is expressed in kilo-

grams per minute (kg/min) rather than in kilograms.

(1) *Problem.* A toxic chemical agent is released at a rate of 2 kilograms per minute from a given point. What distance downwind can a toxic cloud having a dosage of 25 mg-min/m' be expected to exist and how wide will the cloud be at that distance?

(2) *Solution.* The following meteorological conditions were found to exist:

(a) Wind speed - 12 miles per hour (322 meters per minute).

(b) Temperature gradient - 2° F.

Step 1. Aline the dosage (25 mg-min/ m') on scale D with the wind speed (322 meters per minute) on scale U. Hold this setting.

Step 2. Swing the swing scale so that the base line of the swing scale alines with 2 kilograms per minute on scale Q. Hold this setting.

Step 3. Read the distance on the swing scale at the point where the 2° F. temperature gradient curve intersects the base line of the swing scale. This is the downwind toxic vapor hazard distance, which is approximately 0.4 kilometer.

Step 4. Swing the swing scale over into the cloud width-meters scale so that 0.4 kilometer (approximately) on the swing scale intersects the 2° F. temperature gradient curve in that area. Hold this setting and read the cloud width where the base line of the swing scale alines with the cloud width-meters scale. This is the cloud width at approximately 0.4 kilometer downwind, which is approximately 15 meters.

5. A C3 Line Source Downwind Toxic Vapor Hazard Calculator

a. Description. The ABC-M8 line source downwind toxic vapor hazard calculator consists of three opaque white plastic disks and one transparent plastic disk held together by a centrally positioned aluminum rivet. On the front of the calculator, an inner disk and an intermediate disk are mounted concentrically on an outer disk.
The transparent disk is mounted on the reverse side of the calculator. The calculator is issued in a green plastic protective envelope.

(1) *Inner disk.* The inner disk has a dosage (D) scale in red and a source strength (Q) scale in blue imprinted on the outer edge. Instructions and conversion factors are imprinted in black on the inner surface.

(2) *Intermediate disk.* The intermediate disk has a line source length (L) scale in red and a vertical temperature gradient (ATG) scale in black imprinted on the outer edge. That portion of the intermediate disk not used for scale has been cut away to aline with the outer edge of the inner disk.

(3) *Outer disk.* On the front the outer disk has a reference K scale in black and a wind speed (U) scale in blue imprinted on the outer edge to conform with the cutaway portion of the outer edge of the intermediate scale. On the reverse side the outer disk has a reference K scale in black on the outer edge with a set of vertical temperature curves in black on the inner surface area.

(4) *Transparent disk.* The transparent disk has a line source length-kilometers (L) scale in black on the outer edge and a downwind distance scale in black on the inner surface area.

b. Limitations. The ABC-M3 line source downwind toxic vapor hazard calculator can be used only for toxic chemical agents capable of being vaporized and only when five values are known. These values are dosage, wind speed, source strength, line source length, and vertical temperature gradient.

(1) *Dosage.* An acceptable dosage must be determined. Acceptable dosages of military toxic chemical agents listed in table 6 can be used as guides.

(2) *Wind speed.* The wind speed must be determined at the time of release by use of an accurate anemometer (TM 3-240).

(3) *Source strength.* The actual weight of toxic chemical agent released must be known.

(4) *Line source length.* The actual distance over which the toxic chemical agent is released must be known.

(5) *Vertical temperature gradient.* Vertical temperature gradient must be determined in the area of release at the time the release occurs.

Note.
Utmost care must be exercised to obtain an accurate temperature gradient. An error of 1° in vertical temperature can produce a significant error in the downwind toxic vapor hazard distance

c. Calculations.

(1) *Problem 1.* Nine hundred kilograms of toxic chemical agent are released over a line 400 meters (0.4 km) long. At what distance downwind can a toxic vapor cloud having a dosage of 75 mg-min/m^3 be expected to exist?

(2) *Solution to problem 1.* The following meteorological conditions were found to exist:
(a) Wind speed - 8 miles per hour (approximately 215 meters per minute).

(b) Vertical temperature gradient (ΔTG) =2° F.

Step 1. Determine the source strength by dividing the weight of toxic chemical agent released by the line source length. 900 ÷ 400 - 2.25 kilograms per meter (scale Q).

Step 2. Aline the source strength (2.25 kg/m) on scale Q with the wind speed (approximately 215 m/min) on scale U. Hold this setting (3, fig. 86).

Step 3. Aline the dosage (75 mg-min/m^3) on scale D -with the line source length (0.4 km) on scale L. Hold this setting (1, fig. 86).

Step 4. Read the value on the reference K scale where the vertical temperature gradient (-2°F.) on scale ATG alines with the reference K scale (2, fig. 86). This value is 12.3.

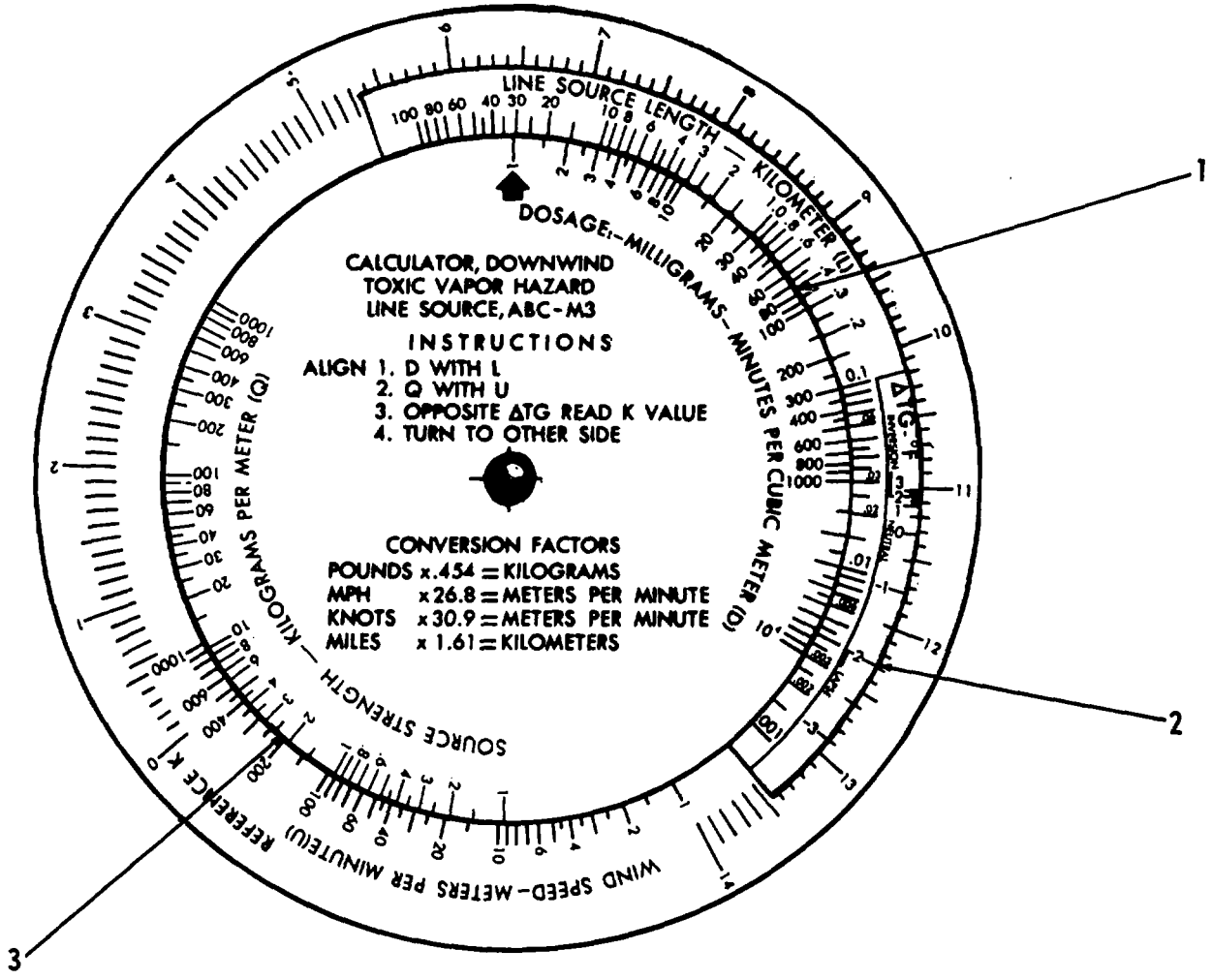
Step 5. Turn the calculator over and aline the line source length (0.4 km) on scale L with 12.3 on the reference K scale (2, fig. 87). Hold this setting.

Step 6. Read the value on the downwind distance scale at the point where the base line of the scale intersects the -2° F. vertical temperature gradient curve (1, fig. 87). This value is 200 meters (0.2 km), which is the downwind toxic vapor hazard distance.

(3) *Problem 2.* Seven hundred and fifty kilograms of toxic chemical agent are released over a line 300 meters (0.3 km) long. At what distance downwind can a toxic vapor cloud having a dosage of 100 mg-min/m' be expected to exist?

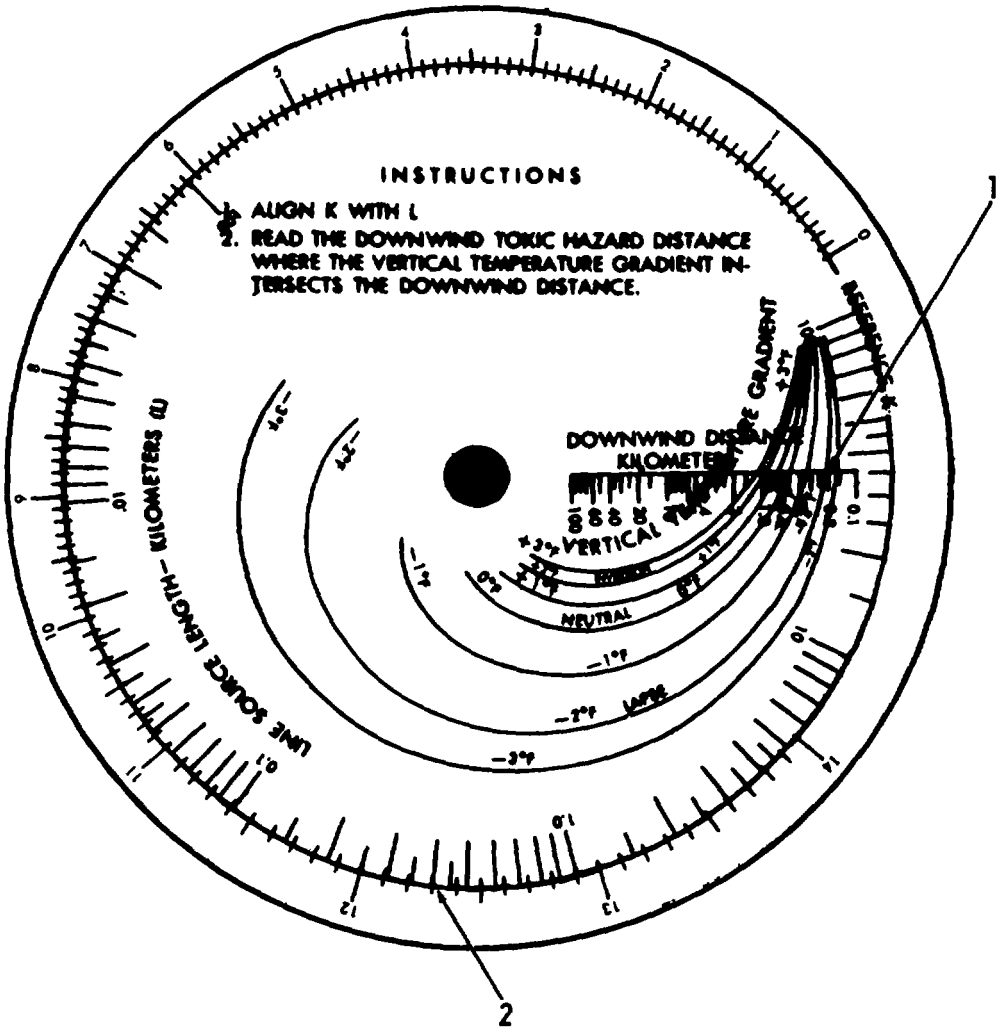
(4) *Solution to problem 2.* The following meteorological conditions were found to exist:

(a) Wind speed = 6 miles per hour (approximately 161 meters per minute).



1. Scale D alined with scale L
2. ΔTG scale alined with reference K scale
3. Scale Q alined with scale U

Figure 86. Determining reference K, ABC-M3 calculator



1. Intersection of -2° F. curve with downwind distance scale
2. Scale L alined with reference K scale

Figure 87. Determining downwind toxic vapor hazard distance, ABC-M3 calculator.

(b) Vertical temperature gradient (ATG) -- 0 ° F.

Step 1. Determine the source strength by dividing the weight of toxic chemical agent released by the line source length. 750÷300 = 2.50 kilogram per meter (scale Q)

Step 2. Alone the source strength (2.6 kg/m) on scale Q with the wind speed (approximately 161 m/min) on scale U. Hold this setting.

Step 3. Aline the dosage (100 mg-min/ m') on scale D with the line source length (0.8 km) on scale L. Hold this setting.

Step 4. Read the value on the reference K scale where the vertical temperature gradient (0° F.) on scale ATG alines with the reference K scale. This value is 11.1.

Step 5. Turn the calculator over and aline the line source length (0.3 km) on scale L with 11.1 on the reference K scale.

Step . 6 Read the value on the downwind distance scale at the point where the base line of the scale intersects the 0° F. vertical temperature gradient curve. This value is 4 kilometers, which is the downwind toxic vapor hazard distance.

6. Point -Source Downwind Toxic Vapor Hazard Nomogram

a. Description. The point source downwind toxic vapor hazard nomogram (fig. 88) contains four scales, two reference lines, and a set of temperature gradient curves.

(1) *Scale Q*. Scale Q is the source strength scale. Source strength is indicated in pounds/ pounds per minute on the left side of the scale and in kilograms/kilograms per minute on the right side of the scale.

(2) *Scale D.* Scale D indicates the acceptable dosage in milligram-minutes per cubic meter (mg-min/m'). See table 6 for acceptable dosages for military toxic chemical agents.

(3) *Scale U*. Scale U indicates the wind 'speed at the time of release of the agent. The left side of the scale indicates the wind speed in miles per hour (MPH), while the right side indicates the wind speed in meters per minute (m/min).

(4) *Scale DD*. Scale DD indicates the downwind distance in kilometers on the top of the scale and in miles on the bottom of the scale.

(5) *Reference lines 1 and 2.* These lines are used for intermediate steps in calculating the downwind toxic vapor hazard distance.

(6) *Temperature gradient curves*. The set of temperature gradient curves represents seven vertical temperature gradients ranging from -3° F.
to +30 F.

Figure 88. Point source downwind toxic vapor hazard nomogram.
(**Located in back of manual**)

b. Limitations. The point source downwind toxic vapor hazard nomogram can be used only for toxic chemical agents capable of being vaporized and only when four values are known. These values are dosage, wind speed, source strength, and vertical temperature gradient. For a discussion of these values, see paragraph 4b of this appendix.

c. Instantaneous Point Source Calculation.

(1) *Problem*. Ten pounds of toxic chemical agent are released at a given point. At what distance downwind can a toxic vapor cloud having a dosage of 2 mg-min/m' be expected to exist?.

(2) *Solution to problem.* The following meteorological conditions were found to exist:

(a) Wind speed - 5 miles per hour (184 meters per minute).

(b) Temperature gradient - -1° F.

Step 1. With a hairline or straightedge, aline the wind speed (5 miles per hour) on scale U ((1), fig. 88) with the dosage (2 mg min/m^3) on scale D ((2), fig. 88). Place a mark at the intersection of this line and reference line 1 ((8), fig. 88).

Step 2. Next, lay a line from the source strength (10 pounds) on scale Q ((4), fig. 88) through the mark placed on reference line 1 ((8), fig. 88) and continue this line to reference line 2. Place a mark at the intersection of this line and reference line 2 ((5), fig. 86).

Step 3. Lay a line at right angles to the mark on reference line 2. Continue this line to the correct temperature gradient curve, which is -1° F. ((6), fig. 88).

Step 4. From the intersection of the line drawn in step 8 and the temperature gradient curve, lay a straight line to the bottom of the chart so that the line intersects scale DD ((7), fig. 88). This will give the downwind vapor hazard distance, which is approximately 0.85 kilometer (850 meters) or approximately 0.53 mile.

*d. Continuous Point Source Calculation*s. Steps in continuous point source calculations are the same as steps for instantaneous point source calculations. Source strength is expressed in pounds per minute rather than in pounds, or in kilograms per minute rather than in kilograms.

INDEX

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For explanation of abbreviations used, see AR 820.

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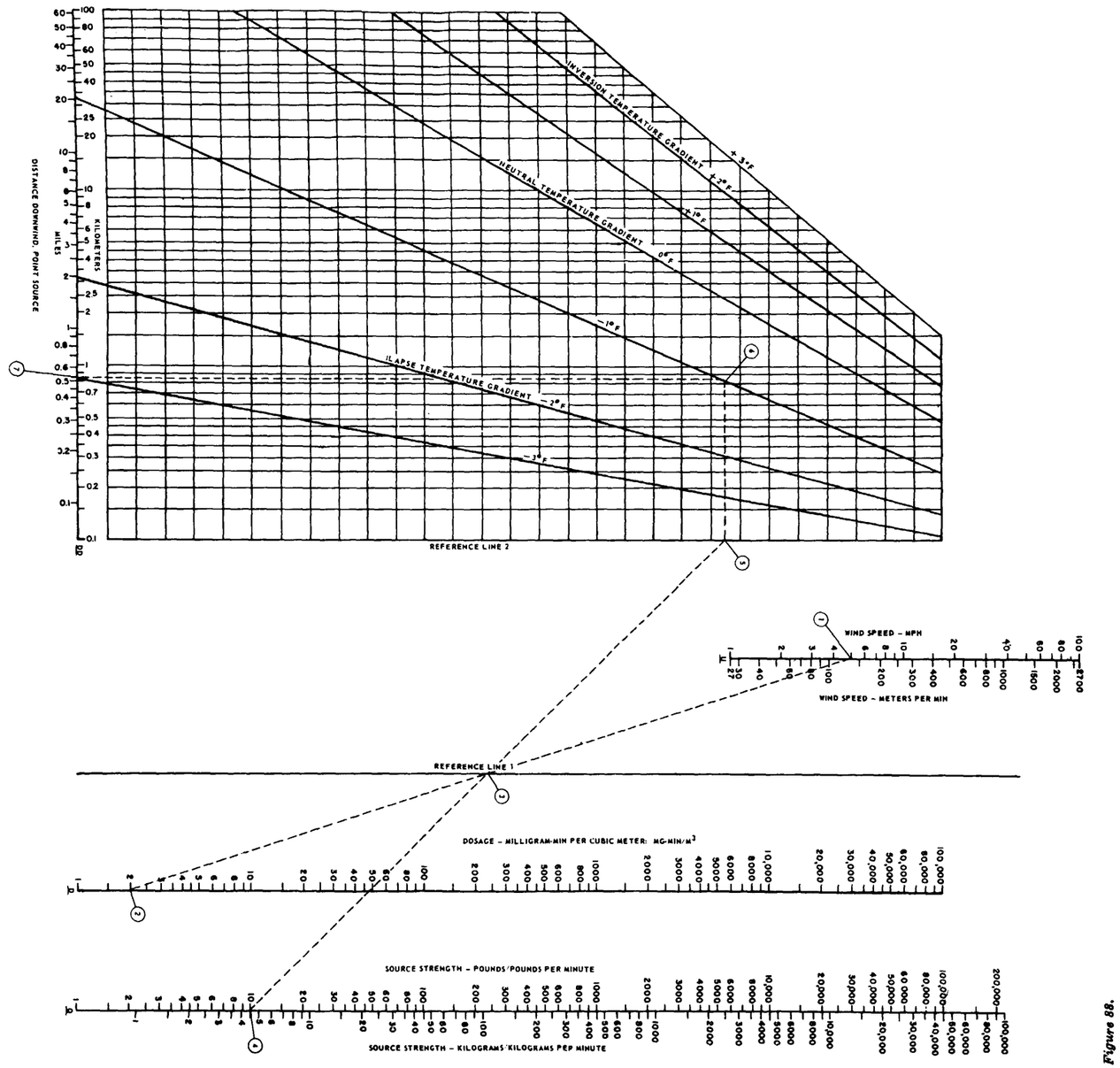

Figure 88.

Figure 88. Point source downwind toxic vapor hazard nomgram

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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