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ORD 2509

NAVAL CHEMICAL MUNITIONS
(Preliminary Manuscript)

Contract NOrd 14547

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BY AUTHORITY OF CD NRI/16
DD SYSTEMS/PAID
NAVAL DC/NAVAL CP
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ORGANIZATION AND LOCATION	ATTN: Mr. G. F. Wohlgemuth	DATE	COORDINATION
2	Munitions Branch		FILE
			INFORMATION
3			NECESSARY ACTION
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REMARKS			
It is the opinion of this office that Hq CmlC RECOM should not comment on the attached draft from Department of Navy, but recommend that Department of Navy personnel responsible for writing the preliminary manuscript be thoroughly oriented by Hq CmlC RECOM and CmlC Engr Agency as to CmlC standards to be included, ^{so} ~~as~~ there will be no conflict between the finished manuscript, and current CmlC directives.			
FROM NAME OR TITLE		DATE	
THOMAS H. AYERS, Asst Chief, Safety Office		26 Apr 55	
ORGANIZATION AND LOCATION		TELEPHONE	
RECOM		8-2251	

DD FORM 95
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Replaces DA AGO Form 895, 1 Apr 48, and AFHQ Form 12, 10 Nov 47, which may be used.

16-48487-4 GPO

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REMARKS			
<i>In review and comments</i> <i>Conts due O asued</i> <i><u>27 April 55</u></i> <i>Recommend that Navy be contacted to arrange for Navy Personnel to visit Sec. (Hendenburg, Fleming & Hollingsworth) to resolve the numerous gross errors contained therein. Errors are so bad that comment could not be made without re-writing</i> <i>Approved</i>			
FROM NAME OR TITLE <i>TCE DW</i>	DATE <i>19 April 55</i>		
ORGANIZATION AND LOCATION	TELEPHONE <i>82122</i>		

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COMMENTS AND SUGGESTED CHANGES OF
THE FIELD THERAPY COMMITTEE ON THE
PRELIMINARY MANUSCRIPT, "NAVAL
CHEMICAL MUNITIONS," ORD-2509.

14 April 1955

Chemical Corps Medical Laboratories
Army Chemical Center
Maryland

ML 4-69-(55)-S

COMMENTS AND SUGGESTED CHANGES OF THE FIELD THERAPY COMMITTEE ON THE
PRELIMINARY MANUSCRIPT, "NAVAL CHEMICAL MUNITIONS," ORD-2509, 14 APRIL
1955 - Page 2

<u>Page</u>	<u>Para or Line</u>	<u>Comments and Suggested Changes</u>
GG 1-15		<u>Add paragraph on artificial respiration as follows:</u> The back pressure-arm lift method of artificial respiration may be used on the casualty wearing his gas mask in a contaminated area. Should this method not be effective, the mouth-to-mouth method is recommended. The air passages should be kept free of mucus and froth."
EH 1-16	<u>Skin:</u>	<u>Delete:</u> 5% Na ₂ CO ₃ . <u>Substitute:</u> 3% Sodium Bicarbonate, if available.
	<u>Mouth:</u>	<u>Delete.</u> <u>Substitute:</u> Rinse with water and then with 3% Sodium Bicarbonate, if available.
	<u>Eye:</u>	<u>Delete.</u> <u>Substitute:</u> Irrigate with water and then with 3% Sodium Bicarbonate, if available.
1-17	<u>Table A</u>	Under Median Lethal Dosage add "uncovered" to No. 3 so that it reads "3. Skin contact, liquid, uncovered". Change GB dose to 1 to 2 grams per 150 lb. man. <u>Add:</u> "No. 4, Skin contact, liquid, covered with clothing." - GB dose "300 mg. per 150 lb. man."
2-10	L-14 & 15	<u>Change:</u> "2000 mg./min./M ³ " to "2000 milligrams per 150 lb. man"
2-12	L-2 & 5	<u>Change:</u> "concentration" to "dosage"
2-14	P-2 L-8	<u>Change to read:</u> Irrigate with water copiously for 30-120 seconds. If the eye pains, then apply BAL Eye Ointment.
11-22	L-16	<u>Change:</u> "psittacosis". . . to "intercurrent infections."
11-22	L-17	<u>Change:</u> "the" to "that"
12-14	L-13	<u>Change:</u> "Effective life of the impregnite" to "storage life of the impregnated clothing"

THE FOLLOWING ARE THE COMMENTS AND SUGGESTED CHANGES OF THE FIELD THERAPY COMMITTEE ON THE PRELIMINARY MANUSCRIPT, "NAVAL CHEMICAL MUNITIONS," ORD-2509, 14 APRIL 1955:

<u>Page</u>	<u>Para or Line</u>	<u>Comments and Suggested Changes</u>
1-1	L-7	<u>Delete:</u> "Vapor GB does not". . . <u>Substitute:</u> "Vapor GB penetrates unbroken skin very slightly, but". . .
1-13	L-6	<u>Delete.</u> <u>Substitute:</u> It is estimated that at a concentration of 100 mg. min./cu. meter, approximately half of personnel exposed will die.
	L-10	<u>Change:</u> "are necessary" to "will."
	L-12	<u>Delete:</u> "large"
	P-2	<u>Change second sentence to read:</u> Except at very high concentrations, exposure of masked personnel to GB vapor will not result in absorption sufficient to produce symptoms. <u>Delete:</u> Second half.
1-14	L-4 & 7 P-2	<u>Change:</u> "symptoms" to "signs and symptoms." <u>Rewrite paragraph as follows:</u> Death from GB is the result of asphyxia brought about by alterations in the nervous system and muscle. Physiological effects include constriction of the pupils; reddening of the eyes; headache; watery, nasal discharge; tightness in the chest; sweating; abdominal cramps and nausea; weakness; muscular twitching; incoordination; difficulty in breathing; convulsions; coma; and asphyxia. In general, death will occur within 15 minutes after inhalation of a lethal dose in the absence of treatment, and within one-half to several hours after absorption by other routes.
1-15		<u>Change to:</u> "one ampin of atropine sulfate or one syrette of atropine tartrate." <u>Change:</u> <u>15 minutes</u> to <u>10 minutes</u> .

COMMENTS AND SUGGESTED CHANGES OF THE FIELD THERAPY COMMITTEE ON THE
PRELIMINARY MANUSCRIPT, "NAVAL CHEMICAL MUNITIONS," ORD-2509, 14 APRIL
1955 - Page 3

<u>Page</u>	<u>Para or Line</u>	<u>Comments and Suggested Changes</u>
12-15	P-2	This Kit is no longer a standard item.
12-18	L-4	<u>Delete:</u> "It does not protect against GB." <u>Substitute:</u> It does not give specific protection against liquid GB, but does afford some mechanical protection.
A4 15-13	P-2	<u>Add:</u> White phosphorus will ignite spontaneously and continue to burn if exposed to air. If particles strike the clothing or skin they should be kept covered with water or wet dressings until they are removed. If 5% copper sulfate solution is available, it may be used to treat the particles. Surgical removal of the particles from the skin is advisable."
A5 Chapter 15		~~The Committee observed that~~ ^S some of the agents discussed in this chapter are no longer standard or are obsolete. They should be so designated or omitted.

Page XXVI

It is believed the first two sentences do not correctly differentiate the responsibilities of the C. and Naval BuOrd.

D/D Directive 5128.7, 12 Nov. 53 states " Dept of the Army is delegated the responsibility for coordination of all military research and development in biological and chemical warfare".

D/D Directive TS 3145.1, 5 Mar. 54 contains paragraphs downgraded to Secret which spell out the D/A responsibility in greater detail.

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Table B.

Section 5 title should be

"Estimated coverage of 1 lb of agent with
 LCt_{50}^* in 0-30 seconds, square yards."

The projectile and rocket coverages are
 twice what they should be because the
 number of rounds required listed in section 6
 are not for the coverage of one artillery square
 with $100 \frac{mg-min}{m^2}$, but 50% of an artillery square.

Example: 5"/39

Given: Agent/round = 3.57 lb. (Section 3)

Rds/AS = 5.7 (Section 6)

Solution to obtain figures in draft:

$$\text{Coverage/lb Agent} = \frac{10,000}{3.57(5.7)} = 490 \text{ sq. yd.}$$

However the 5.7 rds./AS only covers 50% of the AS

$$\therefore \text{Coverage/lb Agent} = \frac{5,000}{3.57(5.7)} = \underline{\underline{245 \text{ sq yd}}}$$

2nd + 3rd sentences, rewrite -

Closures or seals to provide adequate protection are available but are not entirely suitable for mass production methods. Work is continuing to develop a closure system which combines protection and simplicity of production.

Delete sentence which states mustard bombs must be vented.

DRAFT

COMMENTS ON DETECTION DEVICES IN NAVY MANUAL

Page 9-12

bu Ydnt Docks

A2 Your Attention is invited to the fact that the Navy is purchasing E-21 Automatic G-Agent Alarms in moderate quantity for use in storage areas. It is not known whether this particular manual should mention this although it would seem desirable to do so. If this is done, then paragraph 2 is incorrect in that the only detection device available is the M9A2 kit (*see also comment on 11-4 below*)

Page 11-3

The same comment applies. The statement is made that they will not be available *as for* shore installations whereas it is understood that within a short time a number of items will be so available.

Page 11-4 (~~Line 3-5~~)

A3 The approximate weight of the E-21 Alarm is 27 pounds. It is not being considered for shipboard installation, but is being considered for Yards and Docks as discussed above. The E-22^{R1} Alarm is being studied for use afloat.

It is incorrect that the only present available device for detection is the M9A2 Cml Agent Detector Kit. The M10A1 Kit is available and the E-21 Alarm will become available to the Navy as discussed above. It is understood that the Navy is planning to procure the E27R4 Simplified Detector Kit in quantity in FY56. It may be desirable to mention this in ^{the} ~~this~~ manual.

Page 11-5

A4 It may be desirable to mention that the E-28 kit is about to be purchased in quantity for the Navy and that this is a significant improvement over the M9A2, particularly in regard to the area of calculated risk for exposure of personnel at concentrations lower than those ^{detected.} ~~protected~~ by the kit.

Page 11-5 (~~second paragraph~~)

Suggest the wording be changed from "high" to "moderate" since all of the kits will detect what is actually very low concentration, although the M9A2 kit will not go ~~so~~ low as to eliminate ^{completely} the possibility of ^{marginal} casualties.

Page 11-18 (~~first paragraph~~)

The M7A1 Vesicant Detector Crayon will detect Lewisite as well as HD in liquid form. It is not designed as a detector for G-Agents and gives variable results in contact with them. It is unwise to state that the color changes to yellow when in contact with liquid GB since color and intensity varied ^{with impurities} markedly in the agent and other uncontrollable factors.

Page 11-22 (~~1st paragraph~~)

The units of the dosages quoted are incorrect. They should be milligram - minutes per cubic meter for both cases cited. ~~(The remainder of the document has not been checked from this point but if lethal or incapacitating dosages are cited elsewhere in the manual, these are the correct units rather than the units cited in this paragraph the draft manual).~~

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DEPARTMENT OF THE NAVY
BUREAU OF ORDNANCE
Washington 25, D.C.

PLg-CRB:dcs
X6
Ser: 004291

7 March 1955

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From: Chief, Bureau of Ordnance
To: Distribution List

Subj: Chemical Munitions Manual; review of

Encl: (1) Copy (as indicated) of draft of subject manual

1. Enclosure (1) has been prepared in order to furnish technical information to the Naval Establishment relative to certain chemical munitions.
2. Addressees are requested to review enclosure (1) and submit their comments to the Bureau of Ordnance by 30 April 1955. This can be done in the text.
3. Comments are requested as to the lowest possible classification of the manual; and as to what matter should be changed or deleted in order to classify it as confidential.
4. Appropriate illustrations or suggestions in this regard are needed.
5. Return of the enclosure with the comments is requested.

F. S. WITHINGTON

Charles H. Boyer
C. R. BOYER
By direction

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INVENTORY

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INTRODUCTION

The purpose of this manual is to provide the naval forces and other interested services with basic technical information concerning chemical munitions. Emphasis is placed upon toxic chemical munitions because these munitions are, in general, new or unfamiliar to personnel. Non-toxic munitions are described briefly, in one chapter only, to supply current data not given in other Bureau of Ordnance publications. All other chapters deal with the two toxic chemicals, GB and HD, selected as the standard agents which appear to best meet U. S. Navy needs.

This manual does not seek to duplicate existing publications. When subjects are adequately covered in other publications, those publications are referenced in the bibliography. In some instances, information that is not readily obtainable without a search of other publications has been abstracted and summarized for inclusion in this manual. To supplement this manual, however, and to gain a thorough understanding of chemical warfare, the reader should study the publications listed in the bibliography.

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The doctrine, strategy, and tactics of using munitions are not within the purview of publications such as this. A consideration of the use, however, will promote understanding of the technical subjects. Emphasis in this publication is placed upon the use of munitions against troops ashore. This results not only from the fact that the Navy gives air and gunfire support to troops ashore, but from the fact that there are no data or experience pertaining to naval usage, i.e., against ships or shipping. There are available, on the other hand, much data pertaining to use ashore. For further information regarding employment, refer to Naval Warfare Publication 36, Employment of Restricted Weapons.

Many agents can be employed for toxic chemical warfare, yet only a few possess characteristics approaching those of an ideal toxic chemical agent. Of these, GB, a nerve poison, and HD, purified mustard, a vesicant, have been selected for use in naval munitions.*

*Other toxic chemical agents are still in stock; however, they are not intended for use by the Navy except in an emergency.

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Various forms of mustard were used extensively in World War I; GB has never been used in military operations. As a result, the military capabilities of mustard are better known than those of GB. Although the properties and characteristics of GB have been basically determined by tests, its value in application to modern warfare cannot be conclusively stated. Thus, while GB is known to be much more toxic and faster acting than HD, both agents are being produced and stocked, with HD considered as an alternate standard agent.

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Mustard was discovered and its properties known many years before World War I, but it was not until 1917 that mustard was used as a military agent. In that year, Germans bombarded British forces near Ypres in Belgium with mustard-filled projectiles. Before a defense was devised against the agent, it caused thousands of casualties. From July, 1917, to November, 1918, British casualties from mustard numbered nearly 125,000, of whom about four per cent died. An average of one casualty developed for every 60 pounds of agent used. The average American casualty from mustard lost 60 days in a hospital. During World War II, toxic chemicals were not used, but bulk mustard was produced and stocked, and munitions were filled and held ready for immediate use.

GB was discovered by German scientists in 1938. This agent and other G-series agents were developed and stocked by the Germans during World War II. As German units were defeated, stocks of these chemicals were captured and sent to the United States for analysis. Of the G-agents analyzed, GB was selected for development as a standard toxic chemical agent.

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The Army Chemical Corps has the responsibility for developing, producing, and testing chemical agents. The Bureau of Ordnance is responsible for the design, development, production, testing, and maintenance of chemical munitions that are part of naval ordnance. While the Bureau of Ordnance has the responsibility for storage of such naval munitions, they are presently stored under control of the Army Chemical Corps, as a matter of convenience. Other naval bureaus have cognizance of and responsibility for other important factors and equipment involved in the naval chemical warfare program. The Bureau of Ships, for example, has the responsibility for detection devices afloat, the decontamination of ships and their crews, and for certain protective equipment afloat.

Production, maintenance, and use of toxic chemical agents present many problems. Toxic chemicals have not been used by the United States since 1918, and they have never been used in U. S. naval operations. The effectiveness of toxic chemicals under conditions of modern warfare has therefore not been proven. Further, the military use of toxic chemicals by U. S. forces is not permitted unless expressly authorized by proper authority.

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The Navy has no chemical warfare service as such. Toxic chemicals are produced by the Army Chemical Corps, which has established a production capability for both GB and HD. Most of the munitions designed for both agents are still in the development stage. Complete field tests for many weapons and munitions have not yet been conducted. As a result, thorough procedures for all conditions of employment, storage, shipment, detection, and protection are not defined with finality. Nevertheless, the Fleet must be aware of the present status of toxic chemical munitions and be prepared for their handling and use, as well as for defensive measures against toxic chemical attack.

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In addition to these broad problems, the nature of the agents presents specific problems and difficulties that must be overcome before toxic chemical munitions can be made a part of the standard naval weapons system. No closure or seal has been developed that combines simplicity of production and assembly with desired protection against leakage. Designs for a new and efficient closure are being investigated. The filling and storage of chemical munitions present other problems. Under various conditions of storage and handling, with accompanying changes of temperature, toxic chemical agents can build up pressures inside a munition. In the case of mustard bombs particularly, provision must be made for venting. Munitions filled with either agent may develop liquid or vapor leaks. Accordingly, special precautions must be taken for all conditions of handling, storing, shipping, and maintaining the munitions. Under present requirements, for example, not only are all shipments of toxic chemical munitions subject to existing regulations of the Interstate Commerce Commission and other agencies, but also such munitions must be accompanied by members of the Technical Escort Detachment or by qualified naval personnel.

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Further, adequate detection devices and protective equipment are essential. Although efforts are being made to develop reliable detection devices, no practical, foolproof method for the detection of either agent has been developed. A similar situation exists in relation to protective equipment. Several types of masks and impermeable clothing are available, but most of them hamper the wearer by their bulkiness, impracticability, lack of comfort, or lack of prolonged protection. Work is being furthered to provide adequate detection devices and protective equipment.

Finally, factors of tactical employment influence the use of toxic chemical agents. They are subject to many variables of weather and terrain. These influences may be temporarily reduced by rapidly establishing a heavy concentration of the agent on the target in properly designed munitions, but conditions of weather and terrain always affect the efficiency of the agent to some extent. Below 58 degrees, for example, pure HD freezes and becomes less effective; consequently, it can be best employed at warmer temperatures. Vapor clouds of both agents are quickly broken up and dispersed by strong winds and rough terrain. All such factors make the effective use of toxic chemical munitions more difficult than that of conventional munitions.

What about HD gas?

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The problems and difficulties, then, involved in the production, maintenance, and use of toxic chemical agents are many. They are not insurmountable, however, and attempts are being continually made to resolve them. As development and production continues, it is expected that the Navy will be provided with efficient toxic chemical munitions, which fit into the standard weapons system, with the necessary equipment to permit their safe handling, storage, and maintenance. Such development and production are being progressively carried out under the responsibility of the Navy to develop a capability for the offensive use of toxic chemical warfare. To this end, it is essential that naval operating units and shore establishments be apprised of the current chemical warfare program and of toxic chemical munitions that may be authorized for use. This manual is intended for that purpose.

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Chapter 1

GB

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INTRODUCTION

GB is a highly toxic, quick acting, nerve poison. A chemical compound, GB is a colorless, odorless liquid at ordinary temperatures. GB is toxic both as a liquid and as a vapor. Liquid GB is absorbed through any body surface and is quickly lethal, particularly when in contact with the eyes. Vapor GB does not penetrate unbroken skin but is toxic when inhaled. The form of the agent most likely to be encountered during an attack is vapor.

GB is used to attack personnel. Attack may be delivered by projectiles, rockets, bombs, spray tanks, and land mines. In general, exposure to a lethal concentration of GB will be followed by death within a few minutes, unless prompt medical treatment is given.

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CHARACTERISTICS

The properties of GB and mustard, discussed in chapter 2, are given in Table A, page 1-17. These two agents are the only toxic chemical agents presently selected for use by the Bureau of Ordnance.

GB has the following basic characteristics: It has a freezing point far below and a boiling point far above that of water. Its weight is slightly heavier than that of water. When mixed with water, GB reacts to form less toxic compounds.

GB is highly volatile at ordinary temperatures; droplets of liquid GB will evaporate quickly. When disseminated as a vapor or as fine droplets, GB is normally nonpersistent, remaining in an area for ten minutes or less. When disseminated in large drops, GB ranges from moderately persistent to persistent, remaining in an area from one hour to many days, depending upon conditions of weather and terrain.

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GB is colorless and odorless. It does not cause tears. Liquid GB does not burn or sting the skin, but it penetrates quickly, especially through open wounds. Unless detection devices are adequately employed, personnel can expect little or no warning of GB presence before a lethal or incapacitating dosage exerts its full effect.

Compared to mustard, GB is roughly 15 times as toxic by inhalation and many more times as toxic by absorption of liquid through the skin. Protection from GB requires detection devices, masks, special clothing, decontamination material, and thorough training in the use of such equipment. Decontamination and disposal procedures are definite and prescribed, but vary with the circumstances.

GB munitions are considered both an explosive and a poison hazard. Special safety precautions, in addition to standard precautions, are necessary. According to present plans, GB munitions will be procured already filled. They should present no hazard as to storage, except that danger from leakage may develop. Relatively stable in storage, the shelf life of GB is considered to be in excess of three years.

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BEHAVIOR

GB area coverage, concentration, direction of travel, and persistency are determined by the amount delivered to the target, means of delivery, weather, and terrain. The area covered, the quantity of GB released, and its action immediately after release are determined by the types of munitions employed and the method of releasing GB. Persistency of the gas and its direction of travel are determined by prevailing conditions of weather and terrain.

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For example, when GB is disseminated at ordinary temperatures by shell or bomb burst, most of the liquid agent is disseminated as a vapor, and a gas cloud is formed which covers the initial area of the burst. The gas cloud, denser and cooler than the surrounding air, because of the rapid expansion of the gas, collapses or pancakes, spreading out and sinking to a height of under ten feet. As the cloud drifts downwind, it gradually becomes warmer and spreads upward and outward. Under ordinary conditions, with fairly steady winds, the lateral spread of the cloud amounts to about 15 to 20 per cent of the total distance traveled by the cloud and the vertical rise to about five to ten per cent of the distance traveled. Unfavorable conditions, such as rough air currents and high winds, greatly increase the rise and spread of the gas cloud, quickly diluting it and thus rendering it ineffective. Under all conditions, the cloud gradually becomes more subject to air currents, and concentration of the gas is reduced. Finally, the gas cloud becomes so diluted that it is no longer strong enough to cause casualties.

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With properly designed and effectively employed munitions, weather effects can be reduced. Although weather and terrain always affect persistency and cloud travel, enough GB may be disseminated in an area, even under unfavorable conditions, to produce casualties before the gas is dispersed. The Navy plans to disseminate both GB and HD in this manner, i.e., to use munitions with a high ratio of explosive to agent that will release either agent as a heavy concentration of vapor, rather than as a liquid. According to present plans, neither agent will be used for persistent effects. An area will be attacked by saturating it with an extremely high vapor concentration that will immediately attack personnel with casualty-producing or lethal dosages. Disseminated in this manner, the agent will remain in the area only a short time. Normally, weather and terrain conditions will not appreciably affect the gas adversely during the first two minutes after its release, the period in which the agent can be expected to cause most casualties.

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Even when the agent is disseminated in this manner, however, effects of weather and terrain will influence the effectiveness of the attack. Under unfavorable conditions, for example, the vapor will be effective for a few minutes only. Although most casualties should be caused during this period, the maintenance of a heavy vapor concentration for a longer period will evidently increase the possibility of casualties. To establish and maintain a heavy concentration of vapor for ten minutes, for example, fewer munitions are required under favorable conditions of weather and terrain than during unfavorable conditions. Therefore, although the Navy plans to use toxic chemical munitions so as to reduce the effects of weather and terrain conditions, the following table is provided to summarize favorable, average, and unfavorable conditions for the employment of GB and HD.

Since many variables of geography, weather, and terrain affect the behavior of a chemical agent, the conditions listed below are to be considered only approximate. For a complete discussion of all factors of weather and terrain affecting the behavior of chemical agents, refer to TM 3-240 — Field Behavior of Chemical Agents — and other publications listed at the end of this manual.

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Favorable Conditions

Sky Clear
Time of day Night or early morning
Terrain Level fields or water
Ground temperature. . . Colder than air
Wind Steady, 0-4 knots

Average Conditions

Sky Broken or overcast
Time of day Midmorning or late afternoon
Terrain Moderately rolling
Ground temperature. . . Nearly same as air
Wind Slightly shifting, 4-9 knots

Unfavorable Conditions

Sky Clear
Time of day 1100-1600
Terrain Broken or wooded
Ground temperature. . . Warmer than air
Wind Variable or over 12 knots

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EMPLOYMENT OF GB

Toxic chemicals have many limitations. A chemical attack is always to some extent dependent upon conditions of weather and terrain; therefore the use of toxic chemicals is limited to specific conditions and to appropriate targets. The results of a chemical attack are difficult to determine readily. The effectiveness of chemical attacks in a given theater of operations will progressively decrease as enemy personnel become trained and equipped to deal with the agents, munitions, and techniques used.

On the other hand, and within the limits mentioned above, toxic chemical munitions possess certain advantages over conventional munitions. Toxic chemical munitions attack a larger area than an equal number of conventional munitions. Toxic agents have a searching action in that they tend to sink into depressions, hollows, and other low-lying places that usually offer a relative degree of safety from conventional munitions. Toxic agents do not destroy material attacked; areas can be re-occupied. The effective casualty producing period of a toxic agent is longer than that of conventional munitions. Properly used, then, toxic munitions produce effects and yield advantages not obtainable by conventional munitions.

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Because GB is a quick-acting casualty agent and because it is most effective on targets which can be rapidly covered, the use of GB may be primarily tactical rather than strategic. In general, maximum results will be achieved against personnel known to be equipped with protective equipment through a sudden, intense attack. If an area can be covered with GB within 30 seconds, even the best trained personnel will suffer casualties. Camouflage of a GB attack by the use of other munitions should increase the agent's effectiveness. In all cases, speed and surprise must be sought.

Basic factors to be considered for all occasions of GB attack are targets and tactical requirements. The following discussion of these factors is for general information only. This manual is not intended to include the tactical doctrine on the use of chemical munitions; its basic function is to furnish necessary information relative to GB and GB-filled munitions with which the user can evolve tactical doctrines. For a full discussion of tactical employment of toxic chemicals, see the publications listed at the end of this manual.

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Targets

Targets for GB attack will be areas in which personnel are concentrated. These may include population centers, troop assembly areas, fortified strong points, naval bases, islands, and beachheads. Ships underway usually do not offer good target opportunities; ships in port may.

Tactical Requirements

In order to achieve maximum results, GB concentration should be built up in an area in the shortest possible time. When high concentrations are rapidly achieved, only short exposure periods are required to produce casualties; hence, the effects of weather upon a successful attack are reduced. Concentration build-up will depend upon the type and amount of munitions used. Through quick concentration, surprise can be obtained, causing casualties before even a well-disciplined enemy can protect himself. For best results, the target area should be saturated within 30 seconds, but casualties are regarded as probable if saturation can be obtained within two minutes. Against unequipped personnel, the effective attack period may be longer. In all circumstances, the mission should be accomplished in a single attack of short duration.

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Another basic tactical requirement is the safety of friendly forces. Measures to provide for the safety of friendly forces include detection devices, protective equipment, and adequate warnings to all adjacent forces of such information as target area, time of firing, and expected time limit of danger. Attacks on areas which are later to be occupied by friendly forces should be made far enough in advance to ensure dissipation of casualty-producing GB before troop occupation of the area. A very definite hazard exists for at least ten minutes after a GB munition explodes; however, masked troops can usually enter an area attacked by GB after 30 minutes and unmasked troops in two hours, provided they stay clear of craters caused by munition impact.

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EFFECTS OF GB

GB rapidly incapacitates or kills personnel and contaminates food, water, and equipment. As noted in Table A, the minimum concentration of GB vapor to incapacitate fifty per cent of personnel in an area is estimated to be 16 milligrams per minute per cubic meter. The estimated lethal dosage of GB vapor is 100 milligrams per minute per cubic meter. These estimates are for personnel at rest. For personnel engaged in heavy physical activity, much lower concentrations are necessary to produce casualties. In an area containing a lethal concentration of GB vapor, a few large breaths may be enough to cause a man's death.

GB liquid on the skin may cause death if not washed off at once. The absorption of GB vapor through the skin will not incapacitate masked personnel in a single exposure; however, the effects of GB build up, and repeated exposures may cause the development of symptoms.

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At a concentration of two to five milligrams per cubic meter of GB vapor, inhalation for one minute should cause symptoms in the average individual. Symptoms normally consist of a "running nose," contraction of the pupils of the eye, blurring vision, tightness of the chest, and headache. One of the first symptoms to appear is contraction of the eye pupils. In instances where GB liquid is absorbed through the skin, however, pupillary contraction does not usually develop. Ingestion of GB-contaminated food or water causes excessive salivation, nausea, and intestinal cramps, which may be followed by vomiting or diarrhea.

Death from GB is brought about by the inactivation of parts of the nervous system. Physiological effects are dilation of the blood vessels, sweating, slowing of the heart rate, and constriction of air passages in the lungs. In general, death occurs within an hour of exposure to a lethal concentration of GB vapor. Exposure to a lethal amount of GB liquid usually causes death in a much shorter period, depending upon the amount of contamination and the physical condition of the skin.

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FIRST AID

Lethal concentrations of GB act so quickly that self-administered first aid and medical treatment are difficult, sometimes impossible. If any of the symptoms described above are detected, gas masks should be put on at once. All persons rendering aid to others must be properly masked and, if danger of liquid GB is present, equipped with protective clothing. Protective equipment is described in chapter 13.

For mild symptoms, the patient should be removed from the area and taken to the dispensary for treatment. For serious exposure, causing marked symptoms, one ampin or syrette of atropine tartrate or atropine sulfate should be given at once and the patient taken to the dispensary. If symptoms are not lessened within 15 minutes, a second injection should be given. No more than three injections should be given without the advice of medical personnel. If breathing is stopped or feeble, artificial respiration should be given.

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For liquid GB on clothing or skin, the contaminated area should be thoroughly flushed with water and all contaminated clothing cut away. An ampin or syrette of atropine should be given at once if symptoms appear. If liquid GB comes into contact with the eye, it should be flushed with water for at least 30 seconds. Three injections of atropine should be given at once and medical aid summoned immediately.

When available, the following means of decontaminating personnel help to combat liquid splashes of GB upon body surfaces:

Skin -- Flood with plain or soapy water. Afterwards, douse skin with 5% sodium carbonate solution.

Mouth -- Flush with 3% sodium bicarbonate solution.

Eye -- Irrigate with 1% sodium bicarbonate solution.

For a complete description of the effects of GB, first aid, and medical treatment see TM 8-285 (NAV MED P-1328) - Treatment of Chemical Warfare Casualties.

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TABLE A. (1)
TOXIC CHEMICAL AGENTS

Agent	GB	HD, H*
Chemical name	Fluoromethyl isopropoxy phosphine oxide	Bis beta-chloroethylsulfide
Chemical formula	$F(CH_3)_2CHOPOCH_3$	$(ClCH_2CH_2)_2S$
Molecular weight	140.10	159.08
Weight, one gallon, 68 degrees F.	9.138 lb.	10.6 lb.
Physical state, 68 degrees F.	Colorless liquid	Colorless to dark yellow liquid
Odor	None when pure	Garlic-like
Vapor density, compared to air	4.86	5.4
Liquid density, at 68 degrees F.	1.10 gm/cc	1.27 gm/cc
Freezing point	-36°F.	58°F.
Boiling point	297°F.	442°F.
Vapor pressure, at 68 degrees F.	1.57 Hg	0.072 Hg
Volatility, at 68 degrees F.	12,100 mg/m ³	958 mg/m ³
Flash point	High enough not to interfere with military use	221°F.
Decomposition temperature	Decomposes if heated to boiling point for 4-5 hours	300-350°F.
Median concentration detectable by odor	None	1.2 mg/m ³
Median lethal dosage, men at rest, LCt ₅₀ **		
1. Inhalation	100 mg-min/m ³	1,500 mg-min/m ³
2. Skin contact, vapor	15,000 mg-min/m ³ ***	10,000 mg-min/m ³
3. Skin contact, liquid	310 mg/150 lb. man	2,000 mg/150 lb. man
Median incapacitating dosage		
1. Inhalation	16 mg-min/m ³	100-300 mg-min/m ³
2. Skin contact, vapor	8,000 mg-min/m ³ ***	200 mg-min/m ³ (on eye) 2,000 mg-min/m ³ (on skin)
Rate of detoxification	Not detoxified, cumulative	Not detoxified, cumulative
Rate of action	Very rapid, within minutes	4-6 hours before first symptoms appear
Symptoms	"Running nose," pupillary contraction, tightness of chest, headache	Eye inflammation, redness of skin
Protection	Masks, clothing	Masks, clothing
Persistence	Nonpersistent when dispersed in fine droplets, persistent when dispersed in large drops	Nonpersistent to moderately persistent when dispersed as vapor Highly persistent when dispersed as liquid: summer - 3-7 days winter - several weeks
Latent heat of vaporization	85 calories/gm	94 calories/gm
Action on metals	Slightly corrosive to steel	None when pure
Stability in storage	Fairly stable in steel containers	Stable in steel containers
Solvents	Organic solvents	Oils, alcohol, carbon tetrachloride

(1) Measurements are given in the metric system. See a standard conversion table for English equivalents.

* H is Levenstein mustard gas. HD is H that has been purified. H is a substitute standard agent; HD is standard. The data given are for HD. H characteristics are basically the same as those of HD. For a fuller discussion, see chapter 2.

** Lethal dosage is expressed as LCt₅₀ -- which represents the dosage capable of killing 50 per cent of exposed personnel, wherein C is concentration and t is the time of exposure. Lethal dosage is usually expressed in milligrams per minute per cubic meter. Lethal dosage may also be expressed for different percentages of casualties; i.e., LCt₈₀ represents the dosage capable of killing 80 per cent of exposed personnel.

*** Absorption of GB vapor through the skin in a single exposure is not expected to effect masked men significantly. However, GB is a cumulative poison, the body does not build up a resistance to it. Repeated exposures at intervals of 24 hours or less may cause the development of casualties. The incapacitating dosage by skin absorption of GB vapor is estimated to be 8,000 mg-min/m³.

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Chapter 2

MUSTARD

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INTRODUCTION

Mustard is a slow-acting, normally persistent, toxic, chemical agent. It is capable of causing casualties either as a liquid or a vapor. Liquid mustard is toxic when in contact with any part of the body; vapor mustard is toxic when in contact with the body or when inhaled. The agent penetrates clothing and blisters any surface of the body it contacts. If inhaled, it burns and injures the lungs. When in contact with the eyes, it causes tears, pain, and temporary blindness. Because it attacks eyes, lungs, and body surfaces simultaneously, mustard is difficult to defend against.

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Like GB, mustard is used to attack personnel. Munitions used to deliver mustard are similar to those for GB. Unlike GB, which is ordinarily nonpersistent, mustard is ordinarily persistent. Its persistency, however, depends primarily upon the method of releasing the agent. It may be released as a liquid or as a vapor. If released as a liquid, mustard is highly persistent; several hours to several days or weeks are required, depending upon the temperature, for the liquid to evaporate. If released as vapor or an aerosol, mustard is nonpersistent to moderately persistent, the vapor concentration remaining effective until broken up by winds. Under favorable conditions, the vapor cloud persists for many hours.

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If released as a liquid, mustard may be used to contaminate an area and to restrict, but not deny, the use of terrain and material for long periods of time. The Navy, however, does not plan to use mustard for its persistent effects. As stated in chapter 1, munitions being developed for naval use are designed to disseminate the agent as a heavy concentration of vapor, not as a liquid. The object is to cover an area with a casualty-producing or lethal concentration of vapor as rapidly as possible. Such an employment of mustard has two advantages: it produces casualties from speed, surprise, and high dosages, and it reduces the influences of weather and terrain conditions upon the agent during the period of attack. The Navy plans to use mustard, therefore, to attack personnel directly, not to contaminate or restrict an area for long periods. Accordingly, the description of mustard in this manual emphasizes the use of mustard as a vapor; its characteristics, behavior, and employment are discussed primarily in this aspect. Its effect as a liquid is discussed only as necessary for storage, handling, and defensive measures, i.e., for detection, protection, and first aid. For descriptions of the characteristics, behavior, use, and effects of mustard as a liquid, refer to applicable Army publications listed in the bibliography.

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Classified as a moderate casualty agent, mustard usually causes injuries lasting from a few days to several weeks. It seldom causes death. Casualties from mustard are not immediate; ordinarily, they do not develop until several hours after exposure. The casualty period depends upon concentration, length of exposure time, and parts of the body attacked.

CHARACTERISTICS

The properties of mustard are given in Table A, page 1-17. The standard mustard agent is HD. H, Levenstein mustard, is a substitute standard agent. HD is H that has been purified by washing and vacuum distillation. H contains about 30 per cent sulphur impurities, which give the agent a pronounced odor. H is cheaper to produce, and its freezing point is lower than that of HD. HD is more stable in storage, however, and it is more effective in causing casualties. The following discussion deals only with HD, the standard agent, but except for the differences noted, the discussion applies generally to H.*

*Nitrogen mustard gases and other blister gases have characteristics similar to HD, but they have not been developed for standard use by the Bureau of Ordnance.

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HD has a high boiling point, 442 degrees Fahrenheit; its freezing point is 58 degrees Fahrenheit. At temperatures above the freezing point, HD is a dark, heavy, oily liquid, having a garlic-like odor. HD reacts very slowly with water to form less toxic compounds. Below 58 degrees Fahrenheit, pure HD freezes. Accordingly, if it is to be sprayed at moderate or low temperatures, it must be mixed with some other compound that will lower the freezing point and keep the agent in a liquid state. Solvents that may be used for this are carbon tetrachloride, chlorbenzene, carbon disulfide, dichlorethyl ether, and other chemical compounds.

At high temperatures, HD will be least persistent, but the exposure period necessary to produce casualties will be shorter than at moderate or low temperatures. In addition, body surfaces are more susceptible to attack by vapor HD when they are moist or sweaty; consequently, HD is more effective in producing casualties at high temperatures, with a high degree of humidity, than at low temperatures. HD will be least persistent but most effective in attacking personnel, therefore, under summer or tropical conditions.

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In high concentrations, HD is easily detected by its characteristic odor. In low concentrations, the agent is barely detectable by smell. In addition, when small amounts of HD are breathed for several minutes, the sense of smell is dulled so that an individual may remain in a contaminated area without realizing it. Unless liquid HD comes into contact with the eyes, symptoms from either liquid or vapor HD do not appear until several hours after exposure. Therefore, unless detection devices are used, the only method of recognizing HD in high concentrations is by smell. For a low concentration of HD, detection devices alone are the only means of detecting the agent.

Although HD seldom causes death, it is an excellent casualty-producing and harassing agent. In this respect, it has the qualities of multiple attacking capability, causing casualties by inhalation, eye and skin contact, and of persistency, causing casualties long after its release. Because it may cling to and contaminate terrain, vegetation, and equipment for long periods, unprotected troops entering a contaminated area can be affected many hours after entering the area, and troops leaving the area can carry contaminated clothes and equipment with them to other areas and personnel.

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HD munitions are regarded as both an explosive and a poison hazard. Special safety precautions, as well as standard precautions, must be observed. In general, HD munitions will be procured already filled. Such munitions should be stable in storage for long periods and present no unusual problems; however, means for the detection of leakers must always be provided and maintained. Detection devices, protective equipment, munitions, their employment, handling and storage, and procedures for decontamination and disposal are described in subsequent chapters of this manual.

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BEHAVIOR

HD area coverage and concentration depend basically upon the munitions used to deliver the agent to the target. The time that the vapor concentration remains over the target area depends upon wind speed, direction, air turbulence, and terrain. When disseminated by bomb burst, for example, HD will act in a manner similar to that described for GB (see chapter 1). Initially, a gas cloud will be formed above the burst area. The size of the area covered by the cloud is determined by the amount of bomb filling, the strength of the burster charge, thickness of the bomb casing, and the character of the impact surface. During the first two minutes or less, the cloud will be relatively little affected by conditions of weather and terrain. After this period, the cloud in moving downwind will spread upward and outward and be gradually dispersed, at a rate varying according to weather and terrain conditions. Eventually, the cloud will become so dispersed and diluted that it will be too weak to cause casualties. Favorable, average, and unfavorable conditions of weather and terrain for an HD attack are the same as those listed in chapter 1. Refer to TM 3-240 for a complete discussion of all factors of weather and terrain affecting the behavior of HD.

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EMPLOYMENT OF HD

Basic advantages and disadvantages of employing toxic chemicals have been discussed in chapter 1. For HD, tactical targets and tactical requirements are basically the same as for GB. To disseminate HD as a vapor or an aerosol, spray tanks may be used, or bombs, projectiles, and rockets having a high ratio of explosive to agent. The high explosive will vaporize most of the agent upon bursting, and a hazardous vapor concentration will be quickly attained. A vapor HD attack should be used under the same conditions as a GB attack. The attack should be directed against personnel heavily concentrated in an area, and the agent should be placed on the target quickly, within two minutes if possible. Speed and surprise are essential.

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EFFECTS OF HD

Liquid HD penetrates uniforms, leather and rubber boots, and other articles of clothing normally worn by military personnel. When in contact with the skin, the liquid causes no immediate pain. Within 15 to 30 minutes after the contact, a gray splotch often appears on the area attacked. Otherwise, no symptoms develop until several hours after the contact. The affected parts then take on the appearance of sunburned skin. They redden, itch, burn, and eventually develop into painful blisters. If the concentration is high enough and the exposure time long enough, death can result from within one or two days to several weeks following the contact. The average lethal dosage of liquid HD on the skin is estimated to be 2000 milligrams per minute per cubic meter for 50 per cent of exposed personnel. Much lower concentrations, however, can cause death if the exposure time is lengthened. Although symptoms can be expected to appear from four to six hours after contact, 24 hours may pass before symptoms appear if a low concentration of HD is used. In general, the higher the concentration, the shorter will be the interval of time between exposure to the agent and the appearance of the first symptoms.

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Liquid HD is much more toxic when in contact with the eye than when in contact with the skin, and symptoms appear quickly. The eyes become inflamed, sting, and produce tears within a few seconds following liquid contact. Speed in decontaminating the eyes is absolutely essential; after several minutes the liquid will have taken full effect, and decontamination will probably be too late to prevent a serious casualty or death. Under usual attacking conditions, however, it is unlikely that liquid HD will come into contact with the eyes.

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Vapor HD attacks the lungs as well as the eyes and skin. The concentration necessary to bring death by inhalation is estimated to be 1500 milligrams per minute per cubic meter for 50 per cent of exposed personnel; however, lower concentrations can kill if exposure time is lengthened. Symptoms of vapor inhalation do not usually become evident until after symptoms of eye and skin contact with the vapor appear. Symptoms of inhalation of vapor HD are hoarseness, sore throat, coughing, and fever. Severe effects do not develop for several days. They may lead to pulmonary fibrosis, bronchitis, and pneumonia. In most cases, death from HD results from pneumonia. Inhalation of a small concentration of vapor HD in a single attack, however, does not usually cause serious injury.

dosage

also dosage

Exposure to a low concentration of vapor HD affects the eyes before affecting the skin and lungs. Symptoms appear several hours after exposure. The eyes sting, produce tears, and feel as if dirt or grit is in them. The eyelids become red, puffy, and painful.

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Vapor HD on the skin causes casualties requiring hospitalization, but it does not cause death unless unusually long exposures occur. Mild blistering heals rapidly, within one or two weeks; severe blistering may require two months to heal. In temperate weather, symptoms of vapor HD on the skin do not appear before four hours. In summer or tropical temperatures, symptoms are likely to appear sooner. The average dosage estimated to cause casualties among 50 per cent of exposed personnel is 2000 milligrams per minute per cubic meter; the average lethal dosage is estimated to be 10,000 milligrams per minute per cubic meter. An extremely high concentration of vapor HD, therefore, is necessary to cause death from a single exposure. Usually, an attack will provide a vapor concentration high enough to cause casualties, but not to kill.

Vapor HD does not significantly contaminate food or water. Liquid HD contaminates both. Ingestion of food or water contaminated by liquid HD causes nausea, vomiting, diarrhea, and eventual prostration.

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The effects of HD, then, are quite different from those of GB. Under attacking conditions, the most likely form of GB to be met is vapor. HD may be encountered as liquid as well as vapor. GB attacks quickly; symptoms, casualties, and death occur within a few minutes. HD has a delayed effect; symptoms do not ordinarily appear before four to six hours, sometimes not before 24 hours after exposure. Unless an HD concentration is very high or exposure is unusually long, HD only causes casualties; it seldom kills.

FIRST AID

Because the effects of HD are delayed, much more time is available to give first aid for an HD victim than for a GB victim. HD acts at once to cause a severe casualty or death only when liquid HD contacts the eyes, and this condition is improbable under a usual attack. If liquid contamination of the eyes does occur, it must be treated at once. BAL Eye Ointment must be applied immediately to the eye, and it must then be irrigated with water for not less than 30 seconds and for not more than two minutes. The complete treatment is described in TM 8-285 (NAV MED P-1328).

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If liquid HD gets on the skin, it should be decontaminated as soon as discovered. The liquid should be blotted from the skin with cloth, and Protective Ointment M-5 should be rubbed in freely over the contaminated area. If the ointment is not at hand, the affected area should be thoroughly washed with soap and water. Contaminated clothing should be removed and discarded at once. The patient should then be sent to the dispensary for further treatment.

Decontamination is of no value for exposure of the skin to vapor HD. When the vapor is present, personnel should either get out of the area as quickly as possible, or they should wear impregnated protective clothing and a gas mask. If any parts of the skin are left unprotected, they should be covered with Protective Ointment M-5. Anyone exposed to vapor HD should report to the dispensary for treatment as soon as possible.

Inhalation of a small amount of vapor HD will probably cause only a mild respiratory tract injury, with hoarseness and sore throat, and no treatment will be required. Severe attacks require medical treatment.

For a full discussion of first aid and medical treatment for HD casualties, see TM 8-285.

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Chapter 3

MUNITION EXPENDITURE REQUIREMENTS

INTRODUCTION

Toxic chemical munitions being developed by the U.S. Navy are described in chapters 4 through 7. They comprise a 500-pound, low-drag bomb; spray tanks Aero 14A, 14B, and 14C; toxic chemical projectiles 5-inch 38-caliber, 5-inch 54-caliber, and 6-inch 47-caliber; and a 5-inch spin-stabilized rocket. This chapter gives estimated munition expenditure requirements for these munitions. Expenditure requirements for U.S. Army and U.S. Air Force munitions are discussed in applicable publications listed in the bibliography.

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MUNITION EFFECTIVENESS

GENERAL

The efficiency of a chemical munition may be defined as the ratio of the weight of the chemical filling to the gross weight of the munition. Of two munitions having the same gross weight, that which delivers more agent to the target will be more efficient. Other considerations, however, enter into the determination of the effectiveness of any munition. To obtain surprise and hence a greater production of casualties, the munition must be capable of being rapidly and uniformly distributed in the target area. The munition should be designed to give little or no warning until the agent is released. The munition must disperse the agent in the manner desired, i.e., as liquid or vapor, and it must burst at the required height. In addition, it must be tailored to fit modern designs of the gun, launcher, or aircraft releasing it.

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For a specific tactical situation, the most effective munition possible for use will depend upon many variable factors. At appropriate ranges, projectiles and rockets may provide the quickest and most uniform distribution of agent. If the target range is so great, however, that the accuracy of projectiles and rockets cannot be obtained, bombs or spray tanks will be more effective. Spray tanks, on the other hand, require low altitude release, under 100 feet, and are ineffective where dense foliage prevents the agent from reaching the ground. In sum, the effectiveness of a munition in any given situation depends upon the design of the munition, the means and rate of its delivery, and other variable conditions of the tactical situation.

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TYPES OF DISPERSION

Characteristics of toxic chemical munition design depend upon the type of agent dispersion sought, whether as vapor or as liquid. As discussed in the preceding chapters, the Navy intends to use both GB and HD primarily for their vapor effects. Partial restriction of areas for long periods of time from a coverage with HD liquid, for example, is not intended. Instead, the effect sought is a quick, heavy, vapor attack, nonpersistent to moderately persistent, causing casualties from speed, surprise, and high dosage. As such, munitions are designed to have a high ratio of explosive to agent and to be air burst.

FRAGMENTATION EFFECTS

All toxic chemical munitions containing an explosive burster are designed to inflict casualties by fragmentation as well as by release of the agent. Fragmentation of toxic chemical bombs, projectiles, and rocket heads are similar to that of high explosive munitions; however, fragmentation of chemical munitions is much less effective against personnel than that of comparable high explosive munitions.

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In comparison to high explosive munitions, toxic chemical munitions provide less fragments, larger as opposed to smaller fragments, and less velocity of fragments. Figures 3-1 and 3-2 show the differences in the fragmentation of a toxic chemical projectile and the fragmentation of a high explosive projectile of the same size. It can be seen that the high explosive projectile creates more fragments overall and many more small fragments, which, because of their greater number and velocity, have a superior anti-personnel effect than do the fragments of the chemical projectile.

LOSS OF AGENT

Loss of agent after release and the consequent lessening of the efficiency of a chemical munition may result from any of the following causes:

1. Decomposition. Some agent may be chemically decomposed by detonation of the burster explosive, which produces high temperatures and pressures. A well designed munition, however, will limit loss of agent from decomposition to a negligible amount.

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2. Inflammation. The heat of detonation often causes a portion of the agent to inflame, the amount varying with the heat generated and the type of agent. Loss through inflammation is difficult to compute, but with GB and HD, loss should be negligible or absent.

3. Funneling and cratering. When dropped on soft ground from high altitudes, bombs tend to bury before bursting. Much of the vapor is then funneled up to a great height, where it is ineffective against ground troops, and is dispersed. Also, part of the liquid remains in the crater, where it may evaporate so slowly as to be ineffective. Under the most unfavorable conditions, gas loss of nonpersistent agents from funneling and cratering may range up to 20 per cent of the bomb filling. When bombs are dropped on hard ground, no appreciable crater loss occurs. U.S. Navy toxic chemical bombs are designed for proximity fuzes to air burst the bombs, thus preventing funneling and cratering and giving greater dispersion.

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4. Dissipation in air. All toxic vapors will eventually dissipate themselves by becoming diluted with the air. The more numerous, strong, and unstable the air currents, the sooner will a gas cloud become dispersed. Toxic chemical agents are most effective under those conditions listed as favorable or average in chapter 1.

5. Hydrolysis and seepage. In general, the effectiveness of gas clouds is not materially reduced by hydrolysis. Heavy rain and snow, however, tend to break up gas clouds, and they will hydrolyze and drive into the ground liquid agent. Seepage of liquid agent into soft ground or sand will also cause loss of the agent. Munitions designed by the U.S. Navy possess a high ratio of explosive to agent. Most of the agent will be released as vapor, and little agent should be lost from hydrolysis or seepage.

6. Freezing. Pure HD, when released at temperatures below 58 degrees Fahrenheit, will ^{relatively} freeze and become ineffective for immediate attack. Except for loss from hydrolysis and seepage, the agent will again become effective after thawing. The freezing point of GB is -36 degrees Fahrenheit.

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AREA COVERAGE

GENERAL

Area coverage and expenditure requirements given in Table B, page 3-12, are for GB, the toxic chemical agent that has been used in most tests, to date, of U. S. Navy munitions now being developed. Too few tests have been made of these munitions with HD for expenditure requirements to be estimated with any accuracy. Many tests of World War II HD-filled munitions have been made and area coverage exactly determined (See FM 3-5 and FM 3-6, for example.), but these tests were of HD-filled munitions having a low ratio of explosive to agent in order to disperse HD primarily as liquid. U. S. Navy munitions now being developed have a high ratio of explosive to agent, releasing the agent primarily as vapor. Expenditure requirements for World War II munitions, therefore, are not applicable to U. S. Navy munitions now being developed. When expenditure requirements for HD have been established for these munitions, data will be made available.

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EXPENDITURE REQUIREMENTS

Expenditure requirements given in Table B are based upon a standard set of meteorological and terrain conditions. The following conditions are assumed: No precipitation is present; terrain is moderately rolling or flat; wind speed is under seven knots; ground temperature is nearly the same as air temperature, the neutral state of the vertical temperature gradient found usually just after sunrise or shortly before sunset. These are basically the same conditions listed as average in chapter 1. It is also assumed that no heavy vegetation is present, that the temperature is about 70 degrees Fahrenheit, that optimum distribution of munitions is attained within the target area, and that no appreciable loss of agent results from the causes discussed above. Such a set of conditions is theoretical; it is unlikely, for example, that a perfect distribution of munitions can be effected. The figures based upon these conditions, however, can serve as a guide, and allowances can be made for variations.

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Based upon test reports and other information now available, Table B gives munition expenditure requirements for U.S. Navy toxic chemical munitions under the conditions specified above. It should be emphasized that the figures are preliminary, representing only estimates made from a limited number of tests. In addition, because several of the munitions are still in the experimental stages, explosive-to-agent ratios designed for these munitions are not final. They may be changed to provide greater dispersion, and, as a result, the figures given in the table will not apply. When an adequate number of dynamic munition tests have been made, more reliable expenditure data will be furnished.

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MUNITION SELECTION

If the expenditure requirements given in Table B are assumed to be generally correct, it can be seen that, even under theoretically good conditions, extremely high fire power is required to attain rapid coverage over a large area, one square mile, for example. For coverage over a large area, therefore, it would appear that the spray tank is the most practical munition available, if conditions are appropriate for its use. For smaller areas, bombs, rockets, and projectiles can be used effectively, bombs being most practical and projectiles being least practical. As discussed earlier in this chapter, however, the effectiveness of any munition is relative to variable factors of weather, terrain, and the tactical situation.

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TABLE B

MUNITION EXPENDITURE DATA

Munition:	500-pound, low-drag bomb	Spray tank, Aero 14A	5"/38 projectile	5"/54 projectile	6"/47 projectile	5-inch spin- stabilized rocket
Munition wt., GB-filled, lb	490	1605	55.2	71.83	104.7	47.0
Agent:	GB	GB	GB	GB	GB	GB
Agent wt., lb	112	785	3.57	3.26	6.2	4.2
Filling efficiency (filling/gross wt.)	22.8%	#	6.5%	4.5%	6.0%	9.0%
Estimated coverage of 1 lb of agent with LCt ₅₀ * in 0-30 seconds, square yards	150	#	490	540	390	480
Estimated number of munitions required to cover one artillery square** with LCt ₅₀ in 0-30 seconds (50% Coverage)	0.6	#	5.7	5.8	4.2	5.0
Estimated number of munitions required of cover one square mile with LCt ₅₀ in 0-30 seconds	186	#	1800	1800	1300	1550

* LCt₅₀ is a coverage of 100 milligrams per minute per cubic meter; it is the dosage estimated to kill one-half of exposed personnel.

** One artillery square measures 100 yards by 100 yards, giving an area of 10,000 square yards. { Figures in row 6 are for 1/2 Artillery Sq coverage }

Wide variance is shown in the limited number of reports of area coverage by the Aero 14A spray tank. Bureau of Aeronautics Handbook CO39C-10-502 states that with a spray altitude of 50 feet, wind speed at 3-7 knots, airspeed of 360-385 knots, and at maximum flow, two tanks will give LCt₅₀ area coverage over an area 800 feet wide and about one mile long in 0-2 minutes. Width will increase to one and one-half miles for an attack period under the same conditions for 0-30 minutes. No estimate of coverage is given for a period of 0-30 seconds. No estimate of spray tank coverage can be made reliably, therefore, until more data becomes available.

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Chapter 4

TOXIC CHEMICAL BOMBS

INTRODUCTION

The following is a list of World War II toxic chemical bombs which may possibly be used by the U.S. Navy:

<u>Model</u>	<u>Nominal Weight, lb.</u>	<u>Filling</u>	<u>Status</u>
M70	115	H	Limited standard
M70A1	115	HD	Standard
AN-M78	500	CK*	Limited standard
AN-M78	500	CG*	Standard
AN-M79	1000	CK*	Limited standard
AN-M79	1000	CG*	Standard

The above munitions have the following general characteristics:

A. All are at least 10 years old and therefore require continual renovation in order to prevent leakage.

B. Some are in Navy stock; some are in national war reserve; some are U.S. Air Force stock. All are presently in store by the U.S. Army Chemical Corps.

C. None have a low drag or streamlined configuration.

* CK denotes cyanogen chloride. CG denotes phosgene.

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D. All may be carried by Navy aircraft but may impose problems of separation and loss of speed because of drag.

E. None have been used in actual combat operations by U.S. forces.

Complete descriptions of the above munitions may be found in OP 1664, FM 3-6, or TM 3-400.

The following are toxic chemical bombs that may be encountered in time of war:

<u>Model</u>	<u>Nominal Weight, lb.</u>	<u>Filling</u>	<u>Status</u>
LC Mark 2	1000	H	British and tripartite standard
E101R3 Cluster	1000	GB	U.S. Air Force standard
MC1 E136 R3 Cluster	750 750	GB GB	US AF US AF

The Bureau of Ordnance will furnish information relative to the above munitions when and if required.

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It is considered that all Navy requirements for a toxic chemical bomb will be satisfactorily met by the low drag, 500-pound bomb now being developed by the Bureau of Ordnance. This is the only bomb that the Navy plans to stock in readiness as a standard toxic chemical bomb. If it proves to be satisfactory, other bombs of the low drag series may be modified for chemical filling.

BOMB, TOXIC CHEMICAL, 500-POUND, EX. 23

GENERAL DESCRIPTION

Bomb, Toxic Chemical, 500-pound, Ex. 23, (fig. 4-1) is a modification for chemical filling of Bomb, General Purpose, 500-pound, Mark 82 Mod 0. This bomb is one of a series of low drag bombs recently developed by the Bureau of Ordnance. These bombs are of streamlined design, having only a fraction of the drag of World War II bombs. Low drag bombs have been flown successfully on high-speed, jet airplanes without any indication of buffeting.

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Bomb Ex. 23 is still in the testing stages of development. It will probably not be released to production for some time. It is a thin-cased, steel bomb designed to carry 112 pounds of GB or 130 pounds of HD. Gross weight of the bomb, GB-filled, is about 490 pounds; HD-filled, about 508 pounds. Provided with a central burster of tetrytol, the bomb is designed to be airburst by a proximity nose fuse. It also has an impact-type, tail fuze in case of failure of the proximity fuze. Based on the combined fuzing, the bomb should have a functional efficiency of 95 per cent. A side filling opening and closure is being developed and will be incorporated in the munition. The Navy will receive the bomb, filled with the toxic chemical agent, from the Army Chemical Corps.

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The bomb is designed to be stored and to function within wide ranges of temperature. It is to be capable of being transported up to 60,000 feet above sea level without leakage. The bomb will be provided with standard Navy suspension lugs to allow carriage on standard, exterior, double-hook, bomb racks used on many types of naval aircraft. Designed to be ballistically stable, the bomb should not have a ballistic dispersion markedly greater than that of Bomb Mark 82 Mod 0.

Table C, pages 4-16 and 4-17, contains basic descriptive data for the Ex. 23 bomb. Design of the bomb is subject to modifications, however, if test results prove them necessary; therefore the data given, while applicable to the present design, should be considered preliminary.

COMPONENTS

Toxic chemical bomb Ex. 23 comprises the following components, described in the order given:

- Body
- Filling
- Closure
- Burster well
- Burster tube
- Fuzes
- Fin assembly

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Body

The bomb body (fig. 4-2) is of thin-cased steel. It is 60 inches long and 10.75 inches in diameter. With the fuzes and fin assembly in place, length of the bomb is 91 inches. Three drilled and tapped holes provide for the attachment of two suspension lugs, 14 inches apart, and for a hoisting lug between the two suspension lugs.

A nose fuze adapter at the front of the bomb body contains a threaded center hole for installation of a proximity fuze. The nose fuze adapter is threaded into a burster adapter, which extends from about the nose fuze adapter to and around the nose end of the burster well. The burster well extends through the center of the bomb body from the nose fuze adapter and burster adapter to a tail adapter, called a tail closure plate, which closes the rear of the bomb body. The tail closure plate is threaded to hold the tail fuze. The nose fuze adapter, burster adapter, burster well, and tail closure plate are installed and welded in the bomb body as a unit.

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Just aft of the forward suspension lug provision is a side filling hole, provided with a screw-type closure. This opening was the electric cable receptacle for the electric fuzing of Bomb Mark 82 Mod 0.

Filling

The bomb is filled through the side filling hole. The filling consists approximately of either 112 pounds of GB or 130 pounds of HD. Neither filling will completely fill the bomb; the void left allows for expansion of the agent at high temperatures. It is planned that the bomb will be procured already filled. Therefore, except for qualified specialists assigned to filling plants, naval personnel will not be required to fill the bomb.

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Closure

Closure of the side filling hole is accomplished by installation of a lead sealing ring, a steel plug filler, and a screw-type plug (fig. 4-3). The sealing ring and the plug filler serve as a primary seal; the plug serves as a secondary seal. After the bomb is filled, the plug is staked in place.

The present closure has proved adequate in jolt and vibration test; however, it has not proved satisfactory in all respects as to simplicity of installation and removal and as to sealing integrity. Improvements upon this type of closure and development of other types of closure are being investigated.

Burster Well

A steel burster well (fig. 4-2) passes axially through the bomb body and holds the burster tube, filled with the burster explosive. The burster well fits into a burster adapter and abuts the nose fuze adapter at the nose end of the bomb body; at the tail end of the body, the burster well is enclosed by the tail closure plate. The nose fuze adapter, burster adapter, burster well, and tail closure plate are assembled as a unit and welded to the inert bomb body before the bomb is filled with agent. All welds have a reinforcement of weld metal on exterior surfaces.

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Burster Tube

A central burster tube, containing the burster charge, fits into the burster well. The burster is to be of tetrytol, cast in pellets or as a solid. The burster tube has voids at both its nose and tail ends to allow for the nose fuze and the tail fuze adapter booster. Weight of the burster explosive is designed to be 10.5 pounds, providing a ratio of chemical agent to explosive of approximately 10.7 to 1 with GB and 12.4 to 1 for HD. Other ratios are being considered, however, in order to obtain the best dispersion characteristics.

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Fuzes

End sections of Bomb Mark 82 Mod 0 have been cut away to permit installation of the nose burster and fuze adapters, the tail closure plate, and the fuzes. The nose fuze adapter is designed to hold proximity fuze VT-M166E1. The tail adapter or closure plate holds an impact-type tail fuze, AN-M101A2. Fuze AN-M101A2 contains a non-delay primer detonator and an adapter-booster. The adapter, a reducing bushing used for mounting the fuze in the standard fuze cavity, is assembled with an auxiliary explosive charge, the booster, to form the adapter-booster. For complete description of the proximity and tail fuzes and their operation, refer to TM 9-1980 and other publications listed in the bibliography.

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Fin assembly

A fin assembly, having four identical vanes spaced 90 degrees apart about a hollow conical tail, is assembled to the bomb body by hexagonal socket set screws. The tail fuze protrudes from the end of the tail fin when in place. The fuze extends through the hollow tail fin to the adapter booster, which fits into the tail closure plate. The fin assembly is 26.1 inches in length. From tip to tip, distance between vanes is 15.1 inches.

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OPERATION

After the bomb is released from the bomb rack, both fuzes begin to act. As the bomb approaches the target, the proximity fuze explodes the burster at a predetermined height above the ground. If the proximity fuze fails, the tail fuze will act upon impact to detonate the burster. The burster ruptures the thin bomb casing and releases the agent. Except for a small part of the agent lost in the burst, all of the agent will be disseminated, most of it as vapor. For behavior of the agents after release and for expenditure requirements, see the preceding chapters.

MARKING

The bomb body is painted grey. If it is GB-filled, it will have one green band painted around the body between the two suspension lug positions. If it is HD-filled, it will have two green bands painted about the body. Weight, type, filling, model number, and lot number are stenciled in green on the bomb body.

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PACKING AND SHIPPING

The bomb bodies are packed for shipment by installing nose and tail shipping plugs in the nose fuze adapter and tail closure plate. The bodies are protected during shipment by shipping bands. The fin assembly is crated separately, one assembly in each crate, and the fuzes are shipped in separate fuze containers. Suspension lugs are shipped with the fin assembly. The hoisting lug is shipped in the tail fuze cavity of the bomb body.

Toxic chemical bombs are shipped in accordance with shipping requirements set forth in Interstate Commerce Commission regulations and applicable Armed Services regulations. These are discussed in chapter 8. Shipment of these bombs and other toxic chemical munitions will be accompanied by and under the supervision of an escort of the Technical Escort Detachment or by specially trained naval personnel.

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STORAGE

Toxic chemical munitions are not stored with other type munitions, but are set aside in a special storage area. Being both an explosive and a poison hazard, they are subject to special regulations. Specific instructions and regulations applicable to storage, including protection, surveillance, venting, disposal of leakers, and decontamination, are given in subsequent chapters.

SPECIAL EQUIPMENT

Aboard ship, the bomb will be handled by a bomb carrier (Bureau of Ordnance drawing 1445170), which has a carrying capacity of 2000 pounds. The bomb is to be lifted only by the becket of the bomb carrier. Bomb trailers and trucks may also be used. Protective equipment, detection devices, and decontamination equipment are described in subsequent chapters. First aid equipment is discussed briefly in chapters 1 and 2 and described fully in publications listed in the bibliography.

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SAFETY PRECAUTIONS

Toxic chemical bomb Ex. 23 should be handled only by trained personnel and then only as little as possible. Prescribed protection, detection, decontamination, and first aid equipment should be immediately available to all personnel handling the bombs. General and specific safety precautions applicable to this munition and other toxic chemical munitions are discussed in chapter 13.

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TABLE C

TOXIC CHEMICAL BOMB EX. 23

Bomb Data

General arrangement, Army Chemical Corps dwg.	E314-5-3094
Body, length, in.	60.0
Assembly, fuzes, body, and fin, length, in.	91.0
Body, diameter, maximum, in.	10.75
Distance between suspension lugs, in.	14.0
Filling, agents	GB, HD
Weight, GB filling, lb. (approx.)	112
Weight, HD filling, lb. (approx.)	130
Weight, bomb, GB-filled, lb. (approx.)	490
Weight, bomb, HD-filled, lb. (approx.)	508
Burster well, length, in.	55.0
Burster explosive	Tetrytol
Fuze, nose, proximity, model	VT-M166E1
Fuze, tail, impact-type, model	AN-M101A2
Fin assembly, BuOrd dwg.	1380512
Fin assembly, length, in.	26.1
Fin assembly, vane width, maximum, in.	15.1
Suspension lug, BuOrd dwg.	1211687
Hoisting lug, BuOrd dwg.	1211668

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Shipping Data

How shipped: Bomb body - bare, with shipping plugs and shipping bands

Fin assembly - crated, one assembly per crate

Fuzes - crated in standard fuze containers

Suspension lugs - Shipped in fin assembly crate

Hoisting lug - Shipped in tail fuze cavity in bomb body

Crate, fin assembly, model	Mark 17 Mod 0
Crate general arrangement, BuOrd dwg.	1380640
Crate, width, in.	12.0
Crate, height, in.	12.0
Crate, length, in.	27.75
Crate, volume, cu. ft.	2.5
Crate, weight, empty, lb.	12.0
Crate, weight, filled, lb.	32.0

Handling Equipment

Bomb carrier, general arrangement, BuOrd dwg. 1445170

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Chapter 5

TOXIC CHEMICAL SPRAY TANKS

INTRODUCTION

The Bureau of Aeronautics has developed a series of spray tanks for the dissemination of GB or HD. Designation of the tanks is Airborne Spray Tank Aero 14A, Aero 14B, and Aero 14C. Similarly designed, the tanks may be mounted externally on airplanes or guided missiles. Operation, servicing, and maintenance of the tanks are under cognizance of the Bureau of Aeronautics. The Bureau of Ordnance has cognizance of providing the chemical agents used in the tanks and of the storage, handling, surveillance, and shipment of the tank's center section, an assembly that contains the chemical agent in a reservoir.

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A complete description of the Aero 14A spray tank and of its operation is given in Bureau of Aeronautics Handbooks CO39C-10-501, Operation, Service, and Overhaul Instructions With Illustrated Parts Breakdown, Navy Model Aero 14A Airborne Spray Tank and CO39C-10-502, Operation, Service, and Overhaul Instructions With Illustrated Parts Breakdown, Navy Model Aero 14A Airborne Spray Tank Discharge Nozzle Assembly. The material given below is in great part abstracted from that publication in order to present data that should be of most assistance to ordnance personnel. In all cases, however, the material presented below should be supplemented by reference to the Bureau of Aeronautics Handbooks.

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AERO 14A AIRBORNE SPRAY TANK

GENERAL DESCRIPTION

The Aero 14A Airborne Spray Tank (fig. 5-1) is a pressure-controlled medium for the dispersion of toxic liquid chemical agents as an aerosol. The tank is streamlined and can be carried externally either under the wings or the fuselages of naval fighters and attack aircraft and under the bodies of certain missiles. One plane can carry from one to three tanks.

Selection of the tank or tanks to be used and arming of the tanks are controlled from a panel in the pilot's compartment. The agent may be discharged intermittently or continuously by a firing switch on the pilot's control stick. For effective dissemination of the agent, low-level flights will be necessary.

The tank is being tested on a glide missile, the Gorgon V. This missile carries one tank mounted under its body. Two missiles can be launched from one parent plane; each missile should make a low-level run over the target and be accurate to within plus or minus 25 feet. If dissemination in this manner proves successful, the tank may be tested on other missiles.

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The tank has an outer metal shell and a tail assembly of four fins bolted to it. Length of the tank is 15 feet 10 inches; maximum body diameter is 22 inches. Empty, the tank weighs 820 pounds. Each tank is designed to hold 90 gallons* of agent. The tank has its own internal pressure system, containing a pressure bottle filled with dry nitrogen under a high pressure. The system is operated at a regulated pressure of 100 pounds per square inch to discharge the agent. Estimated area coverage of the tank is given in chapter 3.

* approximately 822 pounds of GB or 954 pounds of HD at 68 degrees Fahrenheit. To allow for agent expansion, however, maximum weights of filling have been prescribed by the Bureau of Aeronautics. In all cases, the weight of HD filling is not to exceed 935 pounds. GB filling is not to exceed 785 pounds.

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The center section (fig. 5-2) of the tank holds the reservoir and is the carrier of the agent. A special heating installation and insulation are provided for the center section to prevent the transfer of heat to or from the agent. The center section is stored and shipped separately from other assemblies of the tank in a special center section container. In mounting the tank on aircraft, either the center section is hoisted into position, and the nose, tail, and other units of the tank are then assembled to it, or the tank is assembled as a unit and then hoisted into position.

COMPONENTS

The Aero 14A spray tank consists of the following major components: nose shell, pressure control system, center section, tail shell, overboard discharge pipe, and the tailpipe assembly. A description of these assemblies and of their operation is given in the Bureau of Aeronautics Handbooks. The material that follows concerns only the center section, its container, and a suggested field filling procedure, subjects that should be of most use to ordnance personnel.

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Center Section

The center section (fig. 5-2) of Spray Tank Aero 14A contains an inlet valve, a 90-gallon reservoir, a pressure indicating system, a reservoir relief valve, an outlet valve assembly, and a heating installation. The inlet valve allows high-pressure dry nitrogen, reduced to a pressure of 100 pounds per square inch, to enter the reservoir, driving the agent through the outlet valve assembly. The pressure indicating system shows the pressure developed in the reservoir, and the reservoir relief valve provides a safety outlet in the event that pressure in the reservoir becomes too great. Heating is provided by electrically-heated, longitudinal heater strips installed about the reservoir. These items are described in detail in the Bureau of Aeronautics Handbooks.

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The reservoir itself is a cylindrically-shaped, welded monel structure, contained within glass wool fiber insulation, and the spray tank casing. Both the reservoir and the outer casing have welded fittings for two mounting or suspension lugs, one hoisting lug, a needle filling assembly, and a gravity and vacuum filling assembly. Empty, the center section weighs 485 pounds. It is approximately six and one-third feet in length. It is shipped and stored in a special center section container, described below.

Center Section Container

The container (fig. 5-3) used for the spray tank's center section during shipping and storage is an airtight aluminum cradle, mounted in a carrying and stowing structure. The assembly has a length of eight and two-thirds feet, a height of three feet with its casters retracted, and a filled weight of 556 pounds. The container consists of the following basic components, described in the order given:

Cradle

Post and spring assemblies

Bulkheads

Shock strut assemblies

Hoist beam

Casters

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Cradle. The cradle (fig. 5-3) contains the spray tank center section during shipping and storage. It is basically a cylinder constructed of aluminum alloy, separating longitudinally into two half shells. The two halves are joined and closed by a series of Marman clamps and shear pins along the joining edge. When the cradle is closed, a rubber gasket in the upper cradle joining edge is pressed against a flange in the lower cradle edge to provide a vapor and watertight seal for the cradle. The upper cradle assembly also has a compartment containing a gas mask type canister that prevents passage of contaminated air from the cradle. The center section of the spray tank rests on rubber cushions located circumferentially in the cradle.

Two studs, located on opposite sides of the lower half of the cradle, hold the cradle in trunnion posts of the container post and spring assemblies. Bolted to the ends of the cradle are handles for lifting the empty cradle manually. A small inspection window is located in the floor of the lower cradle assembly.

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Post and Spring Assemblies. Two post and spring assemblies (fig. 5-3), one on each side of the cradle, hold the cradle by its studs in a trunnion post. The studs are secured by cotter pins and nuts. Tapered beam springs are pinned to the upper and lower sections of each trunnion post. The springs are pinned at their ends to bulkheads.

Bulkheads. Two bulkheads (fig. 5-3), one at each end of the container assembly, join to the spring and post assemblies and make up the open-sided rectangle in which the cradle is supported. Each bulkhead is a four-sided frame, curved to reduce the force of impact if the container rolls over. Ends of the beam springs of the post and spring assemblies are pinned to the bulkheads, and the shock strut assemblies are pivoted on the lower bulkhead member. A phenolic skid is bolted to the bottom of each bulkhead. The skids serve as a support for the container when the caster wheels are retracted. Two shackles, attached to each bulkhead, are used as towing and tiedown fittings.

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Shock Strut Assemblies. Shock strut assemblies (fig. 5-3) extend from fittings in the underside of the cradle to the lower bulkhead members. The two assemblies, one at each end of the cradle, are made up of helical coils enclosing oil-filled shock absorbers.

Holst Beam. A centrally-located hoist beam (fig. 5-3) extends over the cradle and is pinned to the two trunnion posts of the post and spring assemblies. The hoist beam, having two spring-loaded shackles at its center, is used for hoisting and lowering the filled center section container.

Casters. Four caster wheels (fig. 5-3), attached to caster retracting mechanisms, are lowered for moving the center section container. They are raised during storage. The caster retracting mechanisms are attached, one at each end of the container, to the bulkheads. A jack handle on each bulkhead is used to lower or raise the wheels.

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FILLING PROCEDURE

The center section reservoir will be filled initially by the Army Chemical Corps. After use, the reservoir will be refilled either by returning the empty center section to the Army Chemical Corps filling plant in the United States or by returning the empty spray tank to the nearest overseas base supplied with the toxic chemical agent. In the second case, ordnance personnel may be required to assist in the operation.

Field filling will evidently save much time; however, the toxic danger of the agents creates many problems. The life expectancy of the spray tank closing seal assembly, for example, has not been definitely established. It may be found necessary to replace seals or other parts of the center section for refilling. Nevertheless, field filling can be accomplished with relatively little danger, if adequate safety measures are taken.

The field filling procedure described below is intended as a tentative method for filling spray tanks pending further development of mobile field filling equipment. This procedure has been successfully employed on an experimental basis.

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Field Filling Equipment

In general, the liquid chemical agents will be received in Type D, one-ton containers. These containers, their handling and shipping, are discussed in later chapters of this manual. With the Type D container and the empty, decontaminated spray tank at the filling area, the following equipment is needed:

Supporting Stands. The one-ton agent container should be supported on an elevated stand to insure proper drainage. A stand that will rest securely on platform scales will be required for the spray tank.

Platform Scales. Filling is to be accomplished by weight in accord with a temperature-weight table to be developed. Therefore, a platform scale of enough capacity to accommodate the gross weight of the filled spray tank and its supporting stand will be required.

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Pressurizing Source. A source of air or inert gas pressure is necessary to pressurize the Type D container. A portable air compressor unit, hand or electrically operated, or a compressed gas cylinder may be used for this purpose. If an electrically operated unit is used, a 15-pound-per-square-inch limit switch is recommended.

Filling Device. A filling device, which attaches to the filling line from the agent container, has been developed and found satisfactory for use. If the filler opening of the spray tank is threaded, a nipple is all that is required for installation of the filling device. If the tank is not provided with a threaded opening, however, an appropriate adapter will be required.

Vapor Scrubber System. One or more carboys, filled with a suitable decontaminating solution, will be required. The recommended solution is a ten per cent aqueous soda ash (sodium carbonate) solution. Other decontaminating solutions which may be used are described in chapter 10. Metal tubing and agent resistant rubber tubing will be required for assembling the scrubber system and joining it to the filling equipment.

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Tools and Accessories. Various valves, pressure gages, flexible hoses, pipe connections, wrenches, and hand tools will be required for assembly and operation of the filling system. Tools and accessories employed for filling M10 Airplane Smoke Tanks, as described in TM 3-255 and TB 3-255-1, will be satisfactory where applicable to the Aero 14A filling operation.

Protective Clothing. Full protective clothing suitable for the agent being filled will be required for personnel engaged in the filling operation. For protective equipment required with GB and HD, see later chapters of this manual.

Decontaminating Equipment. Decontaminating trucks containing soda ash solution or the appropriate decontaminating solution will be required for decontaminating after filling the tank. A bucket containing decontaminating solution and a sponge is convenient for decontaminating filling lines and for localized decontamination.

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Supporting Vehicles. Besides the decontaminating trucks mentioned above, supporting vehicles should include a fork lift truck for handling the agent containers, bomb trailers for transporting the spray tank, service trucks and other vehicles as required.

Filling Operation

A diagrammatic sketch of the filling operation is shown in figure 5-4. After checking the equipment:

1. Place the one-ton agent container on its supporting stand. Attach the pressurizing line assembly with valves and pressure gage to the upper angle valve of the container. Attach the filling line to the lower angle valve.
2. Place the spray tank supporting stand on the platform scale, and position the spray tank on the supporting stand. Install the filling device in the filling opening of the spray tank. Connect the filling device to the filling line.
3. Fill the carboys with decontaminating solution and install the connecting lines. Attach a vent pipe to the filling device.
4. Attach an air inlet pipe to the air pump or gas cylinder, and connect the air inlet line to the pressurizing source.

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5. Move the counterpoise on the beam of the platform scale until it balances the weight of the supporting stand, the empty spray tank, and the connecting filling and vent lines. Set the counterpoise to indicate a gross filling weight of 20 to 30 pounds below the required gross filling weight. When this point is reached, the filling rate will be lowered to prevent an overrun.

6. Pressurize the air inlet line to approximately 15 pounds per square inch. Open the angle valve at the agent container. Gradually open the inlet valve to the pressurizing line until the pressure gage indicates five pounds per square inch. A pressure of 5 pounds per square inch is to be maintained in the agent container during filling operations.

7. Open the angle valve at the agent container connected to the filling line. Open the valve at the filling device permitting the liquid agent to flow into the spray tank.

8. Fill the tank to a weight of 20 to 30 pounds below the required weight. When this point is reached, reset the scale counterpoise for the final weight and resume filling at a reduced rate. Continue filling until the required weight is reached.

9. Close the agent container filling valve; open the valve at the filling device. Drain the filling line by opening the filling line bleeder valve.

10. Disconnect the filling line from the spray tank, and allow the excess liquid agent to drip into the decontaminating bucket.

11. Insert closure in the spray tank filling opening immediately after the filling device has been disconnected from the spray tank.

12. Shut off the pressure source, and disconnect the pressurizing line. Vent the pressure in the agent container through the scrubber carboys.

13. Close the air inlet valve on the agent container, and disconnect the pressurizing line from the agent container.

14. At the conclusion of filling operations of the spray tanks, decontaminate personnel and equipment. Decontaminating procedures are described in later chapters of this manual.

SAFETY PRECAUTIONS

Special detection devices and safety precautions applicable to filling and handling spray tanks are described in the Bureau of Aeronautics Handbooks and in later chapters of this manual.

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Chapter 6

TOXIC CHEMICAL PROJECTILES

INTRODUCTION

The following toxic chemical projectiles are planned by the Bureau of Ordnance: 5-inch 38-caliber, 5-inch 54-caliber, and 6-inch 47-caliber. These projectiles are modifications of high-capacity projectiles for chemical filling with GB or HD. Emphasis has been placed on the development of the 5-inch 38-caliber toxic chemical projectile; if tests prove this munition satisfactory, development of the 5-inch 54-caliber and 6-inch 47-caliber projectiles will follow.

The projectiles are similarly designed, each having an instantaneous, impact-type, nose fuze, an auxiliary detonating fuze, an axial burster, and a weight ratio of filling-to-explosive of about two-to-one for GB and about three-to-one for HD. Each will use standard Navy fuzes and cartridge assemblies. Except for special equipment and regulations applicable to toxic chemical munitions, handling and firing of these munitions are expected to be the same as for high-explosive projectiles.

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Estimated munition requirements for these projectiles are given in chapter 3. Specific safety precautions, stowage and shipping regulations, decontamination, and detection devices applicable to these munitions are discussed in later chapters. The following descriptive data apply to the 5-inch 38-caliber projectile. When developed, the 5-inch 54-caliber and 6-inch 47-caliber projectiles are expected to be similar.

**5-INCH 38-CALIBER TOXIC CHEMICAL
PROJECTILE EX. 34 MOD 0**

GENERAL DESCRIPTION

The 5-inch 38-caliber Toxic Chemical Projectile Ex. 34 Mod 0 (fig. 6-1) is a modification for chemical filling of the 5-inch 38-caliber high explosive Projectile Mark 49. The toxic chemical projectile is still in the testing stages of development and will probably not be released to production for some time. It is designed to carry 3.5 pounds of GB or 4.1 pounds of HD. Gross weight of the projectile, GB-filled, will be approximately 55 pounds. The projectile has a central burster, an impact-type nose fuze, and an auxiliary detonating fuze. It is filled through the nose opening before the burster well is installed. The Navy will receive the filled projectile from the Army Chemical Corps.

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The projectile is designed to be stored and to function within wide ranges of temperature and to have a functional efficiency of 95 percent. Its ballistic dispersion should be about the same as the 5-inch 38-caliber Projectile Mark 49.

Table D, page 6-11, presents data applicable to the 5-inch 38-caliber Toxic Chemical Projectile Ex. 34 Mod 0. The data in this table and in the following discussion, however, should be considered preliminary.

COMPONENTS

The projectile comprises the following components, described in the order given:

Body

Filling

Closure

Burster well

Burster tube

Fuzes

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Body

The projectile has a hollow steel body (fig. 6-1) of varying thickness. It has an opening at the nose for filling and for installing the burster well and burster. At the nose opening, the body is internally threaded to hold a threaded fuze adapter and the fuzes. The body is 16.63 inches long and has a maximum diameter, measured about the rotating band, of 5.20 inches. Diameter about the bourrelet is 4.985 inches. Empty, the projectile body weighs 42.59 pounds.

Filling

Filling of the projectile is made through the nose opening before the burster well is installed. The burster well, press fitted against the projectile body at the nose opening, closes the opening and seals in the agent. A void is left to allow for expansion of the agent from high temperatures. The filling consists of either 3.5 pounds of GB or 4.1 pounds of HD.

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Closure

Closure is accomplished by installation of the burster well in the projectile after the projectile has been filled with the agent. The burster well is flanged at the nose end, and this end is tightly fitted, under pressure, against the interior of the projectile body.

Burster Well

The burster well (fig. 6-1) holds the burster tube loaded with high explosive composition B, and it serves to seal the agent within the projectile. The burster well is of steel, 14.54 inches long, 2.00 inches in diameter at its base end, and 2.505 inches in diameter at its nose end. At its nose end, the burster well is threaded on the inside to mesh with threads on the outer nose end of the burster tube. A flanged portion extends about 1.5 inches along the outside of the burster well at its nose end. This flanged portion is press fitted against the projectile body to provide an effective closure for the agent. The burster well is designed to withstand a pressure in excess of that expected to be developed by the agent.

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Burster Tube

A burster tube (fig. 6-1), a thin steel cylinder, fits into the burster well and contains the burster explosive. About 1.5 pounds of Composition B is loaded into the burster tube before it is placed into the burster well. The burster tube is threaded on the outside at its nose end to mate with threads on the interior of the burster well nose end. The tube has two wrench slots in its head to permit installation or removal. The burster tube is closed at its base by a rubber plug. Length of the burster tube is 14.26 inches, about 1/4-inch shorter than the burster well. Weight of the burster tube, filled with Composition B, is 2.6 pounds.

Fuzes

The projectile is designed to burst on impact from the action of Nose Fuze Mark 29 Mod 3 and Auxiliary Detonating Fuze Mark 54 Mods 0, 1. The fuzes are held in place by an adapter, threaded on the outside to mate with the projectile body and threaded on the inside to mate with the fuzes.

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Nose Fuze Mark 29 Mod 3 is armed by projectile rotation of from 1500 to 2000 revolutions per minute. Before firing, the fuze is set at the SQ-ON position, giving "superquick" or instantaneous burst upon impact. At all other times, it is set at the OFF position. Auxiliary Detonating Fuze Mark 54 Mods 0, 1 is a one-piece assembly closed at one end by a booster cap and at the other end by a plug. It is designed to set off the burster charge with a high order explosion. The auxiliary detonating fuze does not function by itself; it is set off only by detonation of the nose fuze. A description of these fuzes and their operation is given in OP 1212, Projectile Fuzes, and in other publications listed in the bibliography.

CARTRIDGE

The cartridge to be used with Projectile Ex. 34 Mod 0 is listed as Assembly V in OD 5297, Ammunition Assemblies. It is Cartridge Mark 5, a full, flashless cartridge. It weighs 28.07 pounds and is 28.57 inches long. The cartridge is shipped separately from the projectile and is assembled with the projectile just before firing.

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OPERATION

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After firing, projectile rotation arms the fuzes. Upon impact, the nose fuze sets off the auxiliary detonating fuze which immediately explodes the burster. The burster explosion shatters the projectile and releases the agent as a vapor. Casualties can be expected both from fragmentation of the projectile and from the vapor. For estimated munition expenditure requirements, see chapter 3.

MARKING

The projectile body is painted grey. If it is GB-filled, it will have one green band painted about the center of the body. If HD-filled, two green bands are painted about the body. The word GAS is stencilled on the body as are letters denoting the filling, either GB or HD. Stamped on the body are the mark and mod, size, and type of the projectile, the lot number, year of specification, the inspector's seal and initial, and the manufacturer's name.

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PACKING AND SHIPPING

Projectiles are packed for shipment by installing a nose shipping plug in the nose opening. The bodies are protected during shipment by protecting grommets placed about the rotating bands.* Cartridge cases are shipped separately in cartridge tanks. The auxiliary detonating fuze is shipped either threaded and staked in the projectile or in a separate fuze container. The nose fuze is shipped in a separate fuze container. Regulations and precautions to be observed during shipping are discussed in chapter 8.

STORAGE

Toxic chemical projectiles will present both an explosive and a poison hazard. Instructions and regulations pertaining to storage are discussed in later chapters.

* Projectiles may also be shipped crated, two per crate. Crate dimensions are 23 x 13 x 7.2 inches. See Bureau of Ordnance drawing 179057.

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SPECIAL EQUIPMENT

Cartridges used with this projectile are shipped in tanks. A tank wrench (Bureau of Ordnance drawing 204023-1) is used for opening the tanks, and Cartridge Extractor Mark 1 (Bureau of Ordnance drawing 179059) is used to remove the cartridges from the tanks. Other special equipment, such as protection, detection, and decontamination equipment, is described in later chapters.

SAFETY PRECAUTIONS

Safety precautions to be observed in handling toxic chemical projectiles are given in chapter 13.

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TABLE D

5-INCH 38-CALIBER TOXIC CHEMICAL PROJECTILE EX. 34 MOD 0

Projectile Data

General arrangement, BuOrd sketch	329674
Body, length, in.	16.63
Body, diameter, maximum, in.	5.20
Body, cavity, volume, cu. in.	150.60
Body, weight, empty, lb.	42.59
Filling, agents	GB, HD
Weight, GB filling, lb. (approx.)	3.57
Weight, HD filling, lb. (approx.)	4.1
Weight, projectile, GB-filled and fuzed, lb. (approx.) .	55.2
Weight, projectile, HD-filled and fuzed, lb. (approx.) .	55.8
Burster well, length, in.	14.54
Burster well, weight, lb.	3.34
Burster tube, length, in.	14.26
Burster explosive	Composition B
Burster tube, weight, filled, lb.	2.6
Fuze adapter, BuOrd dwg.	434045
Fuze, nose, impact-type, model	Mark 29 Mod 3
Fuze, auxiliary detonating, model	Mark 54 Mods 0, 1

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Cartridge Data

Cartridge, model	Mark 5 Mods
Cartridge, BuOrd dwg.	179889
Cartridge, length, in.	28.57
Cartridge, diameter, maximum, in.	6.24
Cartridge, weight, lb.	28.07

Shipping Data

How shipped: Projectile - bare, with nose shipping plug and
protecting grommet, or crated, two per crate

Auxiliary detonating fuze - staked in projectile or
in separate container

Nose fuze - crated in separate fuze container

Cartridge - in tank, one cartridge per tank

Cartridge tanks, models	Mark 6 Mods
	Mark 9 Mods
	Mark 15 Mods
Cartridge tank, Mark 6 Mods, BuOrd dwg.	204789
Cartridge tank, Mark 9 Mods, BuOrd dwg.	329463
Cartridge tank, Mark 15 Mods, BuOrd dwg.	389114

Handling Equipment

Cartridge tank wrench, BuOrd dwg.	204023-1
Cartridge extractor, Mark 1, BuOrd dwg.	179059

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Chapter 7

TOXIC CHEMICAL ROCKETS

INTRODUCTION

The Bureau of Ordnance is developing a 5-inch, spin-stabilized, ship-to-shore, toxic chemical rocket, designated as Rocket Ex. 17 Mod 0. It is designed to carry either GB or HD. The rocket head is a modification for chemical filling of Rocket Head Mark 14. The rocket motor, fuzes, and launchers used with this munition are standard Navy stock items. A description of this rocket is given below.

A toxic chemical rocket head has also been designed and is being tested for the Army-developed HONEST JOHN rocket. If developed, this munition may be procured for use by the Marine Corps. Information pertaining to this munition will be provided when and if necessary.

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**5-INCH, SPIN-STABILIZED, TOXIC CHEMICAL
ROCKET, EX. 17 MOD 0**

GENERAL DESCRIPTION

The 5-inch, spin-stabilized, Toxic Chemical Rocket Ex. 17 Mod 0 (fig. 7-1) consists of a rocket head, a toxic chemical agent, a central burster well and burster, a fuze adapter, a point detonating fuze, an auxiliary detonating fuze, and a rocket motor. The entire assembly is approximately 33 inches long, about five inches at maximum diameter, and weighs 48 pounds. The rocket head is designed to carry 4.2 (5)? pounds of GB or 4.9 pounds of HD. Filling is made through a nose opening in the rocket head before the burster well is installed. According to present plans, the rocket will be filled by the Army Chemical Corps.

The rocket can be fired from Rocket Launcher Mark 102 Mod 0 or Rocket Launcher Mark 105 Mod 0. Functional efficiency of the rocket is designed to be at least 95 per cent; it should function satisfactorily within wide ranges of temperature.

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Table E, page 7-13, lists preliminary data applicable to the Toxic Chemical Rocket Ex. 17 Mod 0.

COMPONENTS

The rocket comprises the following components, described in the order listed below:

- Rocket head
- Filling
- Closure
- Burster well
- Burster tube
- Fuzes
- Motor

Rocket Head

The rocket has a hollow steel head (fig. 7-1) of varying thickness. The head is closed at its base and open at its nose for filling and for insertion of the burster well and burster. At its base, the rocket head is externally threaded for assembly to the rocket motor. Two spanner wrench holes are located on opposite sides of the head near the base; they facilitate assembly of the head and the motor. The head is 14.567 inches long and has a maximum diameter of 4.89 inches.

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Filling

The rocket head is filled through the nose opening before the burster well is installed. When installed, the burster well fits tightly against the rocket head at the nose opening to seal in the agent. As with other toxic chemical munitions, a void is left to allow for expansion of the agent at high temperatures. The filling is either 4.2 pounds of GB or 4.9 pounds of HD. (5) (6) 7

Closure

After the rocket head has been filled, closure of the head is obtained by pressing the burster well in place. The burster well is flanged at its nose end, which is pressure fitted into and against the rocket head nose. The burster well is designed to withstand any pressure that can ordinarily be expected to be developed by either agent.

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Burster Well

The burster well (fig. 7-1), a hollow steel cylinder, holds the burster tube and burster explosive, and it provides the closure by which the agent is sealed in the rocket head. When the well is in place, a flanged portion at the nose end of the well extends through and around the nose opening of the rocket head. A special press fit is made between the interior surface of the rocket head nose opening and the flanged portion of the burster well. This fit closes the rocket head and prevents the agent from escaping.

The inner surface of the burster well nose is threaded to a length of about two inches. This threaded surface mates with exterior threading on the burster tube and on the fuze adapter to hold both in place.

Burster Tube

A thin steel burster tube (fig. 7-1) fits into the burster well and contains the burster explosive. The burster tube is externally threaded at its nose end to screw into the internal threading in the nose end of the burster well. The tube has two wrench slots in its head to facilitate assembly or disassembly. Length of the burster tube is 13.6 inches. The burster explosive is Composition B.

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Fuzes

Fuzes used in the toxic chemical rocket are Nose Fuze Mark 30 Mods 3 and 4 and Auxiliary Detonating Fuze Mark 44 Mod 2. They are held in place by a fuze adapter which threads into the nose end of the burster well. Nose Fuze Mark 30 Mod 3 has a plastic ogive; Mod 4 has a drawn steel ogive; otherwise, the fuzes are alike. Nose Fuze Mark 30 Mods 3 and 4 is armed by centrifugal force. With targets offering sufficient resistance, it functions instantaneously upon impact. Before the rocket is fired, the setting sleeve of the fuze must be set to the SQ-ON position. At all other times, it must be kept at the OFF setting. The fuze arms at a spin rate of from 1500 to 2000 revolutions per minute, after approximately 17 to 30 feet of travel.

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Auxiliary Detonating Fuze Mark 44 Mod 2 is used with the nose fuze to provide additional safety and to assure complete detonation of the burster explosive. The fuze is centrifugally armed and requires a greater spin -- about 3000 to 4500 revolutions per minute -- to arm than does the nose fuze. Upon impact, the auxiliary detonating fuze is fired by the detonator in the nose fuze. For a complete description of these fuzes and their operation, see OP 1212, Projectile Fuzes, and other publications listed in the bibliography.

Motor

Rocket Motor Mark 4 Mod 4 is the propelling unit of the rocket. It is encased in a motor tube, which has internal threads for assembly to the rocket head. External bourrelets on the motor tube provide bearing surfaces for the round when it is fired from a launcher. The components of the motor tube comprise a nozzle assembly, an igniter, an igniter electrical circuit, the propellant grain, and front and rear closures. The entire assembly is 15.65 inches long, 4.97 inches in diameter, and weighs 21.75 pounds as fired. Its functioning is briefly discussed below. For a complete description of this motor, see OP 1260, first revision, Rocket Ammunition.

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LAUNCHERS

Launchers used for firing the rocket are Rocket Launcher Mark 102 Mod 0 and Rocket Launcher Mark 105 Mod 0. These are deck-mounted launchers, automatically driven in train and elevation by remote control. Rocket Launcher Mark 102 has a potential firing rate of 30 rounds a minute (15 salvos). Rocket Launcher Mark 105 has a potential firing rate of 48 rounds a minute (24 salvos). For a description of Rocket Launcher Mark 102, see OP 1424; for a description of Rocket Launcher Mark 105, see OP 1915.

OPERATION

When the rocket is fired, an electrical impulse from the launcher firing contact pin is passed from the nozzle end of the motor to the igniter at the forward end of the propellant grain. Ignition of the black powder charge in the igniter produces burning gases that in turn ignite the exposed surface of the propellant grain. The propellant grain burns rapidly, producing large quantities of hot gas at a high pressure. The gas is expelled through the motor nozzles at a high velocity, providing the propelling force for the rocket.

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The nose fuze and the auxiliary detonating fuze are armed by the centrifugal force of the rocket spin. Upon impact, the nose fuze functions to fire the auxiliary detonating fuze that, in turn, explodes the burster. Explosion of the burster shatters the rocket head and releases the agent as a vapor. Both the fragmentation and the toxic vapor can cause casualties.

MARKING

The rocket head is painted grey. It has one green band painted about it if GB-filled, two green bands if HD-filled. Both the rocket head and motor are stencilled with mark, mod, size, and type.

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PACKING AND SHIPPING

The rocket head and motor are shipped unassembled in a shipping container. The head is plugged at its nose, and thread protectors are installed about the threads of both rocket and motor. A spacer is placed between the head and the motor and another between the motor and the cover ring of the container. A short-circuiting band is fastened around the nozzle assembly of the motor during shipping and storage. It provides a short circuit to prevent accidental functioning of the igniter. The band must be removed just prior to loading the round onto the launcher. The auxiliary detonating fuze is shipped threaded and staked in the rocket head. Nose fuzes are shipped in separate fuze containers.

Special shipping regulations applicable to toxic chemical munitions are discussed in chapter 8.

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STORAGE

Unless otherwise authorized, the rounds will be stored as shipped, unassembled in containers.

Stowage temperatures should be maintained below 90 degrees Fahrenheit, if practicable. Prolonged stowage at or above 100 degrees Fahrenheit is considered definitely hazardous. Toxic chemical rockets present both an explosive and a poison hazard. Specific storage regulations are discussed in chapter 9.

SPECIAL EQUIPMENT

Unless otherwise specified, the rocket round will be shipped in Rocket Container Mark 10 Mod 0.

Data for this container are given in Table E.

Besides the head and motor, the container holds an extractor for removing the round from the container, a nose support for the rocket head, spacers, and thread protectors about the head and motor. Assembly and disassembly of the motor and head are performed by the use of Assembly Kit Mark 2 Mod 0, in accordance with OP 1260, first revision.

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Prior to issuing the rocket to ships, the motor electrical circuit should be checked by the use of Circuit Continuity Tester Model 680-A, described in OP 1260, first revision.

Special equipment for protection, detection, and decontamination are described in later chapters.

ASSEMBLY AND DISASSEMBLY

For a step-by-step description of assembly and disassembly of the round, see OP 1260, first revision, pages 26-30.

SAFETY PRECAUTIONS

General safety precautions applicable to the handling and firing of rocket assemblies are specified in OP 1260, first revision, and other applicable publications listed in the bibliography. Special precautions relating to toxic chemical munitions, including Rocket Ex. 17 Mod 0, are set forth in chapter 13.

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TABLE E

5-INCH, SPIN-STABILIZED, TOXIC CHEMICAL
ROCKET EX. 17 MOD 0

Rocket Data

Rocket head, BuOrd sketch	329477
Rocket head, length, in.	14.567
Rocket head, diameter, maximum, in.	4.890
Rocket head, weight, GB-filled, lb.	25.8
Filling, agents	GB, HD
Weight, GB filling, lb. (approx.)	4.2 ⁵
Weight, HD filling, lb. (approx.)	4.9 ⁶
Weight, assembled round, GB-filled and fuzed, lb. (approx.)	47.0
Weight, assembled round, HD-filled and fuzed, lb. (approx.)	47.7
Burster well, length, in.	14.083
Burster tube, length, in.	13.612
Fuze adapter, BuOrd dwg.	433698
Fuze, nose, impact-type, model	Mark 30 Mods 3,4
Fuze, auxiliary detonating, model	Mark 44 Mod 2
Motor, model	Mark 4 Mod 4
Motor, general arrangement, BuOrd dwg.	655922
Motor, length, in.	15.656
Motor, diameter, maximum, in.	4.970
Motor, weight, lb.	21.75

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Shipping Data

How shipped: Head and motor - unassembled in rocket container,
one round per container

Auxiliary detonating fuze - threaded and staked in
rocket head

Nose fuze - crated in separate fuze container

Rocket container, model	Mark 10 Mod 0
Rocket container, general arrangement, BuOrd dwg. .	433511
Rocket container, length, in.	39.00
Rocket container, stacking diameter, in.	6.88
Rocket container, volume, cu. ft.	0.84
Rocket container, weight, empty, lb.	9.7
Rocket container, weight, filled, lb.	63.0

Handling Equipment

Assembly kit, model Mark 2 Mod 0

Assembly kit, components:

Vise, model Mark 2 Mod 0

5-inch Utility Spanner Wrench, BuOrd dwg. 592822 Rev. A

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Chapter 8

SHIPMENT OF TOXIC CHEMICAL AGENTS AND MUNITIONS

INTRODUCTION

Because most toxic chemical munitions are in the development stage, there is little experience in the logistical aspect thereof. Nevertheless, the Bureau of Ordnance is attempting to develop doctrine and techniques for storing, shipping, and otherwise handling these items. Procedures described in this manual and in the sources referenced may be changed or added to as required by later developments, but they are considered adequate for all conditions of storage, shipping, and handling.

SHIPPING REGULATIONS

Transportation of explosives and other dangerous articles, including toxic chemicals, within the limits of the jurisdiction of the United States is regulated by federal law. (See OP 5, Vol. 1, para. 991 for titles of this legislation.) The laws provide that the regulations issued by the Interstate Commerce Commission will be binding upon all shippers and common carriers engaged in interstate and foreign commerce.

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Shipment by the Navy of toxic chemical agents and munitions must comply with Interstate Commerce Commission regulations, Bureau of Explosives regulations, U.S. Coast Guard regulations, Army Chemical Corps regulations, port and harbor regulations, state and municipal laws, and Bureau of Ordnance regulations set forth in this manual and in other applicable Bureau of Ordnance publications.

Regulations are set forth in the following publications:

Interstate Commerce Commission Regulations for Transportation by Rail of Explosives and Other Dangerous Articles in Freight, Express, Baggage, Including Specifications for Shipping Containers, Revised

Interstate Commerce Commission Motor Carrier Safety Regulations, Revised, Part 7

Bureau of Explosives Pamphlet No. 6, Drawings and Photographs Illustrating Methods for Loading and Staying Carload and Less than Carload Shipments of Explosives and Other Dangerous Articles, Revised

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Bureau of Explosives Pamphlet No. 6A,
Drawings and Photographs Illustrating Methods
for Loading and Bracing Carload and Less than
Carload Shipments of Loaded Shell (Projectiles)
and Loaded Bombs, Revised

NAVCG Pamphlet No. 108, Rules and Regulations
for Military Explosives, second revision, 1954

USCG Pamphlet No. 187, Explosives or Other
Dangerous Articles on Board Vessels, Revised
17 July 1950

Army Chemical Corps Pamphlet No. CMLWS
(SD-2), Shipping Regulations for Chemical Warfare
Agents, Chemical Ammunition, Poisons, and other
Dangerous Articles, January 1951

Bureau of Ordnance Pamphlet No. 5, Ammunition
Ashore, Volume 1, 10 June 1944

NAVORD OS 1588, Palletizing Unit Load and
Carloading and Bracing Plans for Live Ammunition,
Second Revision, 30 November 1945

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Other publications pertaining to the shipment of toxic chemical munitions are listed in the bibliography. Copies of these publications may be obtained, when required, by addressing a request to the nearest District Publications and Printing Office.

SHIPPING METHODS

Shipments of GB and HD munitions and bulk containers may be made by land (rail and highway), air, and water. Specific requirements and precautions, including information concerning routes, packing, loading, and surveillance in route are described in detail in the publications listed above. Protective equipment, decontamination, and handling of leakers are described in later chapters of this manual.

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TECHNICAL ESCORT DETACHMENT

GENERAL

All shipments of toxic chemicals are to be accompanied by escorts of the Army Chemical Corps Technical Escort Detachment or by specially trained naval personnel. At the present time, the Technical Escort Detachment escorts all shipments, except shipments made aboard U.S. Navy vessels. In such cases, a chemical officer will be assigned by the Bureau of Personnel. It is the responsibility of the activity or command originating a shipment to request the services of the Technical Escort Detachment and to protect the shipment for safety and security until the shipment is taken over by the escort.

The Technical Escort Detachment, also referred to as the Safety Control Battalion, is a separate field activity of the Army Chemical Corps. It is organized, trained, and equipped to furnish details of experienced officers and men to accompany shipments of dangerous chemical agents and munitions to their destination. It has additional missions pertaining to storage, transfer, transportation, destruction, and demilitarization of Chemical Corps munitions and related items and in safety, plant protection, and security.

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The Chemical Corps, as the representative of the Department of the Army, has responsibility and control of the Technical Escort Detachment. The Chemical Corps will determine, furnish, and maintain materials and equipment required by the escort unit for the shipment of Navy toxic chemical munitions. Escort service will be provided for both aerial and surface shipments of toxic chemical munitions within the Zone of Interior and to the first destination overseas.

MISSIONS

In connection with the shipment of dangerous chemicals, the Technical Escort Detachment is generally assigned the following missions:

- A. To escort and guard shipments throughout the period of transit, with special emphasis on security and safety of the shipments.
- B. To protect all personnel, both military and civilian, who handle or come into contact with the shipments.
- C. To repair or dispose of leakers occurring during shipment.
- D. To decontaminate thoroughly all objects or areas contaminated during shipment.

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The Technical Escort Detachment must see that the prescribed protective and safety provisions are fully observed. In all matters relating to the handling, safety, and disposal of the toxic chemicals, the Technical Escort Detachment has full control and responsibility. It has no jurisdiction, however, over ship crews, plane crews, train crews, and their regular operations. For a complete description of specific duties and activities of the Technical Escort Detachment in relation to land, air, and water shipments, see Chemical Corps Pamphlet No. CMLWS (SD-2) and Chemical Corps Special Text No. 3-250-1.

REQUESTS FOR TECHNICAL ESCORT DETACHMENT DETAIL

The assistance of the Technical Escort Detachment is available for toxic chemical shipments upon request to the Chief Chemical Officer. Requests should be submitted through proper channels to the Bureau of Ordnance for forwarding to the Chief Chemical Officer; the requests should be submitted as far as possible in advance of the shipment date. Requests should include a detailed description of the project, information as to location, size, time, agent involved, type and amount of munitions, and objective.

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CONSIGNOR RESPONSIBILITIES

The Commanding Officer of the activity originating the shipment shall see that it is protected until received by the Technical Escort Detachment and that each outgoing shipment is made in accordance with all applicable regulations. He shall render every assistance to the Technical Escort Detachment and see that proper accommodations are provided by the shipper for the escort and its equipment. In addition, he shall alert the consignee facilities in order that a qualified standby decontamination unit and a base medical service are kept in readiness.

SHIPPING CONTAINERS

CONTAINER TYPES

GB and HD should be shipped and stored only in adapted type munitions or in approved type bulk containers. Munitions designed for these agents and packing of the munitions for shipment are described in chapters 4 through 7. Bulk containers for these agents are described below.

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BULK CONTAINERS

Bulk containers are either of one-ton or 55-gallon size. The one-ton containers are heavy steel cylinders and are the largest type used for field operations. The 55-gallon containers are of 14-gage steel; they should be used whenever one-ton containers are not available or whenever specifically prescribed. Normally, the container used will be the one-ton size.

One-ton Containers

One-ton containers are of three designs, known as types A, D, and E. Although basically the same, the types vary with respect to valves and eduction tubes, depending upon requirements for the different agents.

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Type D One-ton Container. Type D one-ton container (fig. 8-1) is most widely used. It weighs 1310 pounds empty and holds about 1885 pounds of agent. It is 81.25 inches long, has a diameter of 28.5 inches, and a volume of 38.2 cubic feet. Its side walls are approximately 7/16-inches thick and the ends 3/4-inches thick. The ends are concave and forge-lapwelded to the sides for greater strength. It has large diameter education tubes (fig. 8-2), solid brass safety plugs, and Kerostest valves. The valves, protruding from the front end of the container, are protected during shipment by a bonnet fastened in place by four clips, one of which carries a locking bolt to lock the bonnet in place. Equally spaced about the outer edge of both the front and rear heads of the container are three safety plugs that will break loose to prevent the container from bursting in case extreme pressure is built up.

The type D container is used for both HD and GB. Loss of agent from this container occurs only as a result of damage to the valve assembly or the adapter components. A detailed description of this container and the replacement of damaged or faulty valves is given in TM 3-255, Chemical Handling and Loading Equipment. Venting and handling of leaking containers are described in chapters 9 and 10.

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Type A One-ton Container. The type A one-ton container measures 81.5 inches in length and 30.0 inches in diameter; volume is 42.5 cubic feet. It has smaller diameter education tubes than the type D container, and it is fitted with fusible Chlorine Institute safety plugs and Chlorine Institute valves (fig. 8-3). Type A containers are of two kinds: new or old. The old type A container has two bands about it. It was originally fitted with Liberty valves which proved unsatisfactory; it is now fitted with Chlorine Institute valves. Except for the characteristic bands, the old type A container is the same as the new type A container. Both containers are shipped with a protecting bonnet held in place by three clips.

Except for the difference in the size of the education tubes and in the types of valves, the type A container is basically the same as the type D container. Because of these differences, however, type A containers are used only for GB. They are not used for HD. The method of replacing faulty valves for the type A container is given in TB-3-255-1, Valve Replacement Mechanism, M1.

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Type E One-ton Container. The type E one-ton container is lightweight, fusion welded, and all-purpose. It measures 80.75 inches in length and 29.75 inches in diameter; volume is 41.4 cubic feet. It can be used for persistent war gases, such as HD, when equipped with solid safety-type plugs and Kerostest valves or for nonpersistent war gases, such as GB, when Chlorine Institute fusion plugs and valves are installed. Once the valves and plugs for one type agent have been installed, no provision is made for changing them to another type.

Fifty-five Gallon Containers

The 55-gallon containers are drums made of 14-gage steel. They weigh approximately 98 pounds empty and up to 800 pounds filled, depending on the type and quantity of filling. They measure 35 inches in length and 26 inches in diameter and have a volume of 11.2 cubic feet. The drums are of two types, a one bung container (fig. 8-4) and a two bung container. The former has a two and one-quarter inch bung on the side and is used for GB only. The latter has a two and one-quarter inch bung on its side and a three-quarter inch bung on one end. It is used for both GB and HD. For additional information on these containers, see TM 3-255.

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Chapter 9

**STORAGE OF TOXIC CHEMICAL AGENTS AND
MUNITIONS**

INTRODUCTION

All toxic agents and agent-filled munitions under Bureau of Ordnance cognizance are presently stored by the Army Chemical Corps. The procedures described in this chapter will apply when and if the Navy is required to store these items, either ashore or afloat. The following regulations apply not only to U.S. Navy munitions but also to any U.S. Army and U.S. Air Force munitions that the Navy may be required to store and ship.

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REGULATIONS

Regulations for the storage of toxic chemical agents and munitions, either ashore or afloat, are set forth in the following publications:

U.S. Navy Regulations

Bureau of Ordnance Manual, 1943

Bureau of Ordnance Pamphlet No. 4, Ammunition, 1943

Bureau of Ordnance Pamphlet No. 5, Ammunition Ashore, 1944

NAVCG Pamphlet No. 108, Rules and Regulations for Military Explosives, second revision, 1954

USCG Pamphlet No. 187, Explosives or Other Dangerous Articles on Board Vessels, Revised 17 July 1950

Army Chemical Corps Pamphlet No. CMLWS (SD-2), Shipping Regulations for Chemical Warfare Agents, Chemical Ammunition, Poisons, and other Dangerous Articles, January 1951

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All regulations applicable to chemical ammunition group A (persistent vesicants) and group A-1 (nonpersistent lethal gases), as classified by OP 5, must be observed. The regulations and procedures given in this chapter do not supersede, but implement, the regulations set forth in the publications listed above.

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STORAGE ASHORE

GENERAL

Because of the hazardous nature of the agents, stringent control must be exercised over all storage areas, including careful supervision of personnel and adequate provision of prescribed equipment. Local standing operating procedures and an emergency and disaster plan shall be established, setting forth the duties and responsibilities of all personnel and groups involved. For every operation involving handling of agent-filled containers and munitions, a written operation procedure shall be established and enforced. Personnel handling these items must be kept to a minimum; however, no one shall be allowed to work alone. Frequent instruction shall be given to all personnel, and adequate signs and warnings shall be posted about the storage area. Protective equipment and decontamination and first aid facilities shall be made readily accessible, and a communication and alarm system shall be maintained so that all personnel may be quickly alerted in any emergency.

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STORAGE CONTAINERS

GB and HD will be stored either in adapted type munitions, described in chapters 4-7, or in bulk containers, described in chapter 8. When stored out of doors, one-ton containers shall be placed on skids. All valves shall be heavily greased on the outside with cosmoline, and the outside of the bulk containers shall be painted to prevent corrosion.

STORAGE AREAS

Location of storage areas shall be selected to afford maximum protection to the general public and shall not be in or near densely populated areas. The distance from inhabited areas, main roads, and railroads shall be at least two miles. Administration buildings, quarters, barracks, and general storehouses shall be grouped outside and to the prevailing windward side of the magazine area, whenever possible. Such buildings shall be at least 1900 feet distant from storage areas. If possible, they shall be on higher ground than the magazines.

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Storage areas shall be enclosed by cyclone-type fence, and appropriate warning signs shall be posted. A 24-hour guard shall be maintained. Field telephones or other means of communication shall be maintained to contact the responsible officer in cases of emergency.

Wind direction indicators shall be placed conspicuously about the area, and, insofar as practicable, all work and handling shall be done on the upwind side of the chemical items.

STORAGE FACILITIES

Enclosed structures of fireproof construction provided with adequate means of ventilation shall be utilized for storage of GB and HD items whenever possible. Open-sided sheds may be utilized at the discretion of the officer having command jurisdiction. Open yard storage shall be used only as an expedient means in the event of emergency conditions. When open yard storage is used, protection from weathering elements must be provided. Regulations for permanent-type magazines are given below.

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METHODS OF STORAGE

Toxic chemical munitions shall not be stored with any other class of ammunition. Chemical munitions of two or more groups of fillings shall not be stored together except upon specific authorization of the Bureau of Ordnance. Whenever possible, each kind of container or munition shall be stored separately.

MAGAZINES

Permanent storage of chemical ammunition shall be in concrete, earth-covered magazines, in which no other class of munition is stored. Temporary magazines shall conform as closely as possible to the instructions issued for permanent type magazines.

Safety Distances

Minimum safety distances between magazines containing chemical ammunition is 500 feet; minimum safety distances between a magazine containing chemical munitions and a magazine containing explosives depend upon the quantity of explosives and are the same as the minimum safety distances between magazines containing explosives as given in OP 5.

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Drainage

All magazines containing chemical munitions shall have drainage systems completely isolated from the general drainage system of the station and from all forms of water supply. If desirable, however, the drainage systems of several chemical magazines may be interconnected.

Quantity Restrictions

Not more than 100,000 net pounds of agent in chemical munitions are permitted to be stored in any one magazine in permanent storage ashore.

Magazine Construction

Magazines for the storage of toxic chemical munitions shall be constructed and prepared as prescribed in OP 5. The floors, walls and ceilings shall be treated so as to render them nonabsorbent and impervious to chemical agents. Magazine floors shall be of concrete and treated with sodium silicate to render them nonabsorbent. The use of rubberoid or other floor covering is prohibited. Drains and means of washing down the walls and floors shall be provided, and all metallic parts of the magazines shall be protected from corrosion with corrosion-resistive paint.

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Ventilation

Ventilation of magazines is imperative. Either permanent magazine blowers must be installed or portable mechanical blowers shall be readily available. The blowers shall be capable of providing a complete change of air in a standard 25 x 80 feet magazine in a period of not more than 15 minutes, and the operation shall be carried out with all machinery outside the magazine. Regardless of its condition, each magazine shall be ventilated by means of a mechanical blower at intervals not to exceed two weeks. Blowers shall be applied to each magazine for a period of not less than 15 minutes.

Storage Temperatures

Magazine temperatures shall normally be kept at 100 degrees Fahrenheit or below. If the temperature exceeds 110 degrees Fahrenheit for 24 hours, the magazine shall be cooled by applying forced ventilation.

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Markings

Magazines are to be numbered, marked, and painted in accordance with OP 5. Each magazine shall have signs posted in a conspicuous place on the outside of the magazine door giving general rules for chemical munitions and special rules for the munitions stored within that magazine. See OP 5 for samples of such signs.

Storage Arrangement

All containers and munitions shall be stored so as to allow the fullest possible circulation of air. Each item shall be readily removable with the minimum possible handling of other items.

Toxic chemical bombs shall be stored horizontally in tiers in the same manner as high explosive bombs of similar size. Tiers shall be as low as possible, consistent with space requirements. Bombs will be stored with the closure plug up. Projectiles and rockets shall be stored in their containers, and spray tank center sections shall be stored in the special center section container, stacked in tiers to a maximum of three containers high.

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SURVEILLANCE

Surveillance begins with the arrival for storage of the first shipment of agent-filled containers. In order to facilitate the detection of leakers, storage areas shall be laid out so that both ends of the items are available for inspection. Detection devices, protective equipment, and decontamination material shall be in use or at hand. During the storage of chemical items, magazines shall be inspected daily to determine container leakage or other damage and weekly to determine the condition of the magazine. A written surveillance and inspection schedule shall be established, including the procedure to be followed upon the discovery of leakers.

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DETECTION DEVICES

Automatic detector alarm systems are available for operating plants but are not practical as yet for field storage, where wind and climatic conditions would cause recording of information of questionable value. If automatic detector alarms become available, however, they shall be installed in such number and location as to provide optimum protection for personnel.

The M9A2 Chemical Agent Detector Kit is the only detection device presently available for the detection of toxic chemical vapor. In storage areas, tests for vapor contamination shall be made with the M9A2 Chemical Agent Detector Kit by personnel wearing masks and protective clothing. In addition to the kit, caged animals, such as pigeons and canaries, may be placed about the storage area and observed for symptoms of poisoning.

Detector paint, paper, and crayon shall be used wherever leaking liquid agent would most likely accumulate. These devices detect liquid agent only; they do not detect the presence of toxic chemical vapor.

Detection devices and their uses are described in chapter 11.

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LEAKING CONTAINERS AND MUNITIONS

When any of the detection devices indicates the presence of toxic vapors, the magazine shall be closed and forced ventilation applied for at least 15 minutes. The situation shall be reported immediately to the officer in charge of the magazines. The magazines shall then be opened and entered by personnel wearing appropriate protective equipment. In a magazine in which HD is stored, both masks and special clothing are required. In a magazine storing GB, only the mask is required for protection against vapor. If liquid GB is suspected, however, both masks and protective clothing must be worn. These items are described in chapter 12.

Detection of the particular leaking items is accomplished by use of the M9A2 detector kit or by other methods described later. Use of the kit is described in chapter 11.

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After the leaking items have been located and, if necessary, removed from the magazine, the magazine shall again be blown out for at least 15 minutes before detector paper or other detection devices are replaced. Leaking items shall be handled, repaired, or disposed of in accordance with the procedures given in chapter 10.

REPORT OF LEAKING ITEMS

A report shall be made to the Bureau of Ordnance on all chemical ammunition found in a damaged or leaking condition. This report shall include the following data:

- A. Type and amount
- B. Lot number
- C. Date discovered
- D. Detailed information regarding the nature of the leak and whether it appeared to have been caused by defective material or improper handling and packing.
- E. Disposition or, in the event that immediate disposition is not required, recommendations for such disposition.

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VENTING

GB-filled items will not require venting. If they have been subjected to temperatures ranging over 110 degrees Fahrenheit for any length of time, they shall be cooled by ventilation. A report shall then be made to the Bureau of Ordnance and instructions requested.

If is not expected that HD-filled projectiles and rockets will require venting. If venting is required for these munitions, information will be furnished by the Bureau of Ordnance.

HD-filled ton containers and bombs require venting to relieve pressures that build up under high storage temperatures. Under tropical storage conditions, HD-filled ton containers and bombs shall be vented at the end of each six month storage period or oftener, if pressure build-up in the item is suspected. Under temperate storage conditions, HD-filled ton containers and bombs shall be vented at the end of each twelve month storage period. Development of excessive internal pressures within any toxic chemical containers, however, can usually be prevented by following the procedures described above for keeping the items well ventilated and covered from the sun.

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Venting HD-Filled Bombs

HD-filled bombs shall be vented in the open, in a working area removed from the magazines. Personnel shall wear masks and full protective clothing and be equipped with decontaminating agents. Venting shall be done only in the daytime, preferably on a hot, bright day with little wind present. The site for venting shall be isolated, and the area downwind of the site shall be cleared of unprotected personnel for at least one mile. Venting equipment and the venting procedure are given below.

Venting Equipment. The following equipment is required for venting HD-filled bombs:

- A. An improvised stand (fig. 9-1) for holding bombs.
- B. Electric or hand drill. A hand drill can be used satisfactorily only if a few bombs are to be vented. If possible, an electric drill shall be provided.
- C. Adjustable open end wrench.
- D. Can of luting compound.
- E. Center punch.
- F. 21/64-inch drill.
- G. 7/16-inch drill.
- H. 1/8-inch pipe plug.
- I. 1/4-inch pipe plug.
- J. 1/8-inch pipe tap.
- K. 1/4-inch pipe tap.

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L. Protection board and skirt. A piece of plywood and a heavy cloth skirt (fig. 9-2) shall be used as a protection shield during bomb drilling operations.

Venting Procedure. Bombs shall be vented, then tapped and plugged, one at a time. The venting procedure, described below, is shown in figure 9-2. During the procedure, the bomb shall be placed, nose up, on the improvised stand. After checking the equipment:

1. Mark a spot with the center punch on the bomb top surface, at its nose end, about three inches from where the burster well enters the bomb and in line with the suspension lug provisions.

2. Drill 21/64-inch hole in the plywood protection board.

3. Cover the protection board with the cloth skirt, and place the drill through the hole in the board and over the punch mark.

4. Drill 21/64-inch hole in the bomb at the punch mark. Drill until the hiss of escaping gas is heard; stop drilling until the hissing sound ceases; then complete the drilling.

5. Thread the hole with the 1/8-inch pipe tap. Keep the tap as straight as possible while threading.

6. Coat a 1/8-inch pipe plug with luting compound. Insert it into the tapped hole, and install it tightly with the adjustable openend wrench.

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7. If the plug does not fit securely, redrill the hole with 7/16-inch drill, and retap it with the 1/4-inch pipe tap. Coat a 1/4-inch pipe plug with luting compound, insert it into the retapped hole, and install it tightly with the wrench.

After the venting procedure is completed, the bombs shall be tested for leakage, marked "VENTED (DATE)" and returned to storage. Subsequent ventings can be accomplished by backing out the pipe plug. After reventings, the pipe plug shall be recoated with luting compound and securely reinstalled.

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Venting One-Ton Containers

HD-filled one-ton containers shall be vented in the open by personnel wearing protective equipment. The containers are vented by attaching an adapter, piping, and a valve to one of the Kerostest valves of the container and by slowly opening the valves to drain the agent. A pail, partially filled with bleach slurry, shall be placed beneath the piping opening to catch and neutralize the agent. The equipment necessary and the venting procedure are described and illustrated in Chemical Corps Special Text 3-250-1.

RULES FOR STORAGE AND HANDLING

The following general rules and precautions for the storage and handling of toxic chemical containers and munitions shall be supplemented by the publications listed in this chapter under "regulations" and by the safety precautions set forth in chapter 13.

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Handling

GB and HD items shall be handled in separate and distinct toxic chemical areas. Successive operations shall be segregated or isolated as much as practicable in order to reduce the number of personnel subject to possible exposure. Consideration shall be given to conducting "dry runs" or practice runs, using non-hazardous substitute materials, before a hazardous handling operation or an unfamiliar operation is to be conducted.

Personnel Safety

Depending upon the degree and probability of exposure, the following measures should be considered:

- A. Change of clothing upon arrival and departure from work.
- B. A shower or bath before leaving work.
- C. A check of personnel for any indication of exposure, especially for pupillary contraction.

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Protective Equipment

Personnel engaged in handling toxic containers and munitions shall wear protective gloves and carry gas masks in a position of readiness at all times. When handling involves any reasonable possibility of exposure to GB vapor, masks shall be worn. When the possibility of exposure to HD vapor exists, both masks and protective clothing shall be worn. Protective equipment shall be available in the vicinity of, but not inside magazines. Protective equipment is discussed in chapter 12.

STORAGE AFLOAT

GENERAL

Toxic chemicals may be carried on cargo vessels or combatant vessels. Different regulations apply to these two types of storage afloat; therefore they are treated separately.

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STORAGE ABOARD CARGO VESSELS

GENERAL

Cargo vessels carrying toxic chemicals may be either freight ships or U.S. Navy ships acting as cargo vessels. Regulations applicable to the storage of toxic chemical items during shipment as cargo are set forth in the publications listed on page 9-1. If the vessel is a freight or freight and passenger vessel, U.S. Coast Guard Regulations are applicable. If the vessel is a U.S. Navy ship serving as a cargo vessel, Navy Regulations, OP 4, and OP 5 apply. In both cases, local port or harbor regulations must be observed. Either a detail of the Technical Escort Detachment or a specially trained Navy escort will accompany shipments aboard cargo vessels. Specific regulations and conditions for storage of toxic chemicals aboard cargo vessels are given below.

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RESPONSIBILITY FOR STORAGE ABOARD CARGO VESSELS

The master, through the first officer, shall be responsible for the proper storage and safe transportation of chemical munitions as provided under existing law. The master shall be supplied with two copies of all regulations, rules, and laws for the loading, storage, transportation by water, and the handling generally of chemical munitions on ship board. He shall be supplied with two copies of the manifest and two copies of the cargo lading plan before the loading begins. Through the first officer and other deck officers, the master shall assure himself that the cargo of chemical items is properly stored and that the various kinds of munitions are kept separated as required by regulations. When, in the opinion of the master, the cargo of chemical items is not being properly loaded or kept properly separated, the master shall have the authority to stop the loading of the chemical items at once, and the matter will be placed before the proper port authority for decision.

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ESCORT DETAIL

The escort for toxic chemical cargoes will be either a detail from the Army Chemical Corps Technical Escort Detachment, described in chapter 8, or a detail of specially trained Navy enlisted men under the command of a chemical officer. Assignment of the escort will depend upon availability. At the present time, the Technical Escort Detachment accompanies cargoes of toxic chemicals; however, regulations are set forth below for Navy chemical officers and their crews.

Navy Escort Detail

The chemical officer on ships carrying toxic chemical cargoes will be supplied by the Bureau of Naval Personnel. He will have a special crew consisting of a limited number of enlisted men trained to work with toxic chemicals. The chemical officer will report upon his arrival at the port to the master of the vessel to whom he will act as technical aid so long as toxic chemical items are on the vessel. His duties will cease upon the discharge of the cargo and the subsequent clearing of any gas from the holds.

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Regulations governing the chemical officer and his crew are as follows:

A. The chemical officer shall make an inventory of the cargo as it is loaded, giving information on the munitions and their contents, and shall make a similar list when the cargo is discharged, with deductions for any material which had to be disposed of in transit.

B. The chemical officer will drill the personnel on board in the use of protective equipment.

C. The chemical officer will see that he is provided with a sufficient quantity of protective, detection, decontamination, and first aid equipment. He will see that the equipment is in repair and available for instant use. Normally, the appropriate commander Service Force is responsible for the provision of such equipment.

D. The chemical officer will see that the gas cargo is stored so as to provide proper circulation of air around and between toxic chemical items and that all ventilating equipment is in proper working order.

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E. The chemical officer will inspect the entire toxic chemical cargo daily and will take all necessary measures to detect, repair, or dispose of leaking items.

F. The chemical officer will inspect all toxic chemical items as they are withdrawn from the cargo space when cargo is discharged, and he will allow no one in the hold without proper protective equipment. After the cargo has been unloaded, the chemical officer will see that no gas remains in the holds.

METHODS OF STORAGE ABOARD CARGO VESSELS

Toxic chemical items shall not be stored with any other class of ammunition. Items of two or more groups of fillings shall not be stored together except upon specific authorization of the Bureau of Ordnance. Whenever possible, each kind of container or munition shall be stored separately. Toxic chemical items shall be separated as far as possible from other munitions containing explosive, incendiary, pyrotechnic, or smoke material. Small quantities of toxic chemical items may, under certain conditions, be stored on deck. Large quantities must be stored in specially prepared holds.

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On Deck Storage

On deck storage is permitted when a small quantity of toxic chemical items is being shipped and when the character of the items makes jettisoning them a consideration. Whenever possible, however, below decks storage in specially prepared holds is preferable. When stored on deck, the cargo shall be placed as far aft as possible and shall be covered by tarpaulins to protect it from the direct rays of the sun. For specific placing of the cargo on deck, see OP 5.

Below Decks Storage

When shipped in large quantities, and whenever possible when shipped in small quantities, toxic chemical items shall be stored below decks in specially prepared holds. The construction, preparation, and ventilation of such holds and regulations pertaining to the storage arrangement, temperatures, and surveillance are described fully in OP 5.

DETECTION DEVICES

Detection devices used for toxic chemical cargoes stored aboard cargo vessels are the same as those described for "Storage Ashore."

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LEAKING CONTAINERS AND MUNITIONS

Any indication of leaking containers or munitions shall be reported immediately to the chemical officer. If the leaking item is on deck, personnel wearing full protective equipment shall determine which item is leaking. If the leak is small, they shall repair the leaker; if the leak cannot be easily repaired, the item shall be disposed of. If leakage occurs in a hold, the leaking item shall be located and repaired or disposed of whenever practical to do so. If such action is impractical, the hold shall be kept closed, and action must be taken to see that the crew is not endangered. Outlet ducts must be directed to exhaust the air with the wind away from the vessel. When the toxic cargo is unloaded, the leaking items shall be located and removed from the hold first. They shall be isolated as quickly as possible and either repaired or disposed of. A report of all leaking or damaged items shall be made to the Bureau of Ordnance. The handling, repair, and disposal of leaking items is described in chapter 10.

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RULES FOR STORAGE ABOARD CARGO VESSELS

The following general rules for storage of toxic chemical items aboard cargo vessels shall be supplemented by regulations listed in OP 5, applicable Coast Guard Regulations, and the safety precautions listed in chapter 13. When shipments of toxic chemical items are made by water, the local port regulations shall be studied and complied with.

During loading, the safety regulations for open fires, stoves, gasoline, matches, smoking, etc., must be obeyed; decks, runways, and docks shall be free from dirt, rubbish, and spilled explosives; and personnel shall handle all toxic chemical items with the utmost care. If loading is not completed during the day, proper precautions must be taken to guard and protect the shipment against fire and other hazards. Toxic chemical items shall not be left on a dock or elsewhere unless delivery is made to authorized persons or left under proper guard. No toxic chemical items will be left on board boats overnight unless such action is imperative incident to their transportation. Lighters loaded or to be loaded with toxic chemical munitions shall not be tied up to that part of a vessel or dock where the fire room or boiler is located. Toxic chemical items shall be kept as far away from engine

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and boiler rooms as possible. Ships arranged for toxic chemical cargoes shall in no way be prevented from handling other cargoes immediately after discharging the chemical cargo.

STORAGE ABOARD COMBATANT VESSELS

GENERAL

The Navy has had little experience in storing toxic chemical munitions aboard combatant vessels; as a result, the regulations and procedures described below must be considered tentative. When and if a requirement exists for combatant vessels to carry toxic chemical munitions as service munitions, special regulations and procedures will be supplied. It is expected, however, that except for special equipment, surveillance, and protection from hazard, toxic chemical munitions will be stored, handled, and fired as are conventional munitions. For the most part, the safety regulations and precautions now in effect for handling and storing ammunition will suffice.

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ASSIGNMENT OF VESSELS

Vessels carrying toxic chemical munitions will be especially assigned by the Chief of Naval Operations. Such vessels will be restricted to certain specific types and classes; that is, a constant, fleet-wide capability in all combat vessels is not contemplated. As a general premise, the operating forces that will support amphibious operations and that will seek shore targets primarily will receive toxic chemical munitions. No permanent modifications to such ships for storing toxic chemical munitions will be required.

REGULATIONS

Regulations governing the storage of toxic chemical munitions aboard combatant vessels are set forth in U.S. Navy Regulations, the Bureau of Ordnance manual, OP 4, and this manual.

RESPONSIBILITY FOR STORAGE ABOARD COMBATANT VESSELS

The commanding officer of the ship is responsible for the safety and security of toxic chemical munitions. Immediate responsibility of such munitions will ordinarily be that of a specially assigned chemical officer or, if a chemical officer is not available, of the Gunnery Officer.

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METHODS OF STORAGE

Small quantities of toxic chemical munitions may be stored in dry, well ventilated enclosures on the upper decks. They will be arranged so that jettisoning is convenient in an emergency. Large quantities of toxic chemical munitions must be stored in specially prepared magazines provided with adequate ventilation. Toxic chemical munitions shall not be stored with any other class of ammunition. Munitions filled with different agents shall not be stored together unless specifically authorized by the Bureau of Ordnance. Whenever possible, each kind of munition shall be stored separately. Fuzes will not be stored with toxic chemical munitions.

MAGAZINES

Magazines shall be constructed as prescribed in the Bureau of Ordnance Manual and OP 4. Sprinkling systems, operable from outside the magazines, shall be installed in all toxic chemical magazines.

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Ventilation

Magazines shall be ventilated with permanently installed or portable blowers, capable of changing the atmosphere in any magazine in 15 minutes or less. Ventilation ducts leading from the magazine shall exhaust to the atmosphere of a weather deck, as far aft as possible, in order to prevent exposure of personnel to toxic agents. The ducts shall not connect to the ventilation ducts of any other magazine or compartment.

Storage Temperature

The temperature of any magazine containing toxic chemical munitions shall not be allowed to exceed 110 degrees Fahrenheit for more than a short time. Temperature shall normally be kept below 100 degrees Fahrenheit.

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Storage Arrangement

Toxic chemical munitions shall be stored to allow the fullest possible circulation of air and to permit the withdrawal of individual items with a minimum handling of other items. Bombs shall be stacked in tiers, as low as possible in respect to storage space. Projectiles shall be lashed in place and stored upright on their bases. Rockets will ordinarily be stored in rocket containers (described in chapter 7), until assembly for firing is required. Spray tank sections will always be stored in the special center section containers (described in chapter 5). Center section containers will be stacked no higher than three tiers.

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SURVEILLANCE

Munitions will be inspected for leakage or damage when first delivered to the vessel. Equipment for protection and for the handling of leakers shall be available. Thereafter, magazines shall be inspected daily to determine leakage or other damage and weekly to determine the condition of the magazine. Whenever a magazine is opened, a responsible officer, petty officer, or toxic chemical handler shall be present to detect escaping gas. Before anyone enters a toxic chemical magazine, it shall be ventilated for at least 15 minutes.

DETECTION DEVICES

Automatic detector alarms are not yet available for shipboard use. The only device now available for the detection of toxic chemical vapor is the M9A2 Chemical Agent Detector Kit. Daily, at intervals specified by the officer in charge, and whenever contamination is suspected, tests shall be made with the kit. Detector paper, paint, and crayon are used to detect liquid contamination as described in chapter 11. It may be required to supplement these devices with caged pigeons or canaries.

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LEAKING MUNITIONS

The procedure to be followed upon the discovery of leaking munitions is the same as that described under "Storage Ashore." A report of all leaking or damaged munitions shall be made to the Bureau of Ordnance. Handling and disposal of leakers are described in chapter 10.

VENTING

Toxic munitions will not ordinarily require venting when carried on combatant ships. Only during unusual conditions of high temperatures for long periods will HD bombs need to be vented. If venting of HD bombs becomes necessary, the bombs will be transferred ashore to be vented. No venting will be performed aboard ship.

RULES FOR STORAGE AND HANDLING

Insofar as applicable, the rules for storage and handling given under "Storage Ashore" shall be observed. In addition, those rules and the rules given below shall be supplemented by the safety precautions set forth in chapter 13.

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Equipment

Protective equipment and first aid equipment shall be available in the vicinity of, but not inside magazines containing toxic chemical munitions. No other items except required detection material may be stored in the same magazine with toxic chemical munitions. For hazardous operations, rescue breathing equipment shall be made available.

Personnel

Personnel working in a toxic chemical magazine shall be masked. No one shall be allowed to enter or work in a toxic chemical magazine alone, and no one shall work in such a magazine for more than one hour at a time. To avoid the cumulative effects of toxic chemicals in small doses, reliefs will be provided for working parties handling toxic chemical munitions.

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Munitions Servicing

The time for servicing guns, launchers, or aircraft with toxic chemical munitions from magazines shall not be more than one hour. Fuzing and defuzing shall not take place in or near magazines. Such operations shall be done as nearly as practicable to the gun, launcher, or rack. As soon as firing has ceased, all toxic chemical munitions outside the magazines shall be defuzed and returned to the magazines. Personnel working in handling rooms, gun rooms, on hoists, launchers, or on deck will not be masked.

Filling, Assembly, Disassembly

No filling, assembly, or disassembly of toxic chemical munitions will be done aboard ship.

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Chapter 10

DETECTION, HANDLING, REPAIR, AND DISPOSAL OF LEAKERS

INTRODUCTION

If handling, shipping, and storage of toxic chemical items are properly carried out, as described in the preceding chapters, leakage or damage of munitions is unlikely to occur. Because of the extremely dangerous nature of the agents, however, inspections shall be made daily to detect leakage, and any leaking items shall be dealt with immediately. A small leak may become progressively larger, and contamination may be increased considerably if the leak is not promptly discovered and controlled. Once leakage has been discovered, the primary considerations are, in order of sequence, location of the leaking items, control, neutralization, and isolation of the leaking item, repair or disposal of the leaking item, and decontamination of the area. The type of storage or shipping will determine the specific procedure to be used when leakage occurs; however, general procedures applicable to most situations are discussed below. Reports of leaking items and their disposition shall be made to the Bureau of Ordnance, as prescribed in chapter 9.

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LOCATION OF LEAKERS

DETECTION OF LEAKAGE

Leakage in a storage area may be detected by several means. Detection devices, including the M9A2 detector kit, detector paper, paint, crayon, and animals, are the most reliable means of detecting leakage. Of these, only animals and the M9A2 detector kit indicate vapor leakage. Detector paper, paint, and crayon reveal liquid leakage only; they do not detect vapor leakage unless extremely high concentrations are present. Detector alarms have been installed in some plants to detect vapor leakage, but none are presently available for field or fleet usage. Visual observation of damaged items or of individuals showing symptoms of toxic chemical poisoning is another method of detecting leakage. Leakage from HD-filled items can usually be detected by a characteristic garlic-like odor; GB-filled items give off no odor upon leakage.

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None of these methods is foolproof, however; until tests with detector kits have definitely established the absence of leakage, it must be assumed that hazard exists, and all proper procedures and precautions for handling leakers shall be observed. Detection devices are individually described in chapter 11.

PROCEDURE UPON DISCOVERY OF LEAKAGE

A standing operating procedure to be followed upon the discovery of leakage shall be established and shall include the procedures given below. Whenever leakage is indicated, the officer in charge of the storage area and all personnel within the area shall be immediately notified. If the leaking item is known, an attempt shall be made to place it in a position to prevent the liquid portion of the contents from spilling on the deck or on other items by elevating the point of leakage above the level of the liquid. This shall be done by the man discovering the leak, if it is possible for him to do so without becoming contaminated.

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All unprotected personnel shall leave the area at once. Magazine doors shall be closed, and forced ventilation shall be applied for at least 15 minutes. A working party, wearing adequate protective equipment, shall then enter the magazine to locate and remove the leaking item. The only exception to this procedure is during leakage aboard ship, when conditions such as rough sea make such action impracticable. In this case, the magazine shall be kept closed and ventilated until it can be entered or until the vessel reaches port, at which time the leaking items shall be unloaded, isolated, and neutralized and provisions made with port authorities to repair or dispose of the item.

If leakage occurs during land transportation, specific procedures shall be carried out as prescribed in Chemical Corps Pamphlet No. CMLWS (SD-2).

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LOCATION OF LEAKING ITEMS

If the leaking item is not immediately apparent, inspection and tests must be carried out as quickly as possible in order to locate the item. Visual inspection for leakage and damage shall first be made of all items suspected of leaking. If this action fails to locate the leaker, the M9A2 detector kit, detector paper, paint, and crayon shall be used to find the leaker.

The M9A2 Chemical Agent Detector Kit detects dangerous concentrations of HD, GB, and other toxic chemical agents by color changes in tubes through which contaminated air is drawn by a pump. In sampling with this kit, consideration shall be given to the source of the vapor, direction and velocity of the wind, the amount of the agent at the source, and the realization that a particular reading is true only at the particular location and time at which the sampling is taken. Sampling is not rapid; sometimes as long as four minutes is required to obtain results.

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The stock of munitions suspected of leaking shall first be broken into lots and each lot placed under a hood or tarpaulin. After allowing time for contamination to build up under the hood, samples of each lot shall be pumped through the appropriate agent tube of the kit to test for contamination. The contaminated lot must then be broken into smaller lots or into individual items and retested for contamination in order to determine the specific leaker.

Where practicable, sheets of detector paper shall be placed beneath items suspected of liquid leakage. The detector paper will detect liquid leakage only; it is of no use for indicating vapor leakage. If liquid agent comes into contact with the paper, the paper will change color.

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Detector paint and crayon are, like detector paper, good only for the detection of liquid leakage. Areas and items suspected of liquid leakage may be marked with crayon or paint, both of which will change color if liquid leakage is present. Detector paint has also been used successfully as an aid in surveillance. After insuring that the items to be stored are free from leaks, the areas of possible leakage are painted, thus facilitating inspection.

For HD-filled items only, a small amount of bleach slurry may be used to indicate leakage. Deposited about the seams and other areas of possible leakage, the bleach slurry will smoke when it comes into contact with HD. Dry bleach shall not be used in a magazine or other storage area, however, for it may burst into flame. This method of detecting leakage is not as reliable as those described above.

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From the description of locating leaking items, it is evident that the procedure may require a great deal of time in situations where leakage occurs in an area filled with many toxic chemical items. For this reason, it is imperative that personnel shall be thoroughly trained and exercised in the procedures to be taken to locate leakers. They shall also be well trained in all the precautions to be taken in handling leaking items and in the equipment to be used. In cases where heavy contamination is present or when much time is required to locate the leaker, standard Navy oxygen rescue breathing apparatus shall be available for instant use. For a description of this apparatus, see NAVSHIPS 393-0552, Oxygen Breathing Apparatus.

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HANDLING LEAKERS

NEUTRALIZATION AND ISOLATION

As soon as leakers have been located, they shall be neutralized and isolated from the storage area as rapidly as possible. Ashore, a leaking munition may be covered with an impermeable material or placed in a secondary airtight container and carried to a downwind area, or it may be placed in an iron or steel tub filled with a decontaminant solution, preferably, or water. A suitable decontaminant for GB is a 20 to 30 per cent solution of caustic (200 to 300 pounds of decontaminant to 100 gallons of water); for both HD and GB, a freshly prepared bleach slurry (three pounds of bleach to each gallon of water). Tubs containing these solutions shall be prepared and placed conveniently about all areas ashore where much handling of toxic chemical items occurs. After the leaking item has been placed in the tub, the tub shall be moved to an isolated area at least two miles downwind. Aboard ship, it may be feasible to place such tubs adjacent to hoists, or in handling rooms and gun rooms whenever firing of toxic chemical items takes place.

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Ton containers are too large to immerse and handle like a leaking munition. An attempt shall be made to isolate the container and to stop the leak as described below. The leak may be temporarily controlled by placing bleach slurry or mud on the leaking surface.

If a large number of items are involved in the leakage, the magazine shall be ventilated, placed under guard, and the Chief of the Bureau of Ordnance notified by dispatch. Only such munitions as are leaking rapidly enough to constitute a menace should be immediately destroyed.

RENDERING EXPLOSIVE ELEMENTS SAFE

Bombs, projectiles, and rockets are stored unfuzed but will have burster tubes in place during storage at shore magazines or afloat. Ordinarily leakage will not create an explosive hazard, and burster tubes need not be removed. Before any repair work or disposal is carried out, however, the munition shall be completely disarmed by qualified personnel.

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REPAIRING LEAKERS

MUNITIONS

Leakers shall be temporarily repaired, pending final repair or disposal, whenever possible. Final repair of small leaks in seams or welds of HD-filled munitions may be made by soldering. In this case, the areas to be soldered are thoroughly cleaned and the solder applied. Another method of repairing a small leak in a weld or recess is to apply a mixture of litharge and glycerine or, when these are unavailable, mud. This method serves only as a temporary repair for GB-filled items, but it may serve as a permanent repair to HD-filled items if the leak is small. The litharge and glycerine mixture requires some time to set. Generally, permanent repair of GB-filled munitions cannot be safely accomplished. In most cases, leaking GB munitions will be disposed of.

SPRAY TANK CENTER SECTIONS

Center sections of spray tanks shall be repaired by personnel familiar with these particular items. Repair shall be made as authorized by the Bureau of Aeronautics. Consult the handbooks listed in chapter 5.

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ONE-TON CONTAINERS

One-ton containers shall first be placed so that the leak is at the highest elevation. The leaking surface shall then be wiped clean with a cloth saturated with bleach solution and the leaking surface caulked. A lump of moist clay or of litharge and glycerine mixture shall then be bound in place with strips of cloth. This procedure will serve as a temporary control of leakage.

If a container valve is leaking, it shall be repaired or changed as described in TM 3-250 and TM 3-255. If a container cannot be permanently repaired, its contents shall be transferred to another container. Transfer procedures are described in Chemical Corps Special Text 3-250-1.

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DISPOSAL

Whenever practicable, a leaking toxic chemical item shall be repaired, or its contents shall be transferred to a safe container. If these operations are impracticable or if they involve much hazard, the items shall be disposed of. In general, permanent repair or transfer of agent from GB-filled munitions will be impracticable and will involve too much hazard to make repair or transfer feasible. Disposal methods include dumping at sea, demolition, burning, and burial. In addition, HD-filled items may be emptied or vented. All munitions to be disposed of shall first be disarmed by qualified personnel experienced in such work. Spray tank center sections shall be repaired or disposed of as prescribed by the Bureau of Aeronautics.

No disposal of toxic chemical items shall be undertaken without the approval of the Bureau of Ordnance, unless hazard requires immediate disposal. No disposal shall be undertaken except in areas or locations that have been specifically approved by the Bureau of Ordnance or, in the event of emergency, in areas described below. Only one kind or type of munition shall be disposed of by burning or demolition at any one disposal point.

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All disposal operations shall be carried out by specially trained personnel, familiar with the items and the disposal procedures. They shall at all times wear full protective equipment, and they shall have available first aid and decontamination equipment.

DISPOSAL BY DUMPING AT SEA

Disposal of leaking toxic chemical items by dumping into deep ocean water requires good judgment. Instances have occurred where ammunition thrown overboard in heavy containers has washed ashore from considerable distances and depths. Toxic chemical items shall not be dumped overboard within 10 miles of shore or in water less than 1000 fathoms deep.

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DISPOSAL BY DEMOLITION

To dispose of munitions by demolition:

1. Transport the leaking item to an isolated open area at least two miles in every direction from any area that may be frequented by personnel and sufficiently removed from magazines to eliminate danger from the blast and fragments. If such a location does not exist, the most suitable location shall be chosen and all personnel warned away for a radius of two miles in all directions immediately before and for at least one hour after detonation of the firing charge.

When HD-filled items are disposed of by demolition, the point where the item is exploded shall be chosen so that personnel can be excluded for a period of approximately 48 hours from the area at least one mile downwind. Personnel must also be prevented from passing within a distance of 150 yards from the point of demolition for a period of at least two weeks.

2. Dig a trench or pit about six feet deep by six feet long by three feet wide. Place the leaking item in the trench.

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3. Place 1/2-pound or 1-pound blocks of TNT against the side of the item. Pack earth tightly over and around the blocks of TNT. (The number of blocks to be used varies with the item; six 1/2-pound blocks of TNT with electric detonator are adequate for a one-ton container.) Connect an electric detonator or an ordinary blasting cap to the demolition blocks.

4. Lead an electric blasting cable to a blasting machine not less than 400 yards upwind from the leaking item. The blasting machine shall be placed behind a barricade providing adequate cover both from the front and from overhead. If an ordinary blasting cap with safety time fuze is used, the fuze shall be of sufficient length to allow the person lighting it ample time to reach and take shelter behind the barricade.

5. After all preparatory measures have been carried out, take shelter behind the barricade (except for the person lighting the fuze, if a time fuze is used). Detonate the charge. After detonation, the area must be decontaminated or properly posted.

6. In case of a misfire, do not leave the barricade for at least thirty minutes. A hangfire shall be assumed to exist. Permit no one to go within 400 yards of the item for at least 24 hours.

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7. In the event that the area between two and six miles downwind from the demolition site is inhabited, station qualified personnel with protective and detection equipment approximately two miles downwind from the site in the direction of the inhabited area. After the detonation, these personnel shall test the atmosphere for toxic vapor for a period of one hour. If dangerous concentrations are detected, personnel in the area from the demolition site to six miles downwind shall be warned to wear protective equipment or to evacuate the area.

8. Do not carry out the demolition procedure except with a clear sky and bright sun; gusty winds will tend to dissipate the vapor. The hazards to personnel in surrounding areas from toxic vapor released by detonation under unfavorable weather conditions far outweigh the hazards involved in postponing disposal for more favorable weather or in disposing of the item by burial.

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DISPOSAL BY BURNING

Disposal of leaking items by burning should preferably be done on clear, low-humidity days. Personnel should be cleared from the area and downwind from the pit for a considerable distance. The safe downwind distance is not known, but under favorable weather conditions, one to two miles should suffice. If the item is a munition, it should be disarmed by qualified personnel before burning.

The munition shall be placed in a burning pit on dunnage from two to three feet deep and soaked with oil or some similar combustible material. Enough dunnage shall be provided to furnish a good fire for 30 to 80 minutes. The leaking items shall be placed on top of the dunnage. In order to insure complete destruction, it is desirable to destroy the items in small quantities. In no event shall destruction of over 100 net pounds of agent be attempted in one fire.

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The most important feature of this operation is to vent each container simultaneously with ignition of the fire. This can be accomplished by using a shape charge proportional to the thickness of the container on each container and by detonating each charge simultaneously with detonation of hand grenades placed in the pit to ignite the oil. The charges shall be sufficient to rupture the top side of each container but not the bottom.

Upon completion of burning, spray the burning pit with bleach slurry. Leave the solution in the pit for twelve hours and then test the entire area for contamination. Cover the pit with earth and mark it.

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DISPOSAL BY BURIAL

When no other approved method of disposal is practicable, leaking items shall be disposed of by burial. The site for burial shall be in a restricted, guarded, or isolated area, if possible. Dig a pit deep enough to allow a covering of at least three feet of earth. Cover the bottom of the pit with a one foot layer of bleach slurry or dry bleach mix (if the agent is HD) or a sodium hydroxide solution (if the agent is GB). Place the leaking item in the pit, with the leaking area downward, and cover the item with decontaminating material. Fill the pit with earth, and post a sign reading **DANGER! DO NOT DIG. TOXIC GAS BURIED HERE.**

DISPOSAL BY VENTING

Only HD-filled items can be vented; do not vent GB-filled items. Venting is done through the valve of a bulk container or through a drilled hole in a munition. Venting is a slow but practical method for disposing of HD in isolated localities. Venting operations are conducted only during the daytime with the wind blowing toward uninhabited areas. The area downwind of the disposal site shall be cleared of personnel up to a distance of one mile from the site. Venting will be accomplished as described in chapter 9.

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DISPOSAL RULES AND PRECAUTIONS

The following rules and precautions relating to the disposal of toxic chemical items shall be supplemented by Chemical Corps Pamphlet CMLWS (SD-2), Chemical Corps Special Text 3-250-1, NAVORD EODB 52, and by the applicable precautions given in chapter 13.

Disposal Area

The area for disposal must be a cleared space approximately 50 feet in diameter and as far away from any wooded area as possible. The area must be isolated from any movement of troops, civilian population, highways, railroads, and other inhabited areas. See that there is no one within approximately 2000 yards downwind from the disposal site. Mark all roads of entry to the disposal area, and place signs visible from all directions indicating that poisonous gases are in the area. Post as many signs as are deemed necessary by the officer in charge.

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Disposal Time

Whenever possible, dispose of toxic chemical items on a warm, sunny day at about noon. During this time there are usually strong convection currents of air with a high degree of turbulence that will disperse the gas or prevent any degree of concentration at any one place. Unless an emergency exists, do not dispose of toxic chemical items early in the morning, in the evening, or during a cold, low overcast day.

Personnel Safety

Disposal shall not be carried out with inexperienced or untrained personnel. The number of persons engaged in disposal operations will be maintained at the minimum consistent with safety. Personnel working in the disposal area shall be observed by personnel at a safe distance and upwind from the area. Personnel in the area shall wear full protective equipment, and they shall have decontaminating, detection, and first aid equipment readily available. A vehicle should be present in case of casualties or accidents.

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Casualty Reports

Any casualty, mishap, or accident that may occur during disposal operations shall be reported immediately by telephone, teletype, or dispatch to the Chief of the Bureau of Ordnance, if fatalities or injuries to personnel or appreciable property damage results. Otherwise, casualties, mishaps, or accidents shall be reported by normal mail channels as soon as possible.

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DECONTAMINATION

GENERAL

After toxic chemical leakage or other causes of contamination, contaminated areas and equipment must be decontaminated as rapidly as possible, both to eliminate hazard to personnel and to prevent further contamination of material. Contamination can be detected by the M9A2 Chemical Agent Detector Kit or, in some instances, by visual inspection. The decontaminating materials described below can be applied by swabs, hand pump units, or power driven units, described in TM 3-220, Decontamination. In addition, weathering and the application of soap and water are reliable but slower methods of decontamination. Wherever toxic chemical items are stored or handled, and especially where leakage could possibly occur, standard decontaminating equipment and decontaminating squads must be kept available for instant use.

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DECONTAMINANTS

Bleach

Supertropical bleach, also referred to as STB, bleaching powder, chlorinated lime, or chloride of lime, destroys both HD and GB by converting them into harmless or less toxic compounds. It is generally used as a dry mix (two parts bleach to three parts earth) or as a slurry (one pail water to six shovelful bleach). Bleach dry mix or slurry can be applied to most equipment and areas; it is a standard decontaminant. Bleach corrodes metals, however; after application of bleach, surfaces should be scrubbed and rinsed. Bleach may be used on ammunition containers, but not on ammunition. One pound of bleach makes enough slurry to cover one square yard of average contamination.

WARNING: Do not use pure bleach to decontaminate HD.

The reaction is violent, causing flames and heavy vapor.

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Sodium Carbonate

Sodium carbonate, also referred to as washing soda, soda ash, or laundry soda, shall be applied as a solvent (one pound sodium carbonate to two and one-half gallons water). The solvent is a good decontaminant of GB but is slower than bleach when used to decontaminate HD. The solvent shall be stirred rapidly when mixed and applied hot to contaminated surfaces.

Sodium Hydroxide

Sodium hydroxide, also known as caustic soda or lye, shall also be used as a solvent (one pound sodium hydroxide to two and one-half gallons of water). It is an excellent decontaminant of GB, a fair decontaminant of HD. Much heat is generated when the flake sodium hydroxide dissolves in water, and constant stirring is necessary when mixing. The solvent corrodes metal and damages paint if not promptly removed.

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DANC Solution

DANC (Decontaminating Agent, Non-Corrosive) solution is an excellent decontaminant of HD, but it is not to be used to decontaminate GB. The solution consists of a chemical (RH 195) and a solvent (acetylene tetrachloride). Directions for mixing the chemical and the solvent are given on the shipping container; the proportions are, by weight, one part RH 195 to 15 parts solvent and, by volume, one part RH 195 to six parts solvent. The solvent is injurious when breathed or when absorbed by the skin. Personnel using it shall wear masks and protective clothing (fig. 10-1). DANC solution is not entirely non-corrosive, but it is less corrosive than bleach. Surfaces decontaminated by the solution must be scrubbed after the solvent has evaporated and then rinsed. In addition, metal surfaces shall be greased, oiled, or painted to prevent corrosion.

Miscellaneous Decontaminants

There are a number of chemical decontaminants other than those described above. For GB, ammonia, lime, and HTH are considered good decontaminants; for HD, chloramine-T, dichloramine-T, HTH, and GUNK are good. These and other decontaminants are described in TM 3-220.

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**PERSONNEL, EQUIPMENT, AND AREA
DECONTAMINATION**

Personnel decontamination is discussed in chapter 1, for GB in chapter 2, for HD. Decontamination of specific equipment and supplies, including protective equipment, clothing, food, and munitions, and decontamination of an area, including buildings and materials, are discussed in detail in TM 3-220.

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Chapter 11

DETECTION OF TOXIC CHEMICAL AGENTS

INTRODUCTION

Indications of leakage and of toxic chemical hazard result from hearing escaping gas, noting damaged containers, smelling HD, and seeing or feeling symptoms of poisoning. Sensory impressions of toxic chemical agents vary with individuals, however, and are not always reliable. Chemical detection devices and the posting and observation of animals are the only reliable means of determining the presence of toxic chemical agents. These methods shall be used whenever the surveillance of toxic chemical items is required and whenever the possibility of contamination exists. Personnel shall never rely on sensory impressions alone.

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Various chemical detection devices have been developed and are being developed for both the detection and the identification of toxic chemical agents. These include automatic detector alarms, detector kits, detector paper, paint, and crayon, and special sampling and testing kits designed for chemical laboratory teams and medical units. These devices indicate the presence of toxic chemical agents by a chemically caused change of color in the material used. None of the devices presently available function rapidly or accurately enough to warn personnel of toxicity before the agent can cause casualties to unprotected personnel; therefore, personnel must wear masks and protective clothing whenever they enter a toxic chemical storage space or whenever the possibility of leakage exists.

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Other than sensory perception, symptomatic reaction, and the observation of animals, the only method available to operating forces of detecting toxic chemical vapor is use of the M9A2 Chemical Agent Detector Kit. Automatic detector alarms, which can also detect the presence of toxic chemical vapor, are not yet available for fleet or field usage. Detector paper, paint, and crayon do not detect toxic chemical vapor, except in extremely high concentrations. For practical purposes, it should be considered that they detect toxic chemical agents only as liquid. When the presence of toxic vapor is suspected, therefore, personnel in the area shall wear protective equipment and shall assume that hazard exists until tests with the M9A2 Chemical Agent Detector Kit have definitely determined the absence of toxic chemical vapor.

DETECTION DEVICES

AUTOMATIC DETECTOR ALARMS

Several automatic detector alarms, termed field alarms by the Army Chemical Corps, are being developed for the detection of GB and other G-agents. A few such alarms have been installed at operating plants and successfully employed; however, they will not be available to shore installations or to the fleet for some time.

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The most developed of such alarms are Field Alarm E21, Field Alarm E22R1, and Field Alarm E25. They can operate about 12 hours without attention and are equipped with buzzer and visual signals. Field Alarm E21, weighing 24 pounds, is the smallest and lightest of the alarms and is being considered for shipboard installation. Field Alarm E22R1, weighing about 40 pounds, is also being studied for use afloat and for use in aircraft carrying GB munitions. Field Alarm E25, consisting of two units separately carried and connected for operation, gives the greatest promise for fixed, shore-based installations. It is too heavy, 255 pounds, for shipboard use. If such alarms become available, information and instructions will be supplied.

CHEMICAL AGENT DETECTOR KITS

The only presently available device for the detection of GB vapor and HD vapor is the M9A2 Chemical Agent Detector Kit. Other kits are being developed and tested to provide greater sensitivity, simplicity, and stability than that of the M9A2 Chemical Agent Detector Kit, but such kits will not become available for some time.

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M9A2 Chemical Agent Detector Kit

The **M9A2 Chemical Agent Detector Kit** (fig. 11-1) is a portable, light weight, compact unit for use in detecting and identifying toxic chemical agents. It will detect dangerous concentrations of toxic chemical agents by color changes in tubes through which contaminated air is drawn by a pump. Agents that can be detected with the kit are GB and other G-agents, HD, HN (nitrogen mustard), L (lewisite), ED (dichloroethylarsine), AC (hydrogen cyanide), CG (phosgene), and CK (cyanogen chloride).

The kit will determine the presence of high concentrations of GB, but it will not, with certainty, reveal the presence of low concentrations that could cause casualties among unprotected personnel exposed for a considerable period of time. The complete absence of GB in a suspected area can be established only after repeated negative tests with the kit, supplemented by observation of exposed personnel for evidence of marginal symptoms, as described later in this chapter. In addition, the kit is not simple to use, and several minutes are usually required for each test. In sampling air, samples must be taken at several places, at frequent intervals, and with regard to wind conditions.

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The kit consists of an olive drab, cotton duck carrier containing components described below. Weight of the kit is about two and one half pounds. It is 8 1/2 inches long, 5 1/2 inches high, and three inches deep.

Components. Components of the M9A2 Chemical Agent Detector Kit comprise an air sampling pump, detector tubes, solution bottles, vials, chemical reagents, and accessory items (fig. 11-2). Major items are described below.

Air sampling pump. The air sampling pump (fig. 11-3) consists of three principal parts, a head, piston, and cylinder, which are easily removed by unscrewing. Located in the head is a flashlight for night use. The piston is equipped with a cup for suction of air into the cylinder nozzle when the piston is pulled to the rear position. The nozzle also serves as an opening for the insertion of a detector tube.

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Detector tubes. Each detector tube is made of glass and is slightly over an inch and a half long and 1/10-inch in diameter. There are five types of tubes, each marked near the end with a colored dot. The white dot tube is used for the detection of GB and also for the collection and preservation of vapor of an unknown agent for later identification. The blue dot tube is used for the detection of HD. Each tube is encased in a lead-foil wrapper marked with a dot and with a specific number of horizontal stripes for easier identification of night. The white dot tube has a wrapper with five stripes; the blue dot tube has a wrapper with three stripes.

Reagents. Solid and dry reagents are supplied in the pump, in vials, and in an envelope. Vials are colored aluminum, blue, red, green, or white. Two green and two white vials filled with reagent are contained in a green can. A set of dry reagents is contained in an envelope, and another set is stored in the piston of the pump.

Bottles. There are four solution bottles with upper portions painted aluminum, blue, red, and green. They are used for solutions of solid reagents. Each bottle has a screw-type cap to which a dropper is attached.

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Accessories. Accessories include a set of M7A1 Vesicant Detector Crayon, a set of plastic-coated cards giving directions for use of the kit, a pencil, and a set of inspection date record cards and sampling tube report cards.

Operation. Detection tests for toxic agents should be made where the agent would probably be at its highest concentration. In some instances, such as during a high wind, vapors may be difficult to detect even when a large amount of agent is present. The presence of leaking items in a storage area can be detected by sampling the air in several parts of the magazine. If the leaking item is not evident from inspection, the items suspected of leakage must be broken down into lots, covered with tarpaulin, and tested by lots. Each lot may then be broken into individual items and tested. In testing, hold the pump so that the end of the detector tube is within one-fourth of an inch of the surface suspected of being contaminated.

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When a detector tube is inserted in the nozzle of the pump and the pump operated to draw contaminated air through the tube, a color change in the tube establishes the presence of the specific toxic chemical agent tested for. In most of the detection tests, liquid reagents are added to the tubes for the development of color changes.

The pump is manually operated. Approximately 100 cubic centimeters of air are drawn in through the nozzle when the piston is pulled to the rear position. In pumping, it is especially important that full piston strokes be easily and slowly taken (at a rate not exceeding 20 strokes a minute). Otherwise, the sensitivity of the kit in testing is markedly decreased. When taking a sample, the plunger shall be pulled back and held until it has no springlike tendency to return to its original position. The tendency for the plunger to return to its original position indicates that a full stroke has not been taken. Each time the pump is used, it shall first be checked for proper suction of air.

Testing for GB. To use the kit to test for GB:

1. Remove the pump from the kit. Test it for proper air suction.

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2. Take a white dot tube from the kit. Tear off the wrapper, and insert the white dot end of the tube into the nozzle of the pump.

3. Slowly take at least 20 full pump strokes.

4. Remove the tube from the pump, and put one drop of solution from the green reagent solution bottle in the kit into the undotted end of the tube.

(Note: A fresh reagent solution should be prepared in the green bottle each day the kit is in use. For the preparation of this solution, see TM 3-290, Individual Protective And Detection Equipment.)

5. If a greenish blue ring appears within five minutes, GB is present. When high concentrations of GB are present, the test color will appear within one-half to one minute. (Note: The greenish blue ring will also appear if other G-agents or if CK is present. Unless it is known definitely that the agent tested for is GB, a separate test for CK must be made as prescribed in TM 3-290.)

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Additional tests for GB should be made in various locations about a storage area. On subsequent tests, use 60 full pump strokes instead of 20 strokes to insure a full sampling of air. If the tests all prove negative, have two or three men of the squad unmask for a period of five minutes and then remask. After another five minutes, examine the men for pupillary contraction, tightness of the chest, running nose, and loss of night vision. These are preliminary symptoms present within ten minutes after exposure to very low concentrations of GB. If none of these symptoms appear, it is safe to unmask. It should be noted that a five minute exposure to a concentration of GB that is not detected with the kit will cause no ill effects other than the symptoms mentioned. These effects are only temporary and are relieved by an injection of atropine.

Testing for HD. To use the kit to test for HD:

1. Remove the pump from the kit. Test it for proper air suction.
2. Take a blue dot tube from the kit. Tear off the wrapper, and insert the blue dot end of the tube into the nozzle of the pump.
3. Slowly take at least five full pump strokes.

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4. Remove the tube from the pump, and slowly add liquid from the aluminum bottle in the kit to the heating pad placed about the tube. Continue adding liquid to the pad until steam begins to appear and until the foil about the tube is entirely discolored. Do not allow any of the liquid to enter the tube.

5. Allow the tube to cool; then strip off the heating pad.

6. Put liquid from the blue reagent solution bottle into the undotted end of the tube until the grains in the tube are wetted.

7. If a blue ring appears, HD is present. (Note: The blue ring will also appear if HN, nitrogen mustard, is present. Unless it is known definitely that the agent tested for is HD, a separate test for HN must be made as prescribed in TM 3-290.)

Additional tests for HD should be made in various locations in the area suspected of contamination. For these tests, use 50 pump strokes to insure a full sampling of air.

Operating Precautions. The following precautions shall be observed in using the M9A2 Chemical Agent Detector Kit:

1. Personnel shall wear protective masks and clothing until tests indicate that it is safe to unmask.

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2. As tests are based on detector tube color changes, personnel who are color blind shall not make the tests.

3. The operator of the air sampling pump shall not touch a contaminated object with the detector tube while testing.

4. The operator of the pump shall not draw liquid chemical agent into the detector tube while testing.

5. The operator of the pump shall take the number of full strokes called for in the testing procedures.

Maintenance. The kit shall be maintained, inspected, and tested as prescribed in TM 3-290.

Shipment and Storage. Eight kits, each in an individual fiberboard box, are packed for shipment in wooden boxes. A box of eight kits has a volume of 2.1 cubic feet and a weight of about 50 pounds. During shipment and in storage, kits shall be protected from extreme heat and cold and from corrosive chemicals.

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M6A1 LIQUID VESICANT DETECTOR PAPER

M6A1 Liquid Vesicant Detector Paper is a heavy paper, coated on one side with M5 Detector Paint, described below. The detector paper is used to detect the presence of liquid GB or liquid HD. It does not detect toxic chemical vapor. The paper is issued in booklets of 25 sheets (fig. 11-4) wrapped in a heavy paper envelope. Each sheet is five and one-half inches long and five inches wide. In one corner of each sheet is a hole 1/8-inch in diameter. Since drops of certain chemical agents larger than 1/8-inch will penetrate permeable protective clothing, this hole is provided for a rough measurement of drop size of these agents.

The olive green paper changes to a red color when drops or splashes of GB or HD come into contact with the paper. A reddish fringe will appear around the edges of dark stains or large splashes of the agents. The color change remains conspicuous for at least 48 hours. Individual sheets shall be placed, green side up, near or under toxic chemical items and fastened in place. The paper has an outdoor sensitivity life of about three months.

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The paper will also turn to red when it comes into contact with DANC decontaminant solution or with CNS and CNB tear gases. Exposure to the sun and to heat, steam, and oil causes a decrease in the sensitivity of the paper. Extreme heat causes the paper to turn red or reddish-brown. In storage, detector paper shall be protected from exposure to heat or to DANC solution and other corrosive chemicals.

M5 LIQUID VESICANT DETECTOR PAINT

M5 Liquid Vesicant Detector Paint is olive green. The olive green changes to red when drops or splashes of liquid GB or HD contact the paint. The paint cannot be used to detect toxic vapor. Lewisite and nitrogen mustard will also cause the paper to change to a red color.

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The paint is normally issued in a four-ounce metal can (fig. 11-5). It shall be brushed or sprayed on surfaces where it can be easily observed and where liquid leakage would most likely occur. Munitions shall be painted around seams and welds. Although the paint becomes touch-dry within two hours, a longer time is required for it to dry completely. Paint continually exposed to severe heat and sun will remain effective for only two or three weeks. At least five successive layers of paint can be applied without excessive peeling.

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The paint shows the same red color with DANC solution and with CNS and CNB tear gases as it does with GB and HD. Exposure to the sun and to heat, steam, and oil decreases the sensitivity of the paint. Extreme heat will turn the paint to red or reddish-brown. Heat will cause an even color change on a painted surface; liquid toxic chemical agents usually give a spotty appearance. Since the paint is insensitive to toxic chemical vapor, an even color change can be assumed to be caused by heat. When heat has changed the color of a painted surface so that toxic liquid chemical agents would not give a distinguishable reaction, the surface shall be repainted.

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VESICANT DETECTOR CRAYON

The vesicant detector crayon (fig. 11-6) is a pink, chalklike crayon composed of a mixture of pigments, wax emulsion, and other ingredients. M7A1 Vesicant Detector Crayon is issued as a standard service item, but M7 Vesicant Detector Crayon, which differs only in length and packaging, can be used with equal results. The crayon detects the presence of liquid toxic chemical agents only. It cannot be used for vapor. The color of the crayon changes to blue when in contact with liquid HD; the color changes to yellow when in contact with liquid GB. The color change will ordinarily be splotted rather than even.

The crayon is about three inches in length and 1/2-inch in diameter. Crayons are issued wrapped individually in water proof paper and a plastic bag. Three crayons are normally packaged in an airtight can, which has instructions for use on the outside of the can. One such can is a standard component of the M9A2 Chemical Agent Detector Kit, described above.

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To apply the crayon, either rub it directly on a surface suspected of liquid contamination, or scrape or crumble the crayon into a powder and dust the powder on the suspected surface. White paper may be marked on one side with crayon and held against the surface to be tested. If the crayon changes color within five minutes, the surface shall be considered to be heavily contaminated. To test for liquid leakage of containers or munitions, mark crayon on the item near the seal or valve, and observe it for color change.

Detector crayon is affected by such chemicals as DANC solution, bleach, and by strong acids such as hydrochloric and sulfuric acids. Chlorine and phosgene in high concentrations will turn the crayon blue. Since many harmless compounds may hydrolyze to produce strong acids, the possible presence of such substances must be considered. The crayon becomes discolored when exposed for some time to bright light or to heat and loses its sensitivity. In storage, crayons shall be protected from heat and from exposure to fumes from bleach, DANC solution, acids, and other corrosive chemicals.

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SPECIAL SAMPLING AND TESTING KITS

Several types of kits have been designed for the use of chemical laboratory teams, medical units, water supply units, and other designated units for sampling and analyzing chemical agents and for testing and screening food and water. Operation of the kits is highly technical and is only to be done by specialists. Detailed instructions are supplied to the teams and units to which the kits are issued. These kits are discussed in other publications and are included here primarily for reference purposes.

M12 Agent Sampling Kit

This kit is designed basically for the use of chemical laboratory teams in collecting samples of liquid or solid chemical agents from soil, vegetation, or hard surfaces for return to field laboratories for analysis. For details, see TM 3-215.

M10A1 Chemical Agent Analyzer Kit

This kit is designed primarily for the use of chemical laboratory teams in detecting and analyzing chemical agents. Tests made with this kit are more sensitive than those made with the M9A2 Chemical Agent Detector Kit.

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M2 Water Testing And Screening Kit

This kit was designed primarily for the use of medical officers, water supply units, and medical and sanitary inspectors for the testing for various chemical agents in water. For details, see TM 8-285.

M2 Food Testing And Screening Kit

This kit, designed for the use of medical officers and food supply units, tests food and food packages for the presence of chemical agents. For details, see TM 8-285.

ANIMALS

Until automatic detector alarms become available, detection devices shall be supplemented by the use of animals, whenever possible. Many types of animals can be caged and placed about areas where contamination would be most likely; the most desirable are those simple to care for and handle and those responding quickly to low concentrations of agent. Of these, pigeons and canaries are often used to indicate contamination.

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The lethal dosage of GB vapor for pigeons is about 50 milligrams per minute per cubic meter (over a ten minute period). Canaries are more susceptible to GB than are pigeons, the lethal dosage for canaries being about 30 milligrams per minute per cubic meter (over a ten minute period). Symptoms are observed in approximately the following order: shaking of the head, gasping, tremor, unsteadiness, and convulsions. Contraction of the eye pupil may also be observed. Pigeons will ordinarily show symptoms before a lethal human dosage accumulates; however some humans, exposed to the same dosage, might become casualties before the appearance of symptoms in the pigeons. Cages in which pigeons are kept shall be maintained in as clean a condition as possible to prevent psittacosis, which is fatal to pigeons. If pigeons are found dead, however, it must be assumed the GB is present until tests have proven otherwise.

Pigeons and canaries shall be caged and placed about the periphery of storage areas. They shall be examined for symptoms before entry to the storage area is made. If symptoms are seen, personnel shall mask, and tests for GB presence shall be made with M9A2 Chemical Agent Detector Kit.

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Chapter 12

PROTECTIVE EQUIPMENT

INTRODUCTION

Protective equipment discussed in this chapter is individual protective equipment required for the safety of personnel engaged in activities relating to the storing, handling, and shipping of GB-filled and HD-filled items. For the discussion of collective protective devices and other such protective equipment used for defense against enemy toxic chemical attacks, see NAVPERS 10098, Chemical and Biological Warfare Defense, NAVDOCKS TP-PL-3, Chemical Warfare Defense, and other applicable publications listed in the bibliography.

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Individual protective equipment comprises gas masks, specially treated protective clothing, and protective accessories such as ointment. Gas masks protect the eyes, face, and lungs from toxic chemical vapors, both GB and HD. In the presence of GB vapor, only the mask is ordinarily required for protection, for GB vapor does not cause casualties by skin contact unless exposure times are unusually long. On the other hand, HD vapor attacks by skin contact as well as through the eyes and lungs. Where the possibility of HD vapor exists, therefore, both the mask and protective clothing are required. If a toxic chemical vapor is present but not identified, protective clothing as well as the mask shall be worn. For protection from the liquid form of both GB and HD, both mask and clothing are required. Protective accessories, such as ointment, can be used as supplementary protection from contamination.

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Protective equipment shall be made available to all personnel in or near a toxic chemical storage area. Table F specifies the protective equipment to be worn under various conditions of storage, handling, shipping, and servicing of toxic chemical items. Unless otherwise specified by the officer in charge, the equipment shall be worn as prescribed in the table.

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TABLE F

USE OF PROTECTIVE EQUIPMENT

Operation	Location	Agent	Protective Equipment Required
Receiving or loading munitions	Magazines, storage spaces	GB	Make masks and protective clothing available*
		HD	Make masks and protective clothing available*
Entry and inspection	Magazines, storage spaces	GB	Wear masks; make protective clothing available
		HD	Wear masks and protective clothing
Testing for presence of agent	Magazines, storage spaces	GB	Wear masks; make protective clothing available
		HD	Wear masks and protective clothing
Locating leakers	Magazines, storage spaces	GB	Wear masks (if liquid leakage is suspected, wear masks and protective clothing)
		HD	Wear masks and protective clothing
Handling, repair, or disposal of leakers	Storage areas, disposal sites	GB	Wear masks and protective clothing
		HD	Wear masks and protective clothing
Decontamination	Where necessary	GB	Wear masks and protective clothing
		HD	Wear masks and protective clothing
Servicing guns with projectiles	Handling rooms, gun rooms	GB	Make masks and protective clothing available*
		HD	Make masks and protective clothing available*
Servicing launchers with rockets	Handling rooms, decks	GB	Make masks and protective clothing available*
		HD	Make masks and protective clothing available*
Servicing aircraft with bombs or spray tank	Handling spaces, flight decks	GB	Make masks and protective clothing available*
		HD	Make masks and protective clothing available*

Note: Whenever GB vapor only is suspected of being present, the mask shall be worn; whenever GB liquid is suspected of being present, mask and impermeable clothing shall be worn. When HD is present, either as vapor or liquid, both mask and protective clothing shall be worn. Permeable, impregnated clothing protects against HD vapor and small droplets of HD liquid; impermeable clothing is required for protection against large drops or pools of HD liquid.

- It is advisable to wear rubber gloves during the handling, loading, and servicing of toxic chemical munition; however, rubber gloves are easily torn or broken and may therefore prove impractical. In this case, ordinary cloth gloves will be issued.

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GAS MASKS

GENERAL

The gas mask, also known as the protective mask, is the basic item of individual protective equipment inasmuch as it protects the eyes, face, and respiratory tract. Operation of the mask involves inhalation of air into a canister where the air passes through a mechanical filter, to remove solid particles of dust and smoke, and then through a bed of treated charcoal, to neutralize and absorb toxic vapors (fig. 12-1). After purification, the air is drawn into the facepiece of the mask and inhaled. Exhaled air is expelled from the facepiece through an outlet valve. The valve allows air to escape but prevents impure air from entering.

Protective efficiency of the mask gradually decreases as the filter and charcoal become used up. The period of effectiveness depends upon the nature of the agent, concentration of the agent, and breathing rate of the user.

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Gas masks issued to Navy forces, primarily for use at shore establishments, are the Army developed M9A1 Protective Field Mask and the M3-10A1-6 Lightweight Service Mask. Afloat, the Navy developed Gas Mask ND Mark 4 is used. These masks are suitable to protect against GB and HD attack from respiratory means, but they have certain deficiencies that will be eliminated by the development of new and improved items.

M9A1 PROTECTIVE FIELD MASK

The M9A1 Protective Field Mask (fig. 12-2) consists of a facepiece and a canister fitted directly to the facepiece. Canister shelf life in dry storage is estimated to be a minimum of 10 years. The mask is issued in a cloth carrier containing antidim, a special cloth and soap for cleaning the eyepiece of the mask. Antidim leaves an invisible film on the lenses that helps to reduce fogging. A nose cup in the facepiece also acts to reduce fogging. Facepieces come in three sizes, small, medium, and large. Various masks shall be tried by each individual to obtain a proper fit.

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The mask suffers markedly from heavy wear. The head harness loses its elasticity easily and frequently needs replacing, and the metal fittings of the facepiece corrode if perspiration is not removed after each wearing. For a detailed description of this mask, its uses and limitations, see TM 3-205, The Gas Mask.

M3-10A1-6 LIGHTWEIGHT SERVICE MASK

M3-10A1-6 Lightweight Service Mask (fig. 12-3)
functions like the protective field mask, but the service mask has a different canister and facepiece. The canister is carried in the carrier during use, and it is connected to the facepiece by a flexible hose. A modification of this mask is the M3A1-10A1-6 Lightweight Service Mask, which has an improved outlet valve. For a complete description, see TM 3-205.

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GAS MASK ND MARK 4

Gas Mask ND Mark 4 (fig. 12-4) has a separate facepiece and two canisters. The canisters are held in place as a unit behind the neck by attachment to the head harness. They are connected to the facepiece by two flexible hoses, each passing on one side of the head. Functioning of this mask is the same as the Army type masks described above. An improvement of this mask is Gas Mask ND Mark 5, not yet issued. It is fitted with an improved outlet valve and speech diaphragm.

USE OF MASKS

The masks are designed for concentrations no greater than one per cent by volume. Canisters only purify air; they do not manufacture oxygen. When air is deficient in oxygen, therefore, no canister is effective in supplying air suitable for breathing. If it is necessary to enter areas or compartments where there is a deficiency of oxygen, Navy oxygen breathing apparatus shall be used.

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When the mask is worn, the voice is muffled, but it can be heard through the mask over field radios and telephones. Radio transmitters are held either in direct contact with the outlet valve or about three inches in front of the valve. Telephone transmitters are held above and to the side of the outlet valve.

Before use, masks shall be checked in improvised or permanent gas chambers. After use, they shall be inspected and cleaned. All personnel engaged in storing, handling, or shipping toxic chemical items and on a vessel carrying such items shall be provided with gas masks and frequently drilled in using them. Masking with the Army type masks is shown in FM 21-40, Defense Against CBR Attack; donning the Navy Gas Mask ND Mark 4 is shown in NAVPERS 10098, Chemical And Biological Warfare Defense.

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MAINTENANCE OF MASKS

The canister of a gas mask rarely breaks down suddenly. It usually fails gradually and warns the wearer of the need for replacement by minor sensory effects, such as a slight but persistent odor of gas or persistent lacrimation. A procedure shall be established for the periodic inspection of gas masks and canisters. If it is found that the canister has gained 20 grams or more over its original weight, it shall be replaced.

The mask must be kept dry. Moisture causes rotting of parts, corrosion of the metal, deterioration of the canisters, and rotting of the carrier. Perspiration shall be removed as quickly as possible after use. Care must be especially taken during decontamination to prevent wetting of the canister. Masks can be waterproofed, as described in TM 3-205, to make them usable after becoming wet; however, if the canister gets water inside it, it will have to be replaced. Canisters shall be cleaned, therefore, by brushing or scraping, not by washing. If the outside of the canister has been wet, the canister should be retested before being used.

Masks shall be stored in a dry place and not subjected to extremes of temperature. The canister shall not be stored inside the facepiece as damage to the facepiece may result.

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Damaged masks shall be repaired as prescribed in
TM 3-205.

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PROTECTIVE CLOTHING

GENERAL

Ordinary clothing offers very little protection from toxic chemical agents, either as vapor or liquid. It shall not be relied upon for protection and, when contaminated, shall be immediately removed. Two kinds of specially designed protective clothing are available: impregnated, permeable clothing and impermeable clothing. Impregnated, permeable clothing provides protection against HD vapor and against small drops of HD liquid. It does not give adequate protection against large drops of HD liquid, and it affords no protection against GB, except that it slightly delays penetration of liquid GB. Impermeable clothing, when worn as discussed below, provides complete protection from HD and GB as vapor or as liquid droplets. Impermeable clothing may eventually be penetrated, however, from contact with large amounts of liquid agent; therefore liquid contamination shall be neutralized or removed as soon as possible after discovery. Impregnated, permeable clothing protects basically by interposing a chemical barrier between the body surface and the agent; impermeable clothing protects basically by interposing a mechanical barrier.

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Protective clothing should be worn as specified in Table F, page 12-4. Impregnated, permeable clothing shall be worn whenever HD vapor contamination only is suspected of being present. Whenever HD liquid contamination or GB liquid contamination is suspected of being present, impermeable protective clothing shall be worn. For the handling, repair, and disposal of leaking items and for decontamination work, impermeable clothing is required.

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IMPREGNATED, PERMEABLE CLOTHING

Impregnated, permeable clothing is standard issue clothing that is protected by a chemical impregnate. The impregnate is held in the clothing by a binder. It has the property of destroying or neutralizing HD vapor or small droplets of HD liquid. It does not afford protection from GB. Large drops of HD will exhaust the impregnate at the point where the liquid wets the clothing. Should a large drop of liquid be visible upon impregnated clothing, the clothing shall be removed or the contaminated area cut or torn away as soon as possible. The effectiveness of the chemical impregnate used in the clothing is reduced with age. While the effective life of the impregnate is about three years, it is reduced by frequent use and laundering. Accordingly, periodic tests should be made.

Various items of impregnated clothing are issued for wear in hot, warm, and cold weather. The items to be worn and the manner of wearing them under these conditions are described in TM 3-290, Individual Protective And Detection Equipment.

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Impregnation

Impregnation of the clothing is accomplished in impregnating plants before the clothing is issued, but impregnation and reimpregnation may be accomplished in the field. Sets used for this are the M1 Field Impregnating Set and the M3 Clothing Impregnation Chemical Set. Operation of these sets is discussed in TM 3-290. In addition, the Bureau of Yards and Docks is developing a 75-pound portable laundry and reimpregnation unit. When development is completed, this unit will be available for field issue.

M1 Impregnite-In-Clothing Kit is used to determine the impregnite content of clothing. If any of the garments are found to be lacking in impregnite, the whole issue must be reimpregnated or the whole issue must be tested and the deficient garments reimpregnated.

Maintenance

Inspection and test schedules, laundering, decontamination, and storage of impregnated, permeable clothing are given in TM 3-290.

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IMPERMEABLE CLOTHING

Impermeable protective clothing is made of butyl rubber-coated materials that are resistant to vapor and liquid forms of HD and GB. An impermeable outfit (fig. 12-5) offers protection against GB liquid for 300 minutes; it protects against GB vapor for an extended period. During wear, body heat and moisture are held within the suit; consequently, unless worn with a cooling suit (fig. 12-6), the impermeable suit can be worn only for a period of about 30 minutes. With the cooling suit, this period is extended. The cooling suit is of cotton cloth, resembling pajamas. It is worn over the impermeable suit and is kept wet with water spray to provide cooling by evaporation.

All impermeable protective items made of butyl rubber-coated materials are flammable. When any of these items are worn, extreme care must be taken to avoid contact with open flame or hot objects.

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The complete impermeable outfit offering maximum protection consists of impregnated, permeable socks, underclothing, and gloves; an impermeable suit, hood, gloves, and rubber boots; a cooling suit, cooling hood, boot covers, and a gas mask. Except for the gas mask, discussed above, these items, their donning and removal, are described in TM 3-290. In addition, an impermeable apron is available for protection from liquid agents; it is described in TM 3-290.

Each person involved in toxic chemical storing, handling, and shipping shall receive training in the proper wear and care of an impermeable outfit, and thorough inspection of the equipment shall be made at regular intervals. Impermeable outfits shall be decontaminated as prescribed in TM 3-220, Decontamination, and aerated overnight before being used again. Inspection, maintenance, and storage of impermeable clothing are described in TM 3-290.

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PROTECTIVE ACCESSORIES

Protective accessories comprise M5 Protective Ointment and protective dubbing. M5 Protective Ointment is used both to protect against and to decontaminate HD. It does not protect against GB. Against HD, the ointment shall be applied to any exposed surfaces of the body caused by improperly fitted clothing or torn clothing. In an emergency, the ointment may be used as a substitute for protective gloves and hood. When applying the ointment, care must be taken to keep it away from the eyes. The ointment is issued in tubes and is a standard component of the M5A1 Protective Ointment Kit (fig. 12-7), described in TM 3-290.

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Protective dubbing is a soft, waxlike paste. When applied to footwear, it softens, preserves, and waterproofs the leather and makes it resistant to penetration by toxic chemical agents. The dubbing does not neutralize toxic chemical agents; it only makes footwear more resistant to penetration. As a result, contaminated footwear shall be decontaminated as soon as possible. Leather footwear is not originally treated with dubbing; personnel in or near a toxic chemical area shall use the dubbing when directed by proper authority. Dubbing may be applied by hand or by immersion of the footwear in melted dubbing. Both methods are described in TM 3-290.

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Chapter 13
SAFETY

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INTRODUCTION

Safety precautions governing the handling, storage, and shipping of naval ordnance equipment are set forth in U. S. Navy Regulations, the Bureau of Ordnance Manual, OPNAV 34P1 -- U. S. Navy Safety Precautions, OP 4, and OP 5. Precautions specifically pertaining to toxic chemical items are listed below and in other chapters of this manual.

Safety is a command function. Responsibility for the safety of personnel is vested in the commanding officer. Because the following precautions are designed for usual conditions of toxic chemical handling, storage, and shipping, commanding officers or others in authority may find it necessary to issue special, supplementary precautions to their commands in order to provide for local conditions and unusual circumstances. It is the responsibility of the commanding officer to see that all personnel are instructed and drilled in all applicable safety precautions, to see that adequate warning signs are posted about dangerous areas, and to satisfy himself that safety precautions are being observed.

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It is the responsibility of each individual working with toxic chemical items to observe all safety precautions applicable to his work or duty. He shall warn others whom he knows to be endangered by known hazards or by failure to observe precautions, and he shall report any unsafe condition or any equipment or material that he considers to be unsafe.

Standing operating procedures for basic activities of handling, storage, and shipping, including procedures to be followed during leakage or other emergencies, shall be established in writing. Operating personnel shall be required to read the written procedures, and supervisory personnel shall insure that the procedures are clearly understood.

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The history of accidents that have occurred in the handling, storage, and shipping of ammunition shows that, in practically every incident when the cause of accident could be determined, the accidents have resulted from causes that can be classed as avoidable. (For examples, refer to OP 1014, first revision, Ordnance Safety Precautions, Their Origin and Necessity.) Applicable safety precautions, therefore, are to be strictly enforced by naval activities ashore and afloat. It should be kept in mind, however, that the most detailed regulations cannot replace good judgment, careful inspection, sound training, capable leadership, and thorough planning of ordnance activities.

SAFETY PRECAUTIONS

The following safety precautions should be supplemented by precautions in other chapters of this manual and by all applicable precautions set forth in publications referenced in this manual.

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GENERAL

1. To avoid danger of casualties, the observance of the following safety precautions is mandatory. The Bureau of Ordnance shall be informed of any circumstances which conflict with these safety precautions or which for any other reason require changes in or additions to them.

2. When in doubt as to the exact meaning of a safety precaution, an interpretation shall be requested from the Bureau of Ordnance. Conditions not covered by these safety precautions may arise which, in the opinion of the commanding officer, may render further operation of the equipment unsafe. Under these conditions, nothing in these safety precautions shall be construed as authorizing such further operation.

3. Safety devices provided shall always be used as designated to prevent possibility of accident and shall be kept in good order and operative at all times. All instructions promulgated by competent authority to insure safe operation or handling of equipment shall be strictly observed.

4. Suggestions for and constructive criticism of safety precautions are invited. They should be made to the Bureau of Ordnance through official channels.

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PERSONNEL

1. All personnel working with toxic chemical items shall be trained in the fundamentals of handling such items and shall be familiar with instructions and equipment pertaining thereto. Such training must impress personnel with the dangerous potentialities of toxic chemical items and with the fact that carelessness on the part of any individual may result in injury or death not only to himself, but also to many others.

2. A competent officer having chemical munitions training shall be in charge of handling, storage, and shipping of toxic chemical items. If the work does not involve special risks, it may be carried out under the supervision of an experienced and competent chief petty officer or warrant officer. Supervisory personnel shall have had special training in chemical munitions.

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3. Persons engaged in the receiving, transferring, handling, inspecting, storing, or transportation of toxic chemical items must be carefully supervised by those in authority over them and frequently warned of the necessity of using the utmost caution in the performance of their work. As familiarity with any work, no matter how dangerous, is apt to lead to carelessness, all persons who may supervise or perform work with toxic chemical items shall exercise the utmost care that all regulations and instructions are rigidly observed. No relaxation of vigilance shall ever be permitted.

4. Personnel handling toxic chemical items or working in a toxic chemical storage area or magazine shall not be permitted to work alone.

5. In operations involving hazard of sudden exposure to high concentrations of agent, the working crew shall include one or more safety observers. Each safety observer shall have a gas mask in readiness and shall constantly observe the operation from a safe distance upwind. He shall be prepared to assist and to render first aid to any member of the working group showing signs of poisoning.

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6. No one shall be permitted to work in a toxic chemical magazine for more than one hour at a time.

To avoid the cumulative effects of small doses of toxic chemical agents, reliefs will be provided for working parties handling toxic chemical munitions.

7. Personnel shall be given periodic training and instruction in recognizing symptoms of toxic chemical poisoning and in rendering first aid.

8. A dispensary staffed with personnel competent to treat cases of toxic chemical poisoning shall be maintained on active status during all times when exposure to toxic chemicals might occur.

9. Precautions shall be taken to insure that personnel do not enter toxic areas without having knowledge of the hazards involved or without proper authorization.

10. All personnel shall report to work each day with clean-shaven faces; otherwise, a gastight fit of the gas mask facepiece cannot be assured.

11. Eating and smoking shall be prohibited near toxic chemical items and in toxic chemical storage spaces and magazines.

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HANDLING

1. Toxic chemical items shall be handled as little as possible in order to minimize the risk of exposure to personnel. Successive handling operations shall be segregated or isolated as much as practicable.

2. Toxic chemical items shall be handled as carefully as possible. They shall never be struck, dropped, or otherwise subjected to rough handling.

3. Toxic chemical items shall be approached and handled, insofar as possible, from the upwind side.

4. No disassembly, assembly, modification, or repair to toxic chemical items shall be made without specific authorization by competent authority.

5. The time for servicing guns, launchers, or aircraft with toxic chemical munitions shall not be more than one hour. As soon as firing has ceased, all toxic chemical munitions outside of magazines shall be defuzed and returned to the magazines.

6. Fuzing and defuzing of toxic chemical munitions shall not take place in or near magazines. Such operations shall be done as nearly as practicable to the gun, launcher, or rack.

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EQUIPMENT

1. Personnel shall be provided with and trained in the proper care and usage of protective, detection, decontamination, and first aid equipment, including gas masks, protective clothing, detection devices, and first aid kits. The equipment shall be readily available in the vicinity of, but not inside, toxic chemical magazines. The equipment shall be inspected and tested prior to use and shall be used only as prescribed. (See chapters 9 and 10 of this manual.)

2. Masks and, if required, protective clothing shall be worn during entry to magazines, testing for contamination in magazines, locating, handling, repairing, and disposing of leakers, during decontamination, and whenever contamination is suspected. Unless otherwise specified, protective equipment shall be worn as specified in Table F, chapter 12.

3. Detection devices shall be used as prescribed in chapter 11 of this manual.

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STORAGE

1. Toxic chemical munitions are considered to present a toxic as well as an explosive hazard; however, insofar as possible, all magazines intended for the storage of toxic chemical munitions are to be constructed and located as to be suitable for the storage of explosive munitions. (See chapter 9 of this manual.)

2. Open yard storage of toxic chemical munitions shall be used only as an expedient means of storage in emergency conditions.

3. Not more than 100,000 net pounds of agent in chemical munitions are permitted to be stored in any one magazine in permanent storage ashore.

4. Toxic chemical items shall be stored only with items of the same classification.

5. Areas where toxic chemical items are stored or handled shall be equipped with wind direction indicators. Personnel shall be directed to work on the upwind side whenever possible.

6. Toxic chemical items shall be stored at temperatures under 100 degrees Fahrenheit. They shall not be subjected to extreme temperatures. If the temperature of a magazine exceeds 110 degrees Fahrenheit for 24 hours, the magazine shall be cooled by applying forced ventilation.

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7. Toxic chemical magazines shall be provided with mechanical blowers and ventilated as prescribed in chapter 9 of this manual.

8. Toxic chemical items shall not be allowed to remain under the direct rays of the sun for long periods. In any temporary emergency requiring storage out of doors in an area exposed to the sun, toxic chemical items shall be covered with a tarpaulin. The tarpaulin shall be supported above the items and at the edges so that free circulation of air may take place.

9. Magazines shall be inspected daily for leakage or other damage.

10. Whenever a toxic chemical magazine is opened, a responsible officer, petty officer, or toxic chemical munitions handler shall be present to detect contamination. All personnel shall don gas masks before entering the magazine. If evidence of contamination is discovered, the magazine shall be closed, and forced ventilation shall be applied for at least 15 minutes before the magazine is re-entered.

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11. Toxic chemical magazines and magazine areas shall be adequately guarded at all times. Magazine areas shall be protected by nonclimbable fences, and all entrances shall be securely locked unless guards are stationed at them. Special precautions shall be taken to guard areas that are not protected by a suitable fence. Guards shall be thoroughly instructed as to hazards and safety precautions.

12. Guards protecting toxic chemical items shall be specifically instructed regarding the danger of firing in the direction of a toxic chemical magazines. No hunting shall be permitted in magazine areas.

FIRE PROTECTION

1. Fire can cause detonations or bursting of toxic chemical munitions and the release of toxic chemical agents. It is the greatest source of potential disaster in relation to toxic chemical items. All possible steps shall be taken to prevent fire, and all fire precautions shall be strictly complied with. (For specific precautions, see the Bureau of Ordnance Manual, OP 4, and OP 5.)

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TRAINING

1. Training materials shall be used only under the direction of competent, trained personnel and only as prescribed. (See chapter 14 and the publications referenced therein for specific precautions.)

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Chapter 14

TRAINING

INTRODUCTION

Training programs, schools, and curricula are under cognizance of the Bureau of Personnel. Training in subjects pertaining to toxic chemical items will ordinarily be of two types: general indoctrination and specialized training. General indoctrination within units shall be administered by an officer who has received specialized training. Specialized Navy training, not involving joint service instruction, will parallel that currently established at damage control schools, including therein instruction in toxic chemical munitions and in chemical warfare defense.

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Training aids include models, instructional charts, films, and publications. Besides publications issued by the Bureau of Ordnance, Bureau of Personnel, and other Navy bureaus, Army publications relating to toxic chemical warfare are being stocked by the Bureau of Ordnance for issue to appropriate commands. These publications include technical manuals, technical bulletins, field manuals, and other publications listed in the bibliography and referenced throughout this manual. Training for defense against enemy toxic chemical attack is discussed in NAVPERS 10098, Chemical and Biological Warfare Defense, and in NAVDOCKS TP-PL-3, Chemical Warfare Defense.

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TRAINING OBJECTIVES

Personnel shall be instilled with a wholesome respect, but not a fear, of toxic chemical agents. Munition handlers shall have a general knowledge of chemical agents and their uses, and they shall have a practical, detailed knowledge of toxic chemical munitions and of activities relating to the storing, handling, and shipping of such items. This knowledge shall include the use of detection equipment, protection equipment, decontamination equipment and materials, and first aid equipment and all regulations and safety precautions applicable to toxic chemical items, especially those pertaining to personnel safety, fire protection, inspection of munitions, and testing for, handling, and disposing of leaking items. Personnel shall be trained and frequently exercised in using the M9A2 Chemical Agent Detector Kit, gas masks, protective clothing, and the M5A1 Protective Ointment Kit; at toxic chemical storage areas, personnel shall be drilled in procedures to be followed upon the discovery of leakage or other emergencies. Materials that can be used for training purposes in simulating or establishing conditions of toxic chemical contamination, such as those that could occur in storage areas, are described below. In addition, TM 3-305, Use of Chemical Agents and Munitions in Training, shall be consulted.

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TRAINING MATERIALS

Materials used in the training of toxic chemical munition handlers are agent identification sets, tear gas, chlorine, molasses residuum, and smoke. Water, as a fill for spray tanks, may also be used as a training material.

IDENTIFICATION SETS

Various training sets for identification of agents by odor are available. The sets contain small quantities of agents having a characteristic odor, such as HD. GB and most other nerve and blood poisons having no recognizable odor are not included in such sets. Available for use indoors is the MI Instructional Gas Identification Set. For use outdoors, the MI Detonation Gas Identification Set is used. The outdoor detonation set is considered superior to the instructional set for training purposes and shall be used whenever available.

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The M1 Instructional Gas Identification Set (fig. 14-1) consists of agents, including mustard agents, in bottles packed in airtight cans. The cans are packed in a sectioned wooden box. Any agent may be released for "sniff" training by removing the stopper of the appropriate agent bottle. Instructions and precautions for using the set are described fully in OP 1447, Gas Identification Sets.

The M1 Detonation Gas Identification Set (fig. 14-2) consists of agents, including HD, in hermetically sealed glass tubes packed in a metal shipping cylinder. The selected agent is released in a safe training area by exploding the tubes by detonators set off by a blasting machine. The blasting machine is contained in an accessories set (fig. 14-3) to be used with the M1 Detonation Gas Identification Set. The set includes the blasting machine, firing wire, a wire reel, and cutting pliers. Detonation shall be carried out by trained personnel in an area cleared of personnel for at least 50 yards in all directions. The set, accessories used with it, and its operation are described in OP 1447.

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An instruction set to be used to train personnel in the proper operation of the M9A2 Chemical Agent Detector Kit is now being developed. The set will contain agent simulants that cause the same reactions to tubes of the detector kit that toxic chemical agents would cause. Initial development of the set includes simulants for GB and HD. The design of the set will incorporate suitable safety measures, such as nonspilling bottles, to insure safe usage under the supervision of qualified personnel. When such sets become available for training purposes, instructions for their use will be forwarded.

TEAR GAS

CN, tear gas, can be used for testing masks and for developing confidence in personnel. CN capsules can be used in gas chambers for mask drills and tests, and various CN hand grenades can be used at outdoor, training areas. CN Training Spray Guns Mark 1 Mods may be used ashore or afloat for the silent and invisible release of tear gas into magazines or compartments to simulate vapor contamination.

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CN Spray Gun Mk 1 Mods (fig. 14-4), formerly known as the McBride, consists of a steel cylinder containing tear gas and carbon dioxide propellant, a valve body, valve, an eduction tube extending from the cylinder to a nozzle, a curved nozzle, and a heavy wire handle for steadying the gun in operation. While holding the nozzle up and forward, the valve is opened by turning the cylinder counterclockwise, thereby initiating release of tear gas spray by means of the carbon dioxide propellant. A special solution of ten per cent CN in carbon tetrachloride gives an atomized tear gas spray through a distance of about five feet for about a 20 second period. Filling of the spray gun is accomplished by wall-mounted Charging Device Mark 1, scales, and a carbon dioxide cylinder. General arrangement of the spray gun is shown on Bureau of Ordnance drawing 267708; general arrangement of the charging device is shown on Bureau of Ordnance drawing 267713.

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CHLORINE

Chlorine, a nonpersistent toxic agent, used originally as a war gas in World War I, has recently been classified by the Army Chemical Corps as a standard training agent. It has been successfully employed for training purposes by release in gas chambers to provide a realistic training exercise with a toxic agent. This training simulates actual field conditions and gives personnel practice in adjusting masks to a toxic atmosphere. For this use, chlorine is made available in small commercial cylinders. The agent is released simply by cracking the valve of the cylinder sufficiently to set free the quantity of agent desired.

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MOLASSES RESIDUUM

A 25 per cent solution by volume of molasses residuum dissolved in water and stabilized by cresol can be used as a standard simulant for munitions tests of HD. This simulant has been successfully employed in engineering tests of spray tanks, bombs, and land mines. The solution is a dark, brown liquid of thin sirupy consistency, having a viscosity and surface tension close enough to those of HD to insure comparable flow characteristics. Patterns obtained by dispersion of the solution from HD-type munitions are similar to those produced by HD.

The solution has a distinctive molasses odor and a low freezing point. It can be used in moderately cold weather without danger of freezing. By contact, the solution is harmless to humans and animals, but because of the cresol used as a stabilizing agent, the solution must not be swallowed.

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SMOKE

Smoke, ground or air released by generators, smoke pots, grenades, or spray tanks, can be used for general gas mask training; however, smoke is more specifically used in training for defense against enemy chemical attack. For smoke munitions, see chapter 15. For their use in training, see TM 3-305.

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Chapter 15

NONTOXIC CHEMICAL MUNITIONS

INTRODUCTION

This chapter discusses nontoxic chemical agents and munitions, comprising irritant, incendiary, and smoke munitions, used by the U. S. Navy. A brief description of each major item is given; for more detailed information and for information concerning marking, shipping, handling, storage, and tactical employment of munitions, see the references listed below and in the bibliography.

All information in this chapter is to be considered as interim. An OP, which provides complete, detailed data on nontoxic chemical munitions, is being prepared and will soon be issued.

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AGENTS

IRRITANTS

Chemical agents classed as irritants are those that attack the eyes, nose, lungs, and skin, usually causing lacrimation, sneezing, or vomiting.

Masks are required for protection against irritants, but except in very unusual circumstances, they do not cause death and are considered nontoxic. Irritants are used mainly in grenades to attack, harass, and disperse small groups of unmasked personnel. Irritants used by the Navy are tear gases and adamsite, a vomiting gas.

Tear Gases (CN, CNB, CNC)

Tear gases seldom produce casualties, but they irritate the skin and cause tears to flow. Against masked personnel, they have little effect. Tear gases are used today mainly for training in masking and for mob and riot control. Chloroacetophenone (CN) can be used alone or as a solution in benzene and carbon tetrachloride (CNB) or in chloroform (CNC). CN has a fragrant odor, like apple blossoms, CNB smells like benzene, and CNC has an odor of chloroform. All are ordinarily nonpersistent.

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In high concentrations, CN has an effect similar to sunburn. It causes the skin to itch or burn, especially on moist parts of the body. The effects are harmless, however, and usually disappear in a few hours. A gas mask gives adequate protection against all tear gases. For more information, see TM 3-215, Military Chemistry and Chemical Agents.

Adamsite (DM)

Adamsite (DM) is a vomiting gas. It attacks the eyes, nose, and lungs, causing sneezing, coughing, headache, nausea, and vomiting. In high concentrations, it can cause serious illness or, in extreme cases, death. It attacks quickly, usually within one minute. It is dispersed as an aerosol and is nonpersistent as such. A gas mask provides adequate protection. See TM 3-215 for more information.

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INCENDIARIES

Incendiaries are chemical agents used primarily for igniting combustible substances on contact by generating sufficient heat to cause ignition. Incendiaries can be used as a filler for many types of munitions, including bombs, projectiles, grenades, and flame throwers. Three classes of incendiaries exist: oil incendiaries, metal incendiaries, and oil and metal incendiaries.

Oil Incendiaries

Oil incendiaries are based upon gasoline and are either thickened or unthickened. Unthickened oil incendiaries are made up of straight gasoline or of gasoline blended with fuel oil. Because oil burns more slowly than gasoline, a high proportion of oil in the blend is desirable. In most cases, munitions filled with an oil incendiary, either thickened or unthickened, are equipped with white phosphorus igniters to insure ignition.

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Thickened fuel is made up of gasoline and a fuel thickener. Fuel thickeners give slower burning properties to the mixture, and they cause flames to rebound and to go around corners. Thickened fuel is used in most incendiary bombs, including all fire bombs.

Fuel thickener is added directly to gasoline either manually or by a mechanical mixer. The latest mixing and transfer units contain a pump, generator, heater, mixer, and accessories. For a description of these units and for methods of mixing gasoline and fuel thickeners, see TM 3-366, Flame Thrower and Fire Bomb Fuels.

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At temperatures below 65 degrees Fahrenheit, thickeners fail to diffuse properly in the fuel. Either the fuel must be warmed, or a peptizer must be used. Unless a mechanical mixer equipped with a heater is available, it is safer and easier to use a peptizer than to heat the fuel. A peptizer helps to diffuse the thickener in the gasoline. The most common peptizers are cresylic acid (xylenol), octoic acid, and water. Cresylic acid is the preferred peptizer. When used, one part cresylic acid is mixed to four parts thickener. Fuel thickeners are described below.

Fuel Thickener M1. Fuel Thickener M1, formerly known as Napalm, is basically an aluminum soap. Issued as small, brownish, granular particles, it is stirred into gasoline or mixed by a mechanical mixer until the desired consistency is reached. The percentage of thickener used in fuels ranges from 4.2 percent for very thin fuels to 12 percent for the highest consistency likely to be required. An undesirable feature of this thickener is that it absorbs moisture rapidly from the air; this causes the properties of the thickener to change so that it may become unusable.

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Fuel Thickener M2. Fuel Thickener M2 is a mixture of Fuel Thickener M1 and silica aerogel. The mixture is an improvement over M1, Fuel Thickener M2 being more free-flowing and more readily dissolvable than M1. By stirring in Fuel Thickener M2, gelled gasoline can be produced in a minimum time.

Fuel Thickener M3. Fuel Thickener M3, also known as Octal, is being developed as an improvement of Fuel Thickeners M1 and M2. Fuel Thickener M3 has little tendency to absorb moisture when exposed to the air, and its thickening properties are such that a lower percentage of it than of M1 and M2 is required to yield the desired consistency.

Metal Incendiaries

Metal incendiaries include those consisting of magnesium in various forms and those of powdered or granular aluminum mixed with powdered iron oxides. Magnesium is a soft metal which, when raised to its ignition temperature, burns vigorously in air. In solid or powdered form, magnesium can be used as a filling for incendiary munitions; in alloyed form, it can be used as a casing for small incendiary bombs.

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Thermite is a mixture of iron oxide and powdered aluminum. It has been used as an incendiary bomb filling and is considered a standard filling; however, it is usually combined with a first fire charge (a mixture of black powder, sulphur, and certain other oxidizing agents) to make thermate. Thermate, formerly known as Therm 8 and Therm 64C, burns violently and produces a very high temperature. It is almost impossible to extinguish. Thermate is used mainly as a filling for certain incendiary bombs and grenades.

Oil And Metal Incendiaries

The only standard oil and metal incendiary now used is Incendiary Mixture PT-1, a filling for incendiary bombs. PT-1 is a complex mixture of magnesium dust, magnesium oxide, carbon, gasoline, and several other incendiary materials. For its composition, see TM 3-215. PT-1 burns fiercely and relatively fast. It is difficult to extinguish.

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SMOKES

Smokes are of two types, screening and signaling. Screening smokes are used to conceal movement; signaling or colored smokes are used for identification and communication purposes. Screening smokes may be toxic; signaling smokes are nontoxic in concentrations ordinarily used. Smokes are used as a filling in projectiles, rockets, bombs, spray tanks, smoke screen generators, grenades, and smoke pots. In heavy concentrations, smoke is injurious if breathed for even a short time. When a smoke concentration is heavy, therefore, masks must be worn.

Screening Smokes

Screening smokes are released mechanically, by explosion, or by being vaporized from heat. The life of a smoke cloud depends chiefly upon wind and convection currents in the air. Water vapor in the air increases the size of the cloud; high relative humidity, therefore, improves the effectiveness of most smokes. Some screening smokes may be used as markers and as incendiaries.

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Titanium Tetrachloride (FM). Titanium tetrachloride (FM) can be dispersed by spray or by explosion. In contact with air, it reacts vigorously to form a dense, white smoke and mist. The smoke mixture is a colorless to yellow liquid that weighs about 14 pounds a gallon. Traces of moisture cause FM to solidify, making it hard to handle in spraying apparatus. FM has largely been replaced by FS.

Because of the hydrochloric acid within it, FM is highly corrosive. Personnel handling FM should wear acid-proof clothing, goggles, rubber gloves, and boots. FM smoke in the open is not toxic; in enclosed areas or whenever a high concentration is possible, a gas mask must be worn.

Sulphur Trioxide Solution (FS). FS is a solution of sulphur trioxide dissolved in chlorosulphonic acid. It is a heavy, corrosive liquid, weighing about 16 pounds a gallon. It is less expensive and more effective than FM. FS is used primarily in spray tanks and smoke screen generators. When dispersed, it forms a dense, white, corrosive smoke.

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Liquid FS is highly irritating to the skin; splashes of liquid FS in the eye produce painful burns. The smoke is irritating but not toxic; it will decompose material, such as nylon plastic, normally subject to decomposition by acids. Personnel handling FS should wear acid-proof gloves, goggles, aprons, and boots. If possible, personnel operating FS generating equipment should wear gas masks. Masks should always be worn when the smoke is in a confined place where high concentrations of FS can accumulate.

HC Mixture. HC is a mixture of zinc oxide, granulated aluminum, and hexachloroethane. Used in smoke candles, pots, floats, and grenades, HC forms a very dense, persistent, white to gray smoke cloud. The mixture is dispersed by burning; initial heat to start the burning is provided by a starter mixture. Burning of the HC mixture produces intense heat and smoke. In high concentrations, the smoke is somewhat toxic.

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HC mixture is obtained already loaded in munitions. These munitions must be stowed by themselves in fireproof magazines away from other munitions. Aboard ship, they should always be stowed in topside stowage convenient for jettisoning. They should be protected from the weather but never stowed below deck. In the event of a fire, water should never be used to quench the flames. Personnel fighting the fire should wear masks and use chemical extinguishers.

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White Phosphorus (WP). WP is the "white" form of the element phosphorus. At ordinary temperature, it is a yellow liquid. When dispersed in the air, it reacts with oxygen to form a dense white cloud. WP has many undesirable properties. It ignites spontaneously in contact with air; therefore munitions must be designed and handled so as to maintain air-tight integrity. WP has a low melting point, sometimes causing WP to melt in stored munitions. Projectiles filled with WP must be stored on end, therefore, to keep the center of gravity from shifting. Otherwise, instability in flight may result. In addition, the smoke has a tendency to pillar, to rise rapidly without spreading. Pillaring of WP lessens its screening effect.

WP smoke is poisonous on prolonged and repeated inhalation, but it is not likely to be harmful in concentrations usually found in the open.

Recently, white phosphorus has been used mixed with steel wool. This mixture, known as SWP, has been found to offer certain advantages in burning. It is being tested as a filling for projectiles.

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Plasticized White Phosphorus (PWP). Plasticized white phosphorus is an improvement over WP. PWP does not burn as rapidly as WP, and pillaring with PWP is much less marked than with WP. PWP is prepared by melting WP and adding to it a viscous solution of synthetic rubber.

A further improvement of white phosphorus is PWPV, plasticized white phosphorus, vulcanized. PWPV is being developed and tested for use in projectiles, but it is not yet available as a filling.

Fog Oil (SGF1 and SGF2). Low viscosity petroleum oils are used in certain smoke pots and smoke screen generators. These oils are referred to as smoke generator fog (SGF) oils. When dispersed, the oils are broken down into minute particles that produce a whitish smoke. Fog Oil SGF1 has a high viscosity and is used at temperatures above 32 degrees Fahrenheit. Fog Oil SGF2, having a lower viscosity, is used at temperatures below this.

As used, fog oil smoke is harmless to personnel, but masks should be worn by anyone subject to prolonged, high concentrations.

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Signaling Smokes

Signaling smokes are red, yellow, green, and violet, colors clearly distinguishable from white, gray, or black smoke incident to battle. Signaling smokes are used chiefly in howitzer shells and in grenades. Ordinarily, the smoke is visible for several miles. Formulas for the various signaling smokes mixtures are given in TM 3-215.

MUNITIONS

Nearly all kinds of munitions can be adapted to carry either an irritant, incendiary, or smoke filling. Munitions with such fillings presently used by the U. S. Navy comprise bombs, spray tanks, projectiles, rockets, grenades, smoke pots, smoke candles, and smoke screen generators. Basic data for these munitions are given below. For more detailed information, see the publications referenced and the drawings listed.

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BOMBS

Many incendiary and smoke bombs, dropped singly or clustered, are available for U. S. Navy usage. Table G, page 15-17, lists these bombs. Included in the list of incendiary bombs are fire bombs. Fire bombs are large thin-skinned containers filled with gasoline and a fuel thickener. One or more igniter fuzes, inserted in wells or brackets, fire the thickened fuel. Fire bombs were used successfully during World War II against personnel and items easily ignited. The fuel is less effective than unthickened fuel against items relatively difficult to ignite.

Fire bombs are not sturdy enough to be lifted and mounted when they are filled. A bomb must first be installed on an airplane and then filled. Once a fire bomb is filled, it must either be used or destroyed. For detailed information on fire bombs, see OP 1280, Aircraft Bombs, first revision, and OP 1903, Bomb Mark 77 Mod 0 (Fire - 750 pounds).

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TABLE G

NONTOXIC CHEMICAL BOMBS AND CLUSTERS

Type	Mark Mod	Nominal size, lb	Filling	Dwg. Number	Body Diameter, Maximum, in.	Length, Body and Tail, in.	Remarks
Incendiary	AN-M50A3	4	Thermate	C14-5-107	1.7	21.3	Used for Incendiary cluster, 500-lb, M32
Incendiary	M126	4	Thermate	D14-5-3018	1.625	19.5	Used for Incendiary cluster, 500-lb, M36
Incendiary	AN-M69 AN-M69A1	6	Incendiary oil	C14-5-182	2.87	19.42	Used for Incendiary cluster, 500-lb, M19 and M19A1
Incendiary	M74 M74A1	10	PT-1	C14-5-585	2.87	19.42	Length given without circular metal tail. Used for Incendiary cluster, 500-lb, M31 and for Incendiary cluster, 750-lb, M35
Smoke	1 1,2	50	HC	BuOrd 438279	8.85	34.6	
Smoke	AN-M47A3 AN-M47A4	100	WP or PWP	BuOrd 414619	8.00	48.0	
Smoke	3 0	100	HC	BuOrd 142286	10.25	47.65	
Incendiary cluster	M19 M19A1	500	Incendiary oil	C14-23-402	14.75	59.5	A cluster of 38 6-lb bombs.
Incendiary cluster	M31	500	PT-1	C14-23-937	15.125	57.0	A cluster of 38 10-lb bombs.
Incendiary cluster	M32	500	Thermate	C14-23-932	14.875	60.0	A cluster of 108 4-lb bombs AN-M50A3.
Incendiary	AN-M76	500	PT-1	BuOrd 420019	14.18	57.0	
Incendiary cluster	M35	750	PT-1	D14-23-3324	21.0	69.5	A cluster of 57 10-lb bombs. Dimensions given for cluster as shipped.
Incendiary cluster	M36	750	Thermate	D14-23-3226	21.0	69.5	A cluster of 189 4-lb bombs M126. Dimensions given for cluster as shipped.
Fire	77 0	750	Incendiary oil and M1 or M2 thickener	BuOrd 434200	18.6	138.0	
Fire	78 0,1,2	750	Incendiary oil and M1 or M2 thickener	BuOrd 434211	25.355	89.125	
Fire	79 0	1000	Incendiary oil and thickener	BuOrd 1380555	19.52	168.30	Formerly designated Ex. 14

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SPRAY TANKS

Two aircraft spray tanks, used during World War II, are available as smoke screen tanks. They are Smoke Screen Tank Mk 5 Mods and Airplane Smoke Tank M10. For modern aircraft, Aircraft Spray Tanks Aero 14A, 14B, and 14C can be used to generate smoke. For description of this spray tank, see chapter 5.

Smoke Screen Tank Mk 5 Mods is a monel metal tank 67 inches long and 19 inches in diameter. The tank has a capacity of 50 gallons of liquid smoke. When filled with FS, the tank weighs about 947 pounds. It ejects smoke for a period of about 25 to 80 seconds.

Airplane Smoke Tank M10 is a streamlined gravity discharge tank having a net capacity of 30 gallons. Empty, it weighs 68 pounds. It is 69 inches long and 14 inches in diameter. The tank can be installed under the wings or fuselages of U. S. Army aircraft only; therefore its use by the U. S. Navy is restricted to Army aircraft in use by the Navy. Details of installation and operation are given in TB 3-255A-1, Airplane Smoke Tank M10.

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PROJECTILES

Two 5-inch 38-caliber, white phosphorus, smoke projectiles are not in U. S. Navy stock. Under development are smoke projectiles for 5-inch 54-caliber and 6-inch 47-caliber guns. General data for these projectiles are given in Table H.

The filling for most smoke projectiles is white phosphorus. WP acts primarily as a smoke and secondarily as an incendiary. The filling is contained in a canister, which is ejected from the base of the projectile upon activation of an ejection charge. At the same time, a delay detonator in the canister is activated. The delay train prevents the canister from exploding until it is clear of the projectile. For the complete round of 5-inch 38-caliber smoke projectiles, see OD 5297, Ammunition Assemblies.

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TABLE H

NONTOXIC CHEMICAL PROJECTILES

Projectile size	Mark Mod	Approximate weight, lb	Filling	Dwg. Number	Diameter, max., in.	Length, in.
5 ^W /38	30 Mods	52.5	WP	BuOrd 364899	5.205	20.07
5 ^W /38	44 Mods	52.5	WP	BuOrd 364722	5.205	20.07
5 ^W /54	48 Mods	70.0	WP	BuOrd 563096*	5.205	26.60
6 ^W /47	38 Mods	105.0	WP or SWP	BuOrd 561566*	6.245	27.15
6 ^W /47	41 Mods	105.0	WP or SWP	BuOrd 561407*	6.245	30.65

* Drawing number given is for illuminating projectile, but dimensions are applicable to smoke projectile.

ROCKETS

Two sizes of smoke rocket heads, the 3.5-inch aircraft rocket head and the 4.5-inch barrage rocket head, are now in U. S. Navy stock. A 5.0-inch spin-stabilized smoke rocket head is being developed. Filling for the 3.5-inch rocket head and the 4.5-inch rocket head is either FS or WP. The 5.0-inch head will be filled with either PWP or PWPV. WP, PWP, and PWPV produce an incendiary as well as a smoke screen effect. Basic data for these rocket heads are given below in Table J. For more detailed information, see OP 1664, U. S. Explosive Ordnance, and OP 1415, first revision, Rocket Assemblies.

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TABLE J

NONTOXIC CHEMICAL ROCKET HEADS

<u>Rocket head size</u>	<u>Mark Mod</u>	<u>Approximate weight, lb</u>	<u>Filling</u>	<u>Dwg. Number</u>	<u>Length, in.</u>
3.5-inch	6 Mods	16.71*	FS or WP	BuOrd 422160	19.13
4.5-inch	7 Mods	19.8 *	FS or WP	BuOrd 394435	20.2
4.5-inch	10 Mods	19.5 *	FS or WP	BuOrd 423592	20.1
5.0-inch	14 Mods	19.6 **	PWP or PWPV	BuOrd 467186	13.5

* WP-filled

** PWP-filled

GRENADES

Chemical grenades are used for casualty, harassing, incendiary, screening, signaling, and training purposes. Standard grenades are now made of steel bodies; those made of glass containers are no longer used. Grenades can be thrown by hand or, with the use of a launching device, by rifle. Most hand grenades can be converted to rifle grenades by using a special projection adapter.

Grenades used by the U. S. Navy are listed below in Table K. They comprise grenades filled with either an irritant, smoke, or incendiary agent. For further information on grenades, see OP 1664, FM 23-30, Hand and Rifle Grenades, and TM 3-300, Miscellaneous Chemical Munitions.

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TABLE K
CHEMICAL GRENADES

<u>Grenade type</u>	<u>Designation</u>	<u>Filling</u>	<u>Army Dwg. Number</u>	<u>Weight, ounces</u>	<u>Remarks</u>
Hand, irritant	M6	CN-DM	C13-22-2	17.0	
Hand, tear gas	M7	CN	C13-21-3	17.0	
Hand, smoke	M8 AN-M8	HC	C13-19-31	28.0	Produces dense, white smoke
Hand, incendiary	AN-M14	Thermite	C13-17-2	32.0	
Hand, smoke	M15	WP	C13-19-7	31.0	
Hand, smoke (colored)	M18	Signal smoke mixture	C13-19-36	17.0	Issued in red, green, violet, and yellow colors
Hand, riot	M25A1	CN	C13-25-27	7.0	
Rifle, smoke	M19A1	WP	82-0-109	25.1	
Rifle, smoke (colored)	M22	Signal smoke mixture	82-0-117	20.2	Issued in red, green, violet, and yellow colors
Rifle, smoke, streamer (colored)	M23	Signal smoke mixture	82-0-139	15.0	Issued in red, green, violet, and yellow colors

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SMOKE POTS

Smoke pots are cylindrical metal containers filled with a smoke agent and a starting or igniting mixture, which is ignited by a special match or by an electric squib. Two types of smoke pots are issued, non-floating and floating. Non-floating smoke pots are for use ashore or aboard ship. Floating smoke pots are used in bodies of water, primarily to conceal landing operations on enemy-controlled shores. Travel of smoke upon release is chiefly governed by wind, and special consideration must be given to ship and wind direction whenever smoke pots are used.

Smoke pots available to the U. S. Navy are listed in Table L. For additional information, see OP 1042, Ships Chemical Smoke Munitions, OP 1511, Authorized Rounds of Pyrotechnics, Chemical and Smoke Grenades, Chemical and Smoke Pots, Aircraft Engine Starter Cartridges, and TM 3-300.

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TABLE L

SMOKE POTS

<u>Type</u>	<u>Designation</u>	<u>Filling</u>	<u>Dwg. Number</u>	<u>Weight, lb</u>	<u>Height, in.</u>	<u>Diameter, in.</u>
Pot, smoke	M1	HC	C36-1-1	12.0	9.0	5.4
Pot, smoke	Mk 3 Mod 0	HC	BuOrd 344501	35.0	9.5	8.5
Pot, smoke	M5	HC	C36-1-18	33.0	9.5	8.6
Pot, smoke, floating	M4A2	HC	C36-1-26	38.0	13.0	12.0
Pot, smoke, floating	Mk 5 Mods	SGF2	C36-1-45	38.0	13.75	12.5
Pot, smoke, floating	AN-M7	SGF2	C36-1-50	37.0	13.75	12.5

SMOKE CANDLES

A smoke candle is similar to a smoke pot; both are metal cylindrical containers that generate smoke upon ignition of the smoke mixture. The smoke candle, however, is generally much smaller than smoke pots and has, consequently, a much shorter burning time. Smoke candles are used primarily for training purposes. For details, see TM 3-300.

The only smoke candle used by the U. S. Navy is Candle, Smoke M6. The M6 candle contains SGF2 and has a burning time of from one to two minutes. It weighs 1.8 pounds, has a height of 5.75 inches and a diameter of 2.5 inches. For details, see Army drawing C36-1-40.

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SMOKE SCREEN GENERATORS

Smoke screen generators are deck-mounted, mechanical and pressure controlled devices, designed primarily for the generation of smoke screens from surface vessels. Discharge rate of smoke can be manually controlled by nozzles and valves. In most cases, the agent used in smoke screen generators is FM or FS. It is contained in one or more tanks to which exhaust pipes and nozzles are attached for operation.

The smoke screen generator used by the U. S. Navy is Smoke Screen Generator Mk 6 Mods. It has a single tank (Tank Mark 2), an exhaust pipe, and four different nozzles for use. The smallest nozzle gives the longest time of flow, about 25 minutes, and the largest nozzle gives the shortest time of flow, about three minutes.

Smoke Screen Generator Mk 6 is designed especially for use on P. T. boats. It is 58 inches long, 17.5 inches high, and 18 inches wide, occupying about 7 square feet of deck space. Filled with FM, it weighs approximately 545 pounds. For more information, see OP 1042.

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APPENDIX A

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