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★EMPLOYMENT OF CHEMICAL AGENTS

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DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE

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Reid D. Kelly

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No. 3–10

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DEPARTMENTS OF THE ARMY,
THE NAVY, AND THE AIR FORCE
WASHINGTON, D.C., *31 March 1966*

EMPLOYMENT OF CHEMICAL AGENTS

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★CHAPTER 1
INTRODUCTION TO CHEMICAL OPERATIONS

1. PURPOSE

a. This manual provides doctrinal guidance for the employment of anti-personnel chemical agents. With its classified supplement, FM 3–10B, it provides data and guidance for planning the employment of chemical munitions with available weapon systems.

Note. Whenever reference is made to FM 3–10B, the joint-service numbers are also implied.

b. This publication is the subject of STANAG 2133, Subject: Vulnerability assessment of chemical and biological hazards.

2. Scope

a. Chapter 1 provides general policy guidance on the employment of chemical munitions in military operations.

b. Chapters 2 through 8 contain data pertaining to the capabilities and effects of chemical munitions that are available to the field commander. Target effects data and guidance for use in target analysis and in casualty estimation are provided. Classified data pertaining to antipersonnel chemical agents and munitions for use in tactical operations are contained in FM 3–10B.

c. The material presented in this manual is applicable without modification to both nuclear and nonnuclear warfare.

d. Definitions of commonly used terms not defined in the military dictionaries (app I) are contained in the glossary.

3. Army, Navy, Air Force and Marine Corps User Comments

Users of this manual are encouraged to submit recommended changes and comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. *Marine Corps* user comments should be forwarded to Commanding General, U.S. Marine Corps Development and Education Command, Quantico, Virginia 22134; *Navy* user comments to Commander, U.S. Naval Weapon Center, Code 4071, China Lake, California 93557; *Air Force* user comments to TAC/DPLSP, Langley AFB, Virginia 23365; and *Army* user comments to Commanding Officer, U.S. Army Combat Developments Command CBR Agency, ATTN: CSGCB-DP, Fort McClellan, Alabama 36201. Army originators of proposed changes which would constitute a significant modification of approved Army doctrine may send an information copy, through command channels, to the Commanding General, U.S. Army Combat Developments Command, Fort Belvoir, Virginia 22060.

4. Chemical Operations

The term "chemical operations" is defined in the Dictionary of United States Military Terms for Joint Usage (JCS Pub 1). As used in this manual, however, it is limited to the employment of chemical agents to influence combat operations by producing casualties (death or incapacitation) or the threat of casualties among enemy troops.

5. General Policy for the Employment of Chemical Agents

The decision to employ lethal or incapacitating chemical agents is a matter of national policy. When the decision is made, United States Army, Navy, Air Force, and Marine Corps commanders will receive through command channels the authority to use such agents and specific guidance for their use.

CHAPTER 2
CHEMICAL AGENTS

★6. General

The following antipersonnel chemical agents are employed in chemical operations: nerve agents GB and VX; blister agent HD; incapacitating agent BZ; and riot control agents CS and CN. Characteristics and effects of these lethal and incapacitating agents are described in the following paragraphs and are tabulated in appendix II.

7. Nerve Agent GB

This agent acts on the nerve systems of man; interferes with breathing; and causes convulsions, paralysis, and death.

a. Inhalation Effects. Inhaled GB vapor can produce casualties within minutes. For troops engaged in mild activity, the median lethal dosage (LCt_{50}) by inhalation is about 70 mg-min/m³. As an example, 50 percent of a group of unprotected troops breathing at the rate of about 15 liters per minute and exposed to 70 milligrams of GB per cubic meter of air for 1 minute will probably die if they do not receive medical treatment in time. For troops engaged in activities that increase their breathing rate (para 20), the median lethal dosage can be as low as 20 mg-min/m³. The median incapacitating dosage of GB vapor by inhalation is about 35 mg-min/m³ for troops engaged in mild activity. Incapacitating effects consist of nausea, vomiting, diarrhea, and difficulty with vision, followed by muscular twitching, convulsions, and partial paralysis. Dosages of GB less than the median incpacitating dosage cause general lowering of efficiency, slower reactions, mental confusion, irritability, severe headache, lack of coordination, and dimness of vision due to pinpointing of the eye pupils.

b. Percutaneous Effects. GB vapor absorbed through the skin can produce incapacitating effects. Sufficient GB liquid absorbed through the skin can produce incapacitation or death. The effectiveness of the liquid or vapor depends on the amount absorbed by the body. Absorption varies with the original amount of agent contamination, the skin area exposed and the exposure time, the amount and kind of clothing worn, and the rapidity in removing the contamination and/or contaminated clothing and in decontaminating affected areas of the skin.

8. Nerve Agent VX

This agent acts on the nerve systems of man; interferes with breathing; and causes convulsions, paralysis, and death. VX will circumvent the protection afforded by the mask. This agent enters the body primarily by absorption of liquid droplets through the skin, causing delayed casualties. See FM 3–10B or additional information on agent VX and VX munitions.

9. Blister Agent HD

This agent produces casualties by its action on the eyes, skin, and respiratory tract, HD is employed principally to circumvent the protection afforded by the mask. It is used primarily in temperate and hot climates.

a. Vapor Effects.

(1) *In eyes or on skin.* The initial disabling effect of HD vapor on unmasked troops will be injuries to the eyes. Temporary blindness can be caused by vapor dosages as low as 100 mg-min/m³, which are insufficient to produce respiratory damage or skin burns. However, skin burns account for most injuries to masked troops. The vapor dosages and the time required to produce casualties vary with the

atmospheric conditions of temperature and humidity and with the amount of moisture on the skin. Depending on their severity, skin burns can limit or entirely prevent movement of the limbs or of the entire body.

(2) *By inhalation.* Inhaled HD vapor produces delayed casualties, with the first symptoms usually occurring about 6 hours after exposure. For troops engaged in mild activity, the median lethal dosage of the agent by inhalation is 1,500 mg-min/m³, and the median incapacitating dosage is 200 mg-min/m³. It is not practicable to produce lethal dosages of HD in the field. Its usually characteristic odor (garliclike) serves as a warning to troops and may allow them to avoid inhalation of sufficient amount to cause incapacitation. Disabling effects include irritation and inflammation of the respiratory tract, with secondary ulceration and infection. With a dosage higher than 200 mg-min/m³, the time interval between exposure to HD vapor and occurrence of the first symptoms is less than 6 hours. Small, repeated dosages are likely to be cumulative in effect if received in less than 12 hours.

b. Liquid Effects. Droplets of HD liquid can disable troops by causing blisters on the skin. Deaths among exposed troops occur mainly through secondary infection.

10. Incapacitating Agent BZ

This agent temporarily incapacitates personnel. BZ is used in surprise attack against unprotected troops. It functions as a slow-acting incapacitating aerosol having a nonpersistent effect. BZ enters the body by inhalation of the aerosol and interferes with mental processes that control bodily functions. Normally, complete recovery occurs. See FM 3–10B for additional information on agent BZ and BZ munitions.

★11. Riot Control Agents

These agents produce temporary irritating or disabling physiological effects when in contact with the eyes or when inhaled. Riot control agents used in field concentrations do not permanently injure personnel. When they are used in inclosed places, prolonged exposure to the resulting high dosages can disable personnel for several hours and result in serious physiological reactions. The following riot control agents are employed as aerosols against hostile troops or rioting personnel:

a. CS. This agent instantly irritates the eyes, nose, and throat. CS is the most effective of the riot control agents, even in extremely low concentrations. Its effects on the eyes and respiratory system continue for 5 to 10 minutes after exposure to fresh air. During that time most personnel are incapable of effective action. CS that is inhaled before masking or that is trapped in the mask while it is being put on gives the impression that the mask is leaking. This impression, coupled with such effects as chest tightness, nausea, and a burning sensation of the eyes, may cause poorly trained troops to remove their masks, thereby exposing themselves to additional concentrations of CS or of any other agent used in conjunction with CS.

b. CN. This agent quickly irritates the upper respiratory passages and eyes, causing an intense flow of tears from unmasked personnel within seconds of exposure. As a secondary effect, in high concentrations CN is irritating to the skin and can cause a burning, itching sensation, especially on moist parts of the body. Some individuals experience nausea following exposure. CN is dispersed as a thermally or explosively generated aerosol or as a solution in chloroform (CNC).

CHAPTER 3

FACTORS THAT INFLUENCE THE EFFECTS OF CHEMICAL AGENTS

12. General

The factors that influence the behavior and tactical effectiveness of chemical agents are the method and speed of dissemination, the weather, the terrain in the target area, the protection available to target troops, and the defensive posture and training of target troops.

13. Methods of Dissemination

Chemical agents are disseminated by the methods described below; bursting-type munitions and spray devices are the primary methods.

a. Bursting-Type Munitions. When a chemical-filled projectile or bomb bursts on the surface of the ground, the liquid filling is initially dispersed in all directions. Part of the agent is driven into the crater formed by the burst, part is dispersed as coarse liquid particles, and part is airborne in the form of aerosol and vapor. The dimensions of the aerosol and vapor cloud are influenced by the type and amount of agent filling, the size of the burster, the point of burst of the munition, and the weather and terrain. As it travels downwind, the cloud loses its effectiveness because of dilution by the air and diffusion by terrain features. Liquid particles of the agent carried downwind may impact on the surfaces they meet. The larger, heavier particles settle out more rapidly than the small, light particles.

(1) Ground-burst fusing is normally used in munitions containing GB, which vaporises readily, and in HD munitions since a high contamination density level is desired.

(2) Air-burst fusing is used in most VX munitions to provide maximum area coverage at the desired contamination densities.

b. Spray Devices. Spray resulting from aircraft-disseminated chemical agents covers a large area downwind from the line of release. The effects of the liquid contamination and of the vapor and aerosol are similar to those produced by air-bursting munitions. The distribution of the aerosol particles varies with the physical properties of the agent, aircraft speed, release altitude of the agent, and design of spray device and nozzle used. The area coverage achieved from spray tank employment is influenced by the release altitude of the agent and by the wind speed and direction. Over dense foliage, only a small part of the spray released will deposit on the ground.

c. Thermal-Type Munitions. These munitions employ heat to disseminate chemical agents.

(1) The generator utilises combustion gases to force the agent through outlet nozzles into the atmosphere as small particles. Winds distribute the agent in the target area.

(2) The grenade vaporizes a chemical agent in a burning mixture. The agent vapor usually condenses to an aerosol on contact with the air.

d. Dispersers. Dispersers (para 44) employ compressed air to disseminate bulk micropulverised chemical agents, especially riot control agents. Agents released from aircraft dispersers react in a manner similar to those released from spray tanks.

14. Weather Data

Since weather is a highly significant factor in determining the tactical effectiveness, the weather forecast is especially important in planning a

chemical attack. Sources of meteorological data are described below. Refer to paragraph 34 for contingency planning and to appendix III for a sample operational CBR weather forecast.

a. Air Weather Service. The U. S. Air Force Air Weather Service (AWS) forecasts meteorological conditions for use by ground and air forces in a theater of operations. Under current weather forecasting capabilities, weather conditions existing at targets in enemy-held terrain at the time of attack are predicted from observations made some time before the attack and at some distance from the target. Therefore, the accuracy of the weather forecast will vary with the prediction time and the distance of the weather observer from the target area. Meteorological forecasts for specific target areas will be provided by the AWS upon request.

b. Artillery Meteorological Units. These units furnish current weather data. They do not forecast meteorological conditions but make periodic observations at or near the firing sites.

c. Fleet Weather Service. The U. S. Naval Fleet Weather Central provides current large-area meteorological data to fleet units via radio teletype. Fleet weather facilities are subunits of the Fleet Weather Central stations and provide more local data for users. Each task force has a meteorological task unit, which is usually located aboard the flag ship. The task unit meteorologists receive data from their Fleet Weather Central, their Fleet Weather facility, and their own instrumentation. These data are then used to prepare forecasts as needed for all task force operations, including attacks of enemy targets.

d. Additional Sources of Weather Data. Additional meteorological characteristics of the area of operations can be obtained from the following sources:

(1) Statistical studies of weather and terrain in the theater of operations.
(2) Aerial reconnaissance and observations.
(3) Ground reconnaissance and observations.

15. Temperature

The rate of evaporation of liquid chemical agents increases as the temperature rises. High temperatures increase the effectiveness of GB and HD. Troops perspire more freely at high temperatures, thus increasing the skin effects of HD. The multilayer clothing worn for warmth at low temperatures serves as a barrier to protect the skin.

16. Temperature Gradient

The temperature gradient is an expression of the difference in air temperature at two levels. For purposes of chemical operations, it is determined by subtracting the air temperature measured about one-half meter above ground from the air temperature about 4 meters above ground. Vertical variations in temperature affect air stability, which in turn affects the formation of vertical air currents. The more stable the air layer in the target area, the more effective a chemical attack will be. Under unstable conditions, turbulence is great and many vertical air currents form, causing chemical clouds to disperse quickly. For calculation of chemical ammunition requirements, temperature gradient forecasts are desirable in terms of inversion, lapse, and neutral conditions, which are explained below. Temperature gradients can be estimated in the event meteorological data are not available.

a. Inversion Temperature Gradient. An increase in air temperature with an increase in height is known as an inversion (stable) condition. This condition usually exists on a clear or partially clear night when the middle and low clouds cover less than 30 percent of the sky and on early mornings until about 1 hour after sunrise, when the wind speed is less than 5 knots. It is characterized by a minimum of convection currents and by maximum air stability—ideal conditions for the employment of chemical agents. Over large bodies of water, weak inversion conditions tend to prevail during the day.

b. Lapse Temperature Gradient. A decrease in air temperature with an increase in height is known as a lapse (unstable) condition. This condition normally exists on a clear or partially clear day when the middle and low clouds cover less than 30 percent of the sky and when the wind speed is less than 5 knots. It is characterized by turbulence and

thermal air currents and is the least favorable condition for the employment of chemical agents. Over large bodies of water, weak lapse conditions tend to prevail at night.

c. Neutral Temperature Gradient. A condition intermediate between lapse and inversion is known as a neutral condition. It usually exists on heavily overcast days or nights at 1 or 2 hours before sunset or 1 or 2 hours after sunrise when the middle and low clouds cover more than 30 percent of the sky. Independent of cloud cover and time of day, a neutral condition may also exist when the wind speed is greater than 5 knots. Additionally, periods of precipitation are normally accompanied by a neutral condition.

17. Wind

Air moving over an irregular surface sets up eddies, or mechanical turbulence, that act to dissipate a chemical cloud.

a. Speed. High winds increase the rate of evaporation of liquid chemical agents and dissipate chemical clouds more rapidly than low winds. The effects of wind speed on persistent chemical attacks are variable. Large-area nonpersistent chemical attacks are most effective in winds not exceeding 15 knots. Small-area nonpersistent chemical attacks with rockets or shell are most effective in winds not exceeding 5 knots. However, if the concentration of chemical agent can be established quickly, the effects of high wind speed can be partially offset. High wind speed, in general, increases the effectiveness of nonpersistent surprise attack with massive chemical bombs.

b. Direction. Wind controls the travel of chemical clouds. Casualties resulting from downwind cloud travel are generally considered as bonus effects for most weapon systems. The wind direction is given as the direction from which the wind blows.

18. Humidity and Precipitation

High humidity and precipitation alter the effects of chemical agents differently. For example, high humidity increases the effectiveness of HD but does not influence the effectiveness of GB. Heavy or lasting rains wash away liquid chemical agent contamination. Some agents may then collect in low areas and stream beds and present a lingering hazard. Light rainfall occurring hours after VX contamination can cause recurrence of a contact hazard. Snow cover reduces the evaporation rate of liquid chemical agent contamination, thereby lowering the vapor concentration above the contaminated area. A moderate or heavy fall or snow over a layer of previously deposited chemical agent may allow comparatively safe movement across the area until the layers are churned up or melt. However, a chemical agent deposited on the snow presents an immediate contact hazard.

19. Terrain

An understanding of the effects of terrain on agent behavior can often be used to tactical advantage, just as terrain features are exploited in tactical maneuver of troops (fig. 1). Information about the terrain in the target area can be obtained from a study of the intelligence estimate and a map of the area. This is important in planning the employment of chemical munitions and in determining downwind hazard areas.

a. Contour. Under stable conditions chemical agent clouds tend to flow over rolling terrain and down valleys. Dangerous concentrations persist in hollows, low ground, depressions, and foxholes. Chemical clouds tend to go around such obstacles as hills. Rough ground, including that covered with tall grass or brush, retards the chemical cloud movement; flat country (unless it is covered with tall grass or brush) allows an even, steady movement.

b. Trees and Vegetation. Vegetated areas can be more effectively contaminated with HD and VX liquid than can barren terrain. Because of low wind speeds and limited sunlight in heavily wooded and jungle areas, more effective and enduring vapor concentrations can be established in such areas than can be established on open terrain. Wooded and jungle areas require larger munitions expenditures because some rounds detonate on

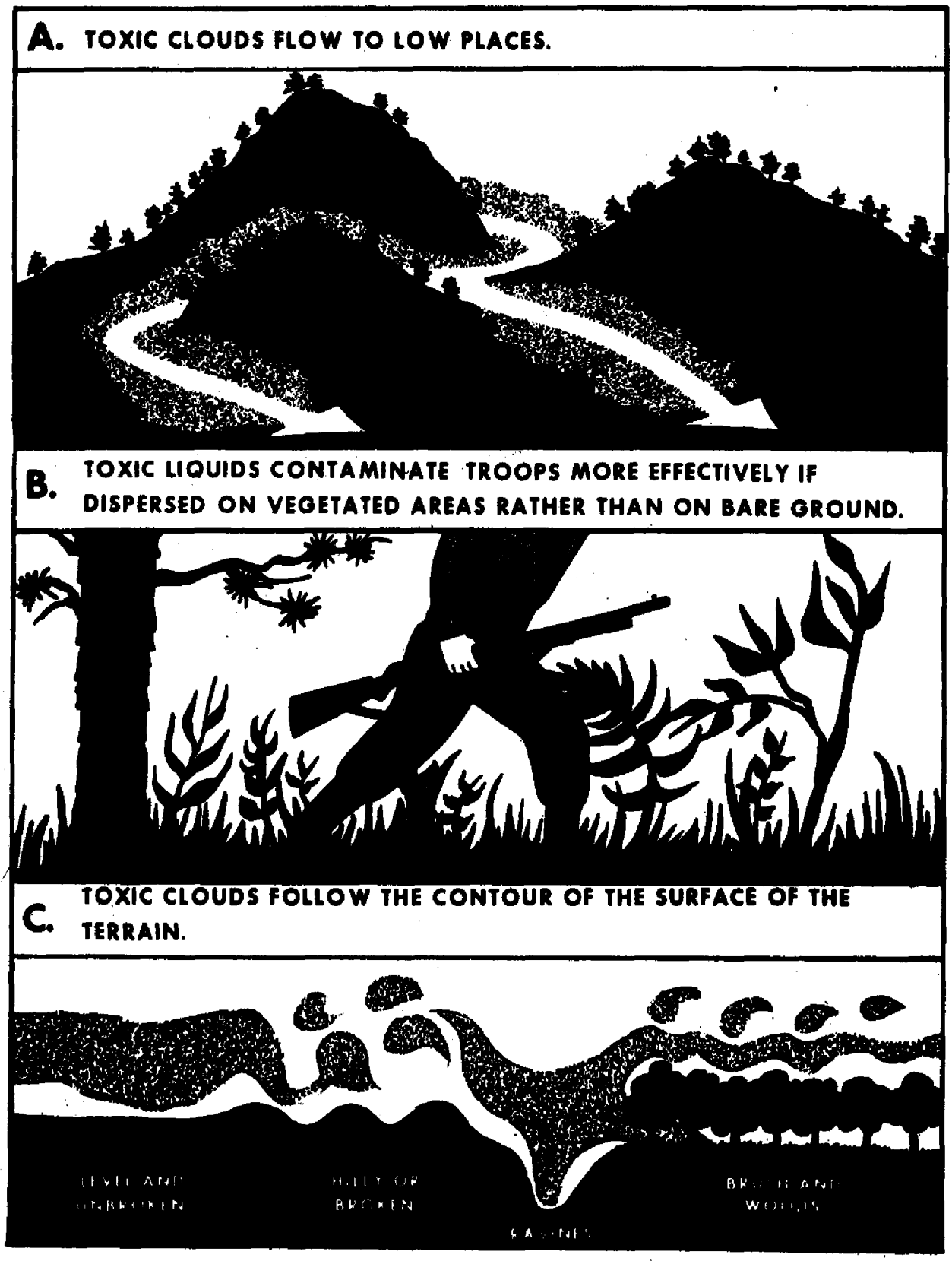


Figure 1. Effects of terrain on chemical agents.

treetops, with consequent loss of the chemical agent at ground level. See FM 3–10B for data on effects of terrain on agent VX.

c. Soil. The type and condition of the soil affect chemical shell penetration, cratering, and the extent of liquid contamination. Point-detonating chemical ammunition tends to bury into soft ground or snow before bursting. Part of the chemical agent filling remains in the crater; and thus the rate of vapor production may be decreased, with a consequent decrease in the vapor cloud. Liquid chemical agent quickly soaks into porous surfaces, from which it evaporates more slowly than from nonporous surfaces.

20. Rate of Breathing

The rate of breathing is an important factor in casualty production from inhalation of chemical agent vapor or aerosol. Because of their rapid breathing, active or excited troops inhale more agent vapor or aerosol than resting troops in a given time period and may not be able to hold their breath during the time required for masking. The amount of agent that the body must absorb (dose) to be casualty-producing remains constant, regardless of the rate of intake. The ammunition expenditure tables in appendix XIII are based on breathing rates accompanying mild activity (15 liters per minute).

21. Reaction and Masking Time

The reaction and masking time is another important factor in casualty production.

a. Reaction Time. Delayed reaction to a chemical attack increases the vulnerability of troops. The response to a chemical attack or alarm is determined by the degree of training, cover available, state of fatigue, time of day or night, and morale of the troops under attack. For example, troops who are greatly fatigued or who are under great mental stress, such as that immediately following a nuclear attack, take additional time to react to a chemical attack.

b. Masking Time. The time that it takes the individual soldier to mask is influenced by a number of factors including the state of his training, the state of fatigue, the activity engaged in, as well as his posture and the uniform worn. For example, troops in hasty foxholes or crawling along the ground under fire take longer to mask than they would if standing in the upright position. Fatigued troops and those wearing bulky cold-weather clothing take longer to mask than fresh, unencumbered troops. Under average field conditions in a temperate climate, troops who are standing up and who are well trained and equipped for defense against chemical attack can mask in about 9 seconds after being alerted.

CHAPTER 4
TYPES OF CHEMICAL MUNITIONS

22. General

Chemical munitions can be delivered on target by ground, air, and naval weapon systems. For purposes of this manual, chemical munitions are grouped in the following general categories: point-source, multiple-point source, and line-source. Refer to FM 3–10B for operational data and munitions expenditure tables for classified weapon systems of the U.S. Army, Navy, Air Force, and Marine Corps.

23. Munitions Capabilities

Chemical munitions and weapon delivery systems are tabulated in table I for ready reference by the target analyst. Refer to FM 6–141–1 for additional data on artillery delivery systems. The average unit capabilities in columns e, f, and g of table I have been calculated from munitions expenditure tables for selected meteorological conditions. These values may be used for planning purposes. The firing times for cannon artillery in column f have been selected to provide a basis for comparison. Other firing times may be used as required and as explained in paragraph 58. When meteorological conditions are known or predictable, refer to the applicable ammunition expenditure table and use the specific meteorological conditions for determining more accurate area coverage data.

24. Point-Source Chemical Munitions

A point-source munition disseminates the agent from a single point; for example, from a massive chemical bomb delivered by aircraft. The peak dosage of the aerosol cloud occurs directly downwind from the release point of the agent and gradually diminishes in strength as it travels downwind.

a. Bombs. Several GB-filled massive bombs are available for use with high-performance aircraft. Classified operational data on air-delivered chemical bombs and weapon systems are contained in FM 3–10B.

b. Land Mines. Chemical land mines include the M23 mine, prefilled with VX, and the 1-gallon mine, filled with HD in the field.

(1) The M23 chemical land mine uses a standard pressure fuze, but it can be fuzed for firing by pressure-release, pull-friction, or pull-release. See FM 3–10B for operational data.

★(2) The 1-gallon land mine is a 1-gallon can with attachments for burster charges. For contamination of large areas, the recommended ratio is about 100 mines per hectare.

★25. Multiple-Point-Source Chemical Munitions

A multiple-point-source weapon system is characterized by a number of point-source munitions that are distributed randomly over a target area. Each point-source munition disseminates the agent as an aerosol or a vapor that merges with other aerosols and vapors downwind. See table I for listing and descriptions of munitions available; see FM 3–10B for operational data.

a. Cannon- and Mortar-Delivered Chemical Munitions. These munitions consist of projectiles filled with a chemical agent and fitted with fuze and burster. See table I for listing and descriptions of munitions available. Tables for determining cannon and mortar expenditures are grouped in appendix XIII, and instructions for their use will be found in paragraphs 58 through 60.

b. Rocket-Delivered Chemical Munitions. These munitions consist of warheads filled either with a chemical agent or with chemical bomblets and attached to rockets. All types are suitable for large-area coverage and have the disadvantage of revealing their emplacement by flash and dust.

(1) Small-caliber chemical rockets are large-volume, rapid rate-of-fire munitions used for close support. Time to reload the rocket launchers is required between firings.

(2) Large caliber chemical rockets are used for attack of deep targets and function by air release of many impact-detonating bomblets that disperse over large areas.

26. Line-Source Chemical Munitions

Line-source munitions are delivered by aircraft and disseminate chemical agents along a line of release, either from a spray tank or from bomblets impacting on the ground in a line. See FM 3–10B for operational data.

a. Elevated-Line-Source Chemical Munitions. These weapon systems consist of spray tanks mounted on aircraft. A typical chemical spray tank consists of the following components:

(1) An agent reservoir section.

(2) A discharge nozzle assembly that can be mechanically adjusted to vary the agent flow rate.

(3) A pressurization system that insures controlled delivery of the agent to the nozzle.

★*b. Ground-Line Source Chemical Munitions.* These weapon systems, categorized as Clustered Bomb Units (CB21s), consist of dispensers mounted on aircraft. The dispenser ejects, at controlled rates, bomblets in a line that burst on impact with the ground.

★*Table I. Chemical Munitions and Delivery Systems*

Delivery system	Agent: Type	Agent: Avg wt (lb)	Munition	Using service	Employment data: a Maximum range (meters)	b Fuze	c Weapons	d Average rate of fire per weapon [1]	Average unit (column C) capabilities [1]: e Area coverage (hectares) [2, 4, 5]	f Firing time [6]	g Effects [7]	Reference (para)
4.2-inch mortar	HD	6.0	Cartridge, M2A1	ARMY	4,500	PD	4/Sec (6/Btry USMC)	50 rds/3 min	5.0	15 min	Casualty-producing vapor (skin)	59
				USMC				105 rds/15 min	4.5	15 min	Contamination of troops or terrain.	
105-mm howitzer	GB	1.8	Cartridge, M360	ARMY	11,100	PD	6/Btry	3 rds/15 sec 30 rds/3 min	0.5	TOT	Casualty-producing dosage.	58
	HD	3.1	Cartridge, M60	USMC	14,800 [3]			66 rds/15 min	2.5 2.5	15 min 15 min	Casualty-producing vapor (skin). Contamination of troops or terrain.	59
155-mm howitzer	GB	6.5	Projectile, M121	ARMY	14,600	PD	6/Btry	1 rd/15 sec 12 rds/3 min 24 rds/15 min	1.0	TOT	Casualty-producing dosage.	58
	HD	9.7	Projectile, M110	USMC	16,000 [3]				2.5 3.5	15 min 15 min	Casualty-producing vapor (skin). Contamination of troops or terrain.	59
	VX	6.5	Projectile, M121			VT			.....		Contamination of troops or terrain.	See FM 3-10B
8-inch howitzer	GB	15.8	Projectile, M426	ARMY	16,800	PD	4/Btry (6/Btry USMC)	1 rd/15 sec 4 rds/3 min 10 rds/15 min	2.0	TOT	Casualty-producing dosage.	58
	VX	14.1		USMC		VT			.....		Contamination of troops or terrain.	See FM 3-10B
115-mm rocket launcher.	GB	11.0	Rocket, M55 (THE BOLT)	ARMY	10,600	PD	2/Dir Spt Bn.	45 rkt/lchr/15 sec.	.....	15 sec	Casualty-producing dosage.	See FM 3-10B
	VX	10.0									Contamination of troops or terrain.	
762-mm rocket, HONEST JOHN	GB	478.0	Warhead, M190 (M139 bomblets)	ARMY	38,000	MT	4/Bn	2 rkt/hr	.....	NA	Casualty-producing dosage.	See FM 3-10B
Chemical landmine	VX	11.5	M23 mine	ARMY	NA	Variety	NA	NA	.....	NA	Contamination of troops or terrain.	57
	HD	9.9	1-gallon mine									See FM 3-10B
Fighter, bomber, aircraft.	GB	.....	Spray tank, Aero-14B.	USMC		NA		NA	.....		Casualty-producing dosage.	
	VX	.....	TM U-28B.								Contamination of troops or terrain.	
	GB	152.0	Dispenser, CBU-15/A (bomblets in line).	USAF		Impact					Casualty-producing dosage.	
	BZ	68.0	Dispenser, [SUU-13/A] (CBU-16A/A) (bomblets in line).								Incapacitation-producing dosage.	
	GB	.....	Bomb, MK 116, Mod 0.	USMC NAVY		Impact					Casualty-producing dosage.	
	GB	.....	Bomb, MC-1, 750-lb.	USAF	Varies with munitions and loading configuration.	Impact	See FM 3-10B for employment data.	Bomb load varies with type aircraft.	.....		Casualty-producing dosage.	See FM 3-10B
	GB	.....	Bomb, MK 94, 500-lb.	USMC NAVY		Impact					Casualty-producing dosage.	

★*Table I. Chemical Munitions and Delivery Systems*—Continued

[1] See paragraph 23 for explanation.
[2] Rate of fire varies with training and experience of gun crews, weather conditions, and number of changes in elevation and deflection required during the fire mission.
[3] One hectare equals 10,000 square meters.
[4] Selected meteorological conditions for GB: Neutral temperature gradient, air temperature above 60° F, and windspeed about 8 knots.
[5] Selected meteorological conditions for HD: Neutral temperature gradient, air temperature above 70° F, windspeed about 8 knots, and dry weather.
[6] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 58b.
[7] A casualty-producing dosage consists of lethal dosages and incapacitating dosages (para 7). For maximum effectiveness in a GB surprise dosage attack, the maximum number of artillery should be used in the minimum period of time to obtain time-on-target (TOT) effects (para 58b).
[8] Extended range capability.
Note. The following abbreviations are used in "Fuze" column: PD—point detonating; VT—variable time; MT—mechanical time; NA—not applicable.

CHAPTER 5

CHEMICAL MUNITIONS EMPLOYMENT CONCEPTS

Section I. INTRODUCTION

27. General

Chemical munitions may be employed separately or integrated with other munitions in military operations. They are employed to cause casualties among enemy troops, to reduce enemy effectiveness through harassment, or to restrict use of terrain or materiel. Factors in the employment of chemical munitions that require staff consideration are: the available systems to deliver the agent; munitions requirements; enemy forces training in defense against chemical attack and the availability to them of protective clothing and equipment; and friendly troop and civilian safety. In addition to the casualty effects from chemical agents, explosive-type chemical munitions produce some casualties from the effects of the munition fragments.

28. Chemical Munitions Used in Military Operations

Factors that should be considered in the conduct of chemical operations are—

a. Penetration of Structures. Chemical agent clouds penetrate fortifications and similar structures that are not airtight or that do not possess effective filter systems. This capability of chemical agent GB produces a means for attacking troops in a fortification that presents a difficult target to high-explosive munitions or to low-yield nuclear munitions. Refer to appendix XIII for ammunition requirements to attack field fortifications with GB.

b. Dug-in Troops. GB chemical munitions are effective in producing casualties among dug-in troops who either are not provided with protection or are not wearing masks at the time of the attack. Refer to paragraph 58 for guidance in surprise dosage attack.

c. Area Coverage Capability. Under certain conditions chemical munitions can cover large areas. When used in mass they are particularly effective in attacking targets whose precise location is not known.

d. Gradation of Effects. Chemical agents may be employed to produce a variety of effects ranging from harassment through incapacitation to death.

e. Nondestruction of Materiel and Structures. Antipersonnel chemical agents do not destroy materiel. They allow the physical preservation of industrial complexes, cultural institutions, lines of communication, and other facilities and materiel that may be useful to friendly forces or that merit preservation for political or economic reasons.

f. No Physical Obstacles to Maneuver. Chemical munitions do not produce physical obstacles to maneuver, since they cause minimal destruction, blowdown, and rubble. Chemical agents that contaminate terrain, however, may create a hazard to troop maneuver.

g. Exploitation. Chemical munitions may be used to follow up and exploit advantages gained by other means.

h. Hazards to Friendly Troops. Chemical munitions may decrease the maneuverability of friendly troop units because of residual contamination and downwind toxic cloud travel.

29. Major Considerations in the Employment of Nerve Agent GB

This agent is employed primarily as a nonpersistent vapor to cause casualties upon inhalation or to harass enemy troops. The onset of incapacitation from the inhalation of casualty-producing dosages of GB is rapid. After the chemical attack, 5 to 10 minutes may be required for the agent cloud to produce casualties.

a. Employment to Cause Casualties. To achieve maximum casualties among troops equipped with masks but unmasked at the time of attack, a GB fire mission should be completed within 15 seconds if possible. The fire mission is called *surprise dosage attack* if completed within 15 seconds so as to establish a dosage sufficient to produce the desired casualties before troops can mask. A *total dosage attack* is used to build up the dosage over an extended period of time and is normally employed against troops who have no protective masks available. GB munition expenditures for positive neutralization of masked troops are usually too high to be logistically supportable. Under accurate delivery conditions, massive bombs are an exception.

b. Employment to Harass. Because GB poses a continuing but not a readily discernible threat, it is highly effective when used to harass through exposure to low concentrations of the vapor. Rounds fired sporadically may compel the enemy to wear protective masks and clothing for prolonged periods, thereby impairing his effectiveness as a result of fatigue, heat stress, discomfort, and decrease in perception.

30. Major Considerations in the Employment of Nerve Agent VX

This agent is employed primarily as a liquid contaminant to cause casualties by the penetration of liquid droplets through the skin. Liquid VX on the skin produces delayed casualties. Liquid droplets of VX on terrain and equipment produce a casualty threat. Strong winds extend the pattern of the droplets downwind. VX remains effective in the target area for several hours, with the duration of contamination dependent on terrain and weather conditions. Periodic replenishment is required to maintain the contamination. Although VX can be employed close to friendly forces, it should be employed with caution on positions that friendly troops will soon traverse or occupy. Areas contaminated by this agent should be recorded so that friendly troops can take necessary precautions.

a. Employment to Cause Casualties. VX is employed primarily for direct attack of targets containing masked troops in the open or in foxholes without overhead protection.

b. Employment to Harass. Because of its low volatility, VX can be employed to harass enemy forces by means of the continuing casualty threat posed by liquid droplets on the ground or on equipment.

c. Employment to Hamper or Restrict Use of Terrain. Contamination with VX hampers or restricts the use of terrain by enemy forces. Contaminated terrain presents the following four courses of action to the enemy:

(1) Avoid the contaminated area.
(2) Use personnel carriers, tanks, or other vehicles to transport troops.
(3) Decontaminate prior to traversal or occupancy.
(4) Accept the risk of casualties commensurate with the protective measures taken.

31. Major Considerations in the Employment of Blister Agent HD

This agent is employed as both a liquid and a vapor contaminant. It produces delayed casualties, primarily by disabling troops. HD liquid or vapor burns the skin; HD vapor injures the eyes and produces casualties when inhaled. Liquid droplets of this agent contaminate terrain and materiel. HD remains effective in the target area for several hours to days, depending on weather conditions. Periodic replenishment is required to maintain the contamination. Although HD can be employed close to friendly forces, it should be employed with caution on positions that friendly troops will soon traverse or occupy. HD evaporates to produce a

vapor hazard to troops downwind of the contaminated area. Areas contaminated by this agent should be recorded so that friendly troops can take necessary precautions.

a. Employment to Cause Casualties. HD is employed for direct attack of targets containing masked or unmasked troops when delayed casualties are acceptable.

b. Employment to Harass. Because HD droplets and vapor pose a continuing casualty threat, this agent can be employed to harass enemy forces and to create an obstacle to traversal or occupation of areas.

c. Employment to Hamper or Restrict Use of Terrain. The information contained in paragraph 30*c* also applies to HD.

32. Selection of Chemical Agent for Attack of Targets

The following considerations are important in the selection of a chemical agent for attack of various type targets:

a. Targets Containing Predominantly Dug-In Troops. GB can be employed for immediate casualties in surprise dosage attack against targets containing unmasked dug-in troops with overhead cover. VX or HD should be employed if troops are likely to be masked, if no overhead cover is available, and if delay in producing casualties is acceptable. GB may also be used in combination with HD or VX.

b. Fortified Positions. GB is effective against unmasked troops in field fortifications not protected by filtration equipment. GB munitions impacting near field fortifications project a portion of the toxic cloud into the fortifications. Direct hits are not required.

c. Occupied Large-Area Targets. In an attack on occupied large-area targets, the use of GB and VX in lethal or harassing roles will make it difficult for enemy troops to determine the location and degree of the casualty threat. To achieve maximum harassment, the agents should be so employed that they pose a continuing threat. Continued harassment over large areas can be achieved economically by sporadic firing of appropriate chemical munitions at low rates of expenditure per unit area. GB can be used if a low degree of persistency is desired. VX presents primarily a liquid contact hazard. HD presents both a contact hazard and a vapor hazard and will force masking. The hazard may remain for many hours and complicate military operations in the contaminated areas. Continued harassment or attrition will be an important consideration in the use of VX or HD munitions.

d. Selected Areas to Impede the Traversal or Occupation by Enemy Troops. Although there is no chemical munition that will positively deny traversal or occupation of an area, VX or HD presents a hazard to troops occupying or traversing contaminated terrain. The use of VX munitions to contaminate terrain is more effective than the use of HD munitions, since VX is relatively nonvolatile. HD is an effective terrain contaminant and causes casualties from inhalation of vapor and from contact with the liquid or vapor. Fire should be directed into the area to force troops to come into contact with the contaminated terrain, since it is then most effective.

e. Close Combat. In close combat, the defense has a relative advantage when all troops are forced into protective masks. However, chemical munitions are normally not used in such close combat situations as when an enemy attack has reached friendly positions.

33. Relationship to Other Munitions

a. Nuclear Munitions. Chemical munitions complement nuclear munitions by providing a means for—

(1) Offering the commander a large-area attack capability without the destructive effects of nuclear munitions.

(2) Engaging numerous small, individual targets not militarily worth the use of a nuclear munition.

(3) Exploiting the confusion and lack of mask discipline that may exist in the fringe area of nuclear munitions effects.

(4) Neutralizing troops in protected shelters such as foxholes, bunkers, and tanks that may provide considerable protection against nuclear munitions effects, including fallout.

(5) Neutralizing ill-defined targets or widely dispersed troops.

b. High-Explosive (HE) Munitions. Chemical munitions are complementary to HE munitions. The ratio of casualty-producing effectiveness of HE munitions to chemical munitions will vary, depending on the extent of chemical agent and fragment protection available to the troops under attack. Chemical munitions, as a minimum, will approximate the effectiveness of conventional HE munitions against troops. Chemical munitions are superior to HE munitions in attacks on ill-defined troop locations. Against troops in fortifications, chemical munitions that release the agent as a vapor or an aerosol are more effective than HE munitions.

34. Factors to Consider in Making Final Decision to Employ Chemical Agents

Choice of the chemical agent to be used is influenced by the following: the commander's mission, objective, and plan of operations; weather and terrain; status of enemy protection against chemical agents; availability of the agent/munition; and friendly troop dispositions, both present and future. The following factors should be considered in reaching a decision to employ chemical agents:

a. Availability and capabilities of chemical munitions and delivery systems.

b. Enemy defensive capability against chemical attack.

c. Effects desired (death, incapacitation or harassment).

d. Acceptable time for casualty development.

e. Influence of weather and terrain on chemical agents.

f. Advantages and disadvantages of making the chemical attack during the night or day.

g. Advantages and disadvantages of preserving physical facilities.

h. Presence of civilian population in target area.

Section II. EMPLOYMENT OF LETHAL CHEMICAL MUNITIONS

35. Nonpersistent Chemical Attack

Surprise nonpersistent chemical attacks may be made as the primary fire/strike against targets occupied by enemy troops, or they may be made to increase the effectiveness of other fires/strikes. A nonpersistent chemical attack is most effective when delivered to circumvent the enemy's protection against conventional HE munitions, such as those provided by field fortifications and armor. This type of attack is especially useful against a close-in target when a nuclear attack would create obstacles to friendly troop maneuver or problems concerning friendly troop safety.

a. In Offensive Operations. Nonpersistent chemical attacks are made against occupied targets throughout the depth of the battlefield, including those in the path of the attacking friendly forces. Such an attack is normally integrated into preparatory fires/strikes against known or suspected targets as follows:

(1) *In the attack.* GB can be employed to produce casualties among enemy troops in the area selected for the penetration and to assist the attacking units in the initial breakthrough. When practicable, the nonpersistent chemical fire/strike is so coordinated as to enable friendly troops to attack without encountering the hazard of friendly chemical fire. This will require that the chemical fire/strike precede the attack by sufficient time—about one-half hour—to permit the toxic cloud to dissipate. However, enemy counter-

preparation fires placed on the attacking forces will require friendly troops to mask.

(2) *Prior to the attack.* GB can be used prior to the attack to produce casualties in occupied hard targets or in areas suspected of being occupied by enemy troops.

b. In Defensive Operations. Nonpersistent chemical attacks are made against enemy troops at any time or place that they present a profitable target to produce casualties or to slow down the attack by forcing troops to wear masks. Nonpersistent chemical attacks may be made against enemy troops concentrating for the attack and in the attack, to support the forces along the forward edge of the battle area (FEBA), or to assist the counterattack or striking force. Profitable targets consist of occupied attack positions, command posts, artillery positions, and known or suspected enemy troop concentrations.

c. In Night Attacks. Nonpersistent chemical attacks can be made against known or suspected troop concentrations to produce casualties and to harass troops in extensive areas downwind. Through proper selection of targets and spacing of the chemical fires/strikes throughout the night, enemy troops can be subjected to casualty-producing concentrations or can be kept in masks and under frequent alerts.

36. Persistent Chemical Attack

Persistent chemical attacks are made against occupied targets to cause casualties directly among enemy troops or against unoccupied targets to cause casualties from contact with contaminated terrain after troops enter the area. This type of attack severely reduces combat effectiveness of troops because of the protective measures required against contamination of the body, clothing, and equipment. A persistent chemical attack produces delayed casualties among either masked or unmasked enemy troops.

a. In Offensive Operations. Persistent chemical attacks are made on target areas that friendly forces do not intend to enter immediately. Such attacks are effective against enemy reserves *or against positions to be bypassed.* HD or VX may be used—

(1) To produce delayed casualties among enemy troops.

(2) To contaminate alternate defensive positions in an attempt to fix the enemy in preselected uncontaminated positions for attack with other weapons.

(3) To help protect the flanks of friendly forces.

(4) To neutralize enemy observation posts and artillery positions.

b. In Defensive Operations. Persistent chemical attacks are made to produce casualties and to contaminate terrain that is important to the enemy scheme of maneuver, such as avenues of approach, key terrain features, artillery positions, and assembly areas. HD and VX may be used—

(1) To produce delayed casualties.

(2) To canalize enemy attacks along avenues of approach favorable to the defender and to induce the enemy to move into areas that facilitate counterattack by friendly forces.

(3) To contaminate critical targets that have been damaged by high explosives or nuclear munitions, thereby delaying recovery or repairs.

(4) To assist in covering gaps between friendly units and to protect flanks.

(5) To neutralize enemy observation posts and artillery positions.

37. Chemical Minefields and Barriers

Chemical land mines are designed to restrict effective enemy use of selected terrain, to delay minefield breaching operations, and to inflict casualties among troops crossing the mined area. Toxic chemical mines may be employed to provide a chemical minefield or barrier, or they may be used with high-explosive mines to form a mixed HE-chemical minefield. Either use must contribute to the overall defensive plan.

a. HE-Chemical Minefields. The M23 chemical land mine filled with VX is designed for contact activation and electrical fuzing and may be fitted with a variety of fuzes and antilift devices. Chemical mines are intermixed in the HE minefields in a nonuniform pattern. The ratio of chemical mines to other mines is directly related to the type and scale of enemy movement that the minefield is intended to counteract (that is, low ratio for security, and high ratio for cross-country barriers). The use of HE mines reduces the speed of troops in crossing the area, thereby increasing their exposure time to terrain contaminated by activated chemical mines. Chemical mines slow breaching operations by discouraging the use of explosive rapid mine-clearing devices that would cause chemical contamination in the area.

b. Chemical Minefields. Chemical mines may be used to contaminate key terrain features, obstacles, river crossing sites, and demolished facilities. When so employed, chemical minefields are activated by deliberate, simultaneous detonation of all or selected parts of the minefield. The 1-gallon land mine filled with HD is designed for simultaneous detonation, and the M23 mine filled with VX can be modified for simultaneous detonation. To be of maximum effectiveness, chemical minefields should be detonated when enemy troops are in the mined area or just prior to their entry into it. The authority to detonate them may be delegated to the lowest echelon responsible for defending the mined area. To remain effective over an extended period, the contamination must be periodically replenished by some means, such as artillery fire. See table XV, appendix XIII, for HD replenishment data. See FM 20–32 and FM 3–10B for additional information on employment of mines.

Section III. EMPLOYMENT OF INCAPACITATING CHEMICAL MUNITIONS

38. General

Incapacitating chemical munitions are employed on selected targets to incapacitate enemy forces when the use of lethal or destructive munitions is undesirable. There are critical limitations to the use of BZ munitions. See FM 3–10B for additional information.

39. To Neutralize Hard Targets

Incapacitating chemical attacks are made against hard targets, such as fortifications, to obtain delayed and relatively long-term neutralization of personnel. This will permit delayed exploitation or capture by friendly forces when the stage of battle permits, if the initial attack is made at long range. Such an attack can assist in the rescue of friendly personnel imprisoned in the fortifications.

40. Against Intermingled Military Units

Incapacitating chemical attacks can be made to reduce overall fighting capability of intermingled enemy and friendly military units when the location of these units is not well known. This will permit the identification and delayed selective followup and physical separation of friendly military units intermingled with enemy units without incurring heavy casualties among friendly troops.

41. Against Mixed Populations

Incapacitating chemical attacks can be made to reduce the overall capability of intermingled enemy, captured friendly, and civilian personnel in an area. This will permit delayed selective followup and physical separation of personnel by friendly forces without incurring heavy civilian (or captured) friendly casualties.

42. To Neutralize Selected or Critical Targets

Incapacitating chemical attacks can be made against selected targets to assist in the capture of vital or sensitive enemy installations for the purpose of intelligence or to interfere with enemy use of such installations.

Section IV. EMPLOYMENT OF RIOT CONTROL MUNITIONS

43. General

Riot control munitions are used to disable hostile troops or rioting personnel for limited periods of time and are effective in controlling rebellious prisoners of war. The selection of the riot control agent to use in a particular situation is determined by the physiological effects desired and the dissemination means available. The selection of the most effective dissemination method is based on the size and physical characteristics of the target area. Weather, especially wind direction and speed, influences the effectiveness of chemical agents used in riot control operations.

44. Riot Control Munitions

The following munitions are currently available to disseminate riot control agents:

a. M5 Helicopter- or Vehicle-Mounted Disperser. This munition consists basically of an agent container and tanks of compressed air that resemble a mechanized flamethrower. The disperser forces powdered riot control agent into the atmosphere from a low flying aircraft or moving ground vehicle. This munition can disperse about 50 pounds of micropulverized CS in approximately 2 minutes when used with the M9 gun group. A helicopter flying about 44 knots can disseminate an effective concentration over a frontage varying from 1,500 to 2,500 meters and, in a wind speed of about 15 knots, the effective downwind coverage can be about 500 meters.

b. M3 Portable Disperser. This munition consists of an M9 gun group connected to a modified portable flamethrower. It can disseminate about 8 pounds of agent in 19 seconds with a single burst or in several shorter bursts of 5 or 6 seconds each. In a wind of about 5 knots, this munition can disseminate an effective concentration over an area 15 to 25 meters in width to a downwind distance up to 200 meters.

c. Grenades. There are two types of riot control grenades: a burning-type and a bursting-type. In a wind of about 5 knots, the burning-type grenade can cover an area about 5 meters in width to a downwind distance up to 25 meters. In the same wind speed, the bursting-type grenade can cover an area about 10 meters in width to a downwind distance up to 25 meters.

45. Employment in Friendly Areas

When employed against rioters, riot control munitions should be used in sufficient quantities to produce an immediate, decisive effect. Avenues of escape from the advancing agent cloud must be provided for members of a rioting mob. Except in extreme emergencies, riot control munitions are not used when patients in hospitals or children in schools may be affected. Refer to FM 19–15 for guidance in the employment of military forces during civil disturbances and to appendix II of that manual for riot control munitions requirements.

a. Grenades. Burning-type grenades are thrown by hand or projected by a grenade launcher to the upwind side of a mob. Burning grenades should not be thrown into a mob because they can be picked up by its members and thrown back. Bursting-type grenades are thrown into the air so that the burst occurs several feet over the heads of the mob.

b. Mechanical Dispersers. When a larger amount of agent or a greater area coverage is required than can be obtained by the use of standard grenades, mechanical dispersers should be used. They are so employed that the agent cloud is maintained until the mob leaves the area.

46. Employment in Enemy Areas

There are situations where riot control munitions, particularly those filled with CS, can be effectively employed in combat operations.

a. In Offensive Operations. CS munitions are used in offensive operations where it is desired to disable enemy troops for a limited period of time. These munitions may be used to "flush out" un-

masked enemy troops from concealed or protected positions, to reduce their ability to maneuver or use their weapons, and to facilitate their capture or their neutralization by other weapons.

(1) Employment of CS munitions must be integrated with the unit plan of operations, particularly with the employment of other weapon systems, to insure that the unit achieves maximum close-in protection by means of neutralization of enemy fire from small arms and automatic weapons.

(2) CS munitions can be used to disable unmasked enemy troops in bunkers, outposts, and similar strong points and to assist in obtaining prisoners for questioning. Sufficient amounts of CS munitions must be specifically planned for use in selected situations to achieve effective results.

(3) CS munitions may be used to probe suspected ambushes prior to the arrival of friendly troops.

b. In Defensive Operations.

(1) Pre-installed CS munitions should be located around the perimeter of the defended position so that some munitions can be employed, regardless of wind direction, without affecting friendly troops.

(2) The CS attack should be planned so that interference with friendly observation is minimized. Loss of visibility due to the CS cloud may be of greater disadvantage to attacking enemy troops than to defending friendly troops.

(3) CS munitions employed by surprise against attacking enemy troops can assist in repelling the enemy attack. Unmasked enemy troops attacking an outpost, listening post, or strong point may be too preoccupied with the attack to put on protective masks, even if available.

c. Counterinsurgency Operations. Riot control munitions are useful in counterinsurgency operations, particularly in the conduct of raids and ambushes against insurgent or guerrilla forces and in defense against insurgent or guerrilla attacks and ambushes. See FM 3–10B for additional information.

CHAPTER 6
INTRODUCTION TO CHEMICAL TARGET ANALYSIS

47. General

Chemical target analysis is a process of examining existing and potential targets to determine their vulnerability and suitability for chemical attack and the capability of the command to attack the selected targets with available chemical munitions. The chemical target analysis may consist of a rapid mental calculation, the use of a target of opportunity checklist (app VIII), or a written preplanned target analysis (app VI and VII). Chemical target analysis consists essentially of the following activities, but not necessarily in the same sequence:

a. Obtain essential target information, including predicted meteorological conditions.

b. Determine which targets are suitable for chemical attack, in consonance with the commander's concept of operations.

c. Select a suitable agent for producing the desired effects on each target.

d. Determine the delivery means available for and capable of disseminating the selected agent on each target.

e. Determine the quantitative chemical munitions requirements for attack of each target.

f. Estimate the percentage of casualties that can be expected from the chemical attack (para 67–69).

g. Determine troop safety requirements.

h. Make recommendations for the employment of chemical weapons, including time of attack.

i. Make post-attack analysis (para 56).

48. Target Information

Specific targets may be designated by the commander or his staff for consideration in chemical target analysis. The target analyst also considers other targets that might be important in present or future operations. Information pertinent to all these targets may be obtained from intelligence reports, situation reports, weather forecasts, and special studies.

49. Targets Suitable for Chemical Attack

Certain target characteristics, which influence the selection of an agent-munition combination, should be considered in chemical fire planning. These target characteristics are described below—

a. Composition. Targets may be classified into tnose consisting primarily of troops or of terrain and materiel. Chemical munitions are used primarily against troops; however, they are also employed to contaminate terrain and materiel. The typical chemical target consists of troops on the ground or in hasty field fortifications and armored vehicles.

b. Location. Three aspects of target location that must be considered are the target's relationship to the unit plan of maneuver, its distance from the possible delivery means, and the proximity of friendly troops or civilian populations to the target. If friendly troops must traverse or occupy the target area, an agent that produces a nonpersistent effect should be the first choice.

c. Size and Shape.

(1) *Size.* In a surprise dosage attack, the rate of fire and impact patterns of artillery batteries will limit the area coverage and size of the target that can be engaged successfully. On a

typical nuclear battlefield, for example, the platoon-sized unit may be the only target of comparatively constant size (about 300 meters by 150 meters) and of even density. As the target size increases, the percentage of unoccupied area increases. Targets of five hectares (50,000 square meters) or less are classified as *small-area targets*; those over five hectares are classified as *large-area targets*.

(2) *Shape.* Target shape will influence the selection of weapons and, possibly, the disposition of firing units in order to allow characteristic impact patterns to cover the target with the required agent concentration. For example, a weapon system with a circular dispersion pattern 500 meters in diameter could not be used economically to engage a linear target 100 meters wide and 2,000 meters long.

d. Targets of Opportunity. Since targets of opportunity normally are fleeting in nature, they must be attacked as quickly as possible. In chemical fire/strike planning, consideration must be given to the rapidity with which a target can be detected, identified, analyzed, and attacked, all of which will depend largely upon the availability of adequate intelligence and upon the response time of delivery systems.

50. Selection of Agent

The desired effects will be stated or implied by the commander as immediate or delayed casualties or as lethal, incapacitating, or harassing effects. The factors discussed below should be considered in selecting the chemical agent to achieve the desired effect on the target.

a. Level of Protection. Enemy protection levels will influence the choice of agent. If enemy troops have no protective equipment, GB should be employed for immediate casualty effect and HD for delayed disabling effect. If enemy troops are equipped with protective masks only, GB should be used to achieve surprise effects, and VX and HD should be used to circumvent the protection of the mask. Combinations of these chemical agents may also be used.

b. Meteorological Conditions. Weather conditions may limit the effectiveness of chemical agents. The effects of weather are discussed in paragraphs 15 through 18.

c. Terrain Conditions. The effects of terrain are discussed in paragraph 19.

51. Munitions Impact Patterns

Impact patterns of munitions as related to target size and shape influence the selection of a weapon system.

★*a. Rockets.* Bomblets that are dispersed over a target area by rockets produce approximately circular impact patterns, with the size varying directly with the height of the bomblet release. The casualty threat level achieved within the impact area will vary inversely with the size of the area and as modified by meteorological conditions. See FM 3–10B for area coverages.

b. Area Rockets. Area rockets dispersed by multiple rocket launchers have different impact patterns at different ranges. See FM 3–10B for operational data. The casualty threat level produced within the impact area is determined by the size of the impact pattern, the number of rocket launchers used, and the meteorological conditions.

★*c. Cannon Artillery.* Batteries of cannon artillery employed in surprise nonpersistent chemical attack normally fire at center-of-target range using a normal (parallel) sheaf. Cannon are fired as rapidly as the crews can load and fire, with normal dispersion relied upon to distribute the rounds over the target area. If the time of delivery and the establishment of instantaneous casualty-producing dosages are not important, battery area-coverage techniques of fire will achieve a larger impact area. The impact area for one volley fired from howitzers using normal sheaf generally is as follows:

	Meters
105-mm battalion:	430 × 120
105-mm battery:	190 × 105
155-mm battalion:	730 × 135
155-mm battery	250 × 135
8-inch battalion:	720 × 120
8-inch battery: (4 weapons)	250 × 120

d. Air-Delivered Munitions. These munitions include massive bombs, spray tanks, and bomblet dispensers. The impact pattern of chemical bomblets released from an aircraft dispenser will depend on the method, height, and velocity of release. The size of the immediate area coverage of massive bombs compared to the circular error probability (CEP) of the delivery systems is such that multiple releases may be required to achieve a reasonable probability of covering a point target.

52. Selection of Weapon Delivery System

The selection of a weapon system to deliver the selected chemical agent on the target consists of the following steps:

a. Single out the munitions sytems that—

(1) are available to deliver the selected agent.

(2) are within range of the target.

(3) have characteristic impact patterns that can cover the target at that range.

(4) have suitable delivery accuracy for the type target.

b. If surprise effects are necessary, consider those systems with the capability to deliver an adequate amount of chemical munitions to the target area simultaneously or within a maximum of 15 seconds.

c. Determine munitions requirements for each system on the basis of target size, weather and terrain conditions, and expected enemy protection level.

d. Consider limiting logistical and operational factors.

e. Compare *c* and *d* above and select a weapon system to recommend for employment.

53. Determination of Chemical Ammunition Requirements

The ammunition expenditure tables in appendix XIII contain ammunition requirements per hectare for coverage under various meteorological and terrain conditions. See appendix XIV for illustrative examples. The target analyst, in determining the requirements, must also consider the effects of rates of fire, dispersion patterns, and heights of burst. See FM 3–10B for additional munitions requirements tables for classified systems.

54. Troop Safety Requirements

Chemical agents produce a residual contamination hazard and a downwind vapor hazard that must be considered in fire planning and in target analysis. These hazards have tactical implications that must be weighed in planning chemical operations. Weapon system delivery errors are an additional consideration. Guidance for determining troop safety distances is contained in paragraphs 70 through 75.

55. Integration of Chemical Fires/Strikes into Operations Plans

Integration of chemical fires/strikes into the operations plan is performed in a manner identical to that for other types of munitions. For example, the fire support coordinator is responsible for integrating chemical fires/strikes into the fire support plan.

56. Post-Attack Analysis

To determine the effectiveness of a chemical attack and to accumulate experience data for future chemical operations, it is desirable to conduct a post-attack analysis of the effects of chemical attacks after each mission. The target analyst determines the scope and extent of the analysis.

a. Factors for Post-Attack Analysis. After a chemical attack, as much of the following information as is possible should be obtained to evaluate the effectiveness of the attack:

(1) Number and defensive posture of enemy troops in the target area at the time of attack.

(2) Number and type of casualties.

(3) Agent effectiveness against different types of protection and types of positions.

(4) Enemy countermeasures and their effectiveness.

(5) Effects on enemy morale, efficiency, tactics, logistics, and communications.

(6) Effect of the attack on friendly forces.

(7) Area coverage and delivery system accuracy.

(8) Residual hazard and downwind hazard.

(9) Expenditure of chemical munitions if different from planned expenditures.

(10) Meteorological conditions at the time of attack.

(11) Degree of contribution to the success of the command in accomplishing its mission.

b. Data for Post-Attack Analysis. The sources of information for this analysis are essentially the same as those used in procuring the initial target information. Further sources are available if the target area has been occupied or overrun by friendly forces.

CHAPTER 7
DETERMINING CHEMICAL MUNITIONS REQUIREMENTS AND CASUALTY EFFECTS

Section I. CHEMICAL MUNITIONS REQUIREMENTS

★57. General

Employment data for chemical munitions and delivery systems that are useful to the target analyst are presented in table I. Classified data pertaining to chemical air munitions requirements for the Air Force, Navy, and Marine Corps are given in FM 3–10B.

a. GS Munitions Expenditure Tables.

(1) For Army and Marine Corps 105-mm howitzers, 155-mm howitzers and guns, and 8-inch howitzers, see tables VI through VIII and XI through XIII.

(2) For Army 115-mm and 762-mm rockets, see FM 3–10B.

b. VX Munitions Expenditure Tables. See FM 3–10B for VX munitions expenditure tables for all weapon systems.

c. HD Munitions Expenditure Tables. For Army and Marine Corps 105-mm howitzers, 155-mm howitzers and guns, and 4.2-inch mortars, see tables XIV and XV.

58. GB Ammunition Expenditure Tables for Cannon

★Tables VI through VIII and XI through XIII give data for estimating GB ammunition expenditures required to cover a percentage of a typical battlefield target area with a casualty-producing dosage under a variety of conditions.

a. Basis of Tables. Calculations in these tables are based on the number of rounds required per hectare (10,000 square meters) for 50-percent coverage of a target area with at least a casualty-producing dosage. The number of rounds required per hectare for surprise dosage and total dosage attacks is given. Factors are also provided with appropriate tables to obtain the expenditures required for 30- and 80-percent coverages of the target area.

b. Surprise Dosage Attack. For maximum effectiveness all rounds must impact in the target area simultaneously, with the required number of cannon utilized to achive time-on-target (TOT) effects. If this is not practicable, then the rounds should impact within 15 seconds.

c. Total Dosage Attack. The time of firing in a total dosage attack is not critical and may be extended well beyond the 15-second time limit established for surprise dosage attack.

d. Small-Area Targets. To determine the ammunition requirements for attack of targets of 4 hectares or less, add 1 additional hectare. This allowance is required to increase the probability of adequate target coverage (para 64).

e. Field Fortifications and Tanks. For attack of field fortifications or tanks, greater than average ammunition expenditures are required because overhead cover reduces the early (15- and 30-second) casualty-producing dosage by about 50 percent. Because of high munition expenditures, 105-mm howitzer batteries alone may not be considered suitable for attack of hard targets; however, they can be used to augment the fires of higher caliber batteries. See tables XI through XIII for ammunition expenditures.

59. HD Ammunition Expenditure Tables for Cannon and Mortars

Tables XIV and XV contain data for estimating HD ammunition expenditures in rounds per

hectare for 50-percent coverage of a target area with a casualty-producing vapor or liquid contamination.

a. Small-Area Targets. To determine ammunition requirements for attack of targets of 4 hectares or less, add 1 additional hectare. This allowance is required to increase the probability of adequate target coverage.

b. Vapor Effects. Table XIV gives HD ammunition expenditures required for a casualty-producing vapor that will produce one of the following three casualty effects among target troops: cause eye irritation to unmasked troops; disable masked troops in humid weather; or disable masked troops in relatively dry weather. The number of hours of exposure required for target troops to become casualties is also contained in this table. To achieve maximum effectiveness, all rounds should be fired into the target area within 15 minutes.

c. Liquid Contamination Effects. Table XV gives HD ammunition expenditures required for liquid contamination sufficient to produce casualties among troops occupying or traversing the contaminated area. Note that HD ammunition expenditures for liquid contamination effects are greater than expenditures for vapor effects; consequently, contaminated terrain may also produce vapor effects (*b* above). For liquid contamination effects, the time in which rounds are delivered to the target area is not a critical factor. When HD-contaminated terrain is used as a chemical barrier (para 37), the contamination must be replenished periodically.

(1) The number of rounds required per hectare to establish a liquid contamination of the area is given in part A, table XV.

(2) The vaporization rate of the liquid droplets at various wind speeds, temperatures, and temperature gradients and on various types of terrain is derived from data in part B, table XV. The factors for the type of terrain, wind speed, temperature, and temperature gradient multiplied together give the time in hours within which about 50 percent of the liquid contamination will have evaporated. When that time has elapsed or before, the contamination should be replenished by firing one-half of the number of rounds fired to establish the initial contamination. It may be necessary to replenish the contamination more than once to maintain the chemical barrier for the time specified by the commander.

60. Use of the Tables to Obtain Chemical Ammunition Expenditure Requirements for Cannon and Mortars

The steps in using the tables to obtain chemical ammunition expenditure requirements for cannon and mortars, essentially the same for all tables, are listed below. Appendix XIV contains sample problems.

a. Determine Meteorological Data. Obtain the predicted wind speed, temperature, and temperature gradient from intelligence estimates or the Air Weather Service. Predicted wind speeds are approximations, expressed in *knots*, and can be converted to kilometers per hour by multiplying knots by 1.8. In fire planning, meteorological conditions should not be estimated too optimistically in order to avoid overestimation of area coverage capabilities.

b. Determine the Target Size. Determine the target area in hectares. For attack of small-area targets (those less than 5 hectares), see paragraph 58*d* for GB requirements and paragraph 59*a* for HD requirements.

c. Determine the Type of Attack.

(1) *For a GB attack,* determine whether a surprise dosage effect or a total dosage effect is desired. Based on the percentage of casualties desired, determine the percentage of the target area to be covered. Normally, munition expenditures for 50-percent coverage of a target are used; a higher or lower percentage of coverage (80 or 30) gives higher or lower casualty returns (para 67). For attack of hard targets such as field fortifications or tanks, see paragraph 58*e*.

(2) *For an HD attack,* determine whether a vapor effect or a liquid contamination effect is desired. If HD is to be employed for vapor effect, *estimate* the condition of enemy troops: without masks, masked in humid weather, or masked in dry weather. Also estimate the ex-

pected hours of exposure of troops in the target area:

(3) *For a VX attack*, see FM 3–10B.

d. Determine the Weapon(s) to Be Employed in the Attack. In table I check range and area coverage capabilities. Eliminate any obviously unsuitable weapon system.

e. Determine the Required Number of Rounds per Hectare. Use the appropriate table(s) for each munition to be employed. To obtain the total number of rounds required, multiply the rounds required per hectare by the number of hectares in the target area. Note the exception for small-area targets.

61. Use of Munitions Expenditure Tables for Rocket Attack

FM 3–10B contains operational data, area coverage capabilities, and sample problems pertaining to chemical rockets.

★*a. 115-mm Rocket System.* Area coverages for one ripple (45 rockets) of 115-mm rockets fired at different ranges are given. Also given are tables to determine the number of superimposed ripples that must be fired to cover certain percentages of a target area under various meteorological conditions—

(1) With casualty-producing dosages of GB-filled rounds.

(2) To various contamination levels with VX-filled rounds.

b. 762-mm Rocket System. Area coverages by GB-filled bomblets from the 762-mm rocket warhead functioning at either a *high* or a *low* height of burst (HOB) are contained in FM 3–10B.

c. Target Analysis Procedures. General target analysis procedures for rockets are presented below—

(1) Through intelligence channels, determine the predicted wind direction and speed, temperature, and temperature gradient.

(2) Estimate the size of the target area in hectares or as the diameter of a circular area.

(3) Determine area coverage requirements.

(*a*) For 115-mm rockets, determine from the appropriate table the number of superimposed ripples required to cover the target area. A ripple represents 45 rockets fired from one rocket launcher. Consider the size and shape of the impact area based on the range at which the rockets will be fired.

(*b*) For 762-mm rockets, determine whether a *high* or *low* HOB is required.

(4) Determine the total number of ripples (rocket launchers) or total number of warheads required to achieve the desired effect.

62. Use of Area Coverage Tables for Air-Delivered Munitions

FM 3–10B contains operational data, area coverage capabilities, and sample problems pertaining to air-delivered munitions.

a. Spray Tanks. Operational characteristics and area coverage tables, which include the following data, are given for the spray tank weapon systems: flow rates; times to discharge; effective spray line lengths; target areas suitable for attack; recommended tactics for the attack; and casualty percentages expected to result from the attack. Chemical spray missions are not recommended over terrain with dense foliage because of the small amount of spray that will penetrate the canopy and deposit on the ground. High wind speeds and inaccurately predicted wind directions will also tend to produce variable and unsatisfactory results. A general target analysis procedure is given below—

(1) *Meteorological conditions.* Through intelligence channels, obtain the predicted wind speed and wind direction. On the basis of the predicted wind speed, select a release height that will cause the release height-wind speed product to fall within the acceptable limits. Determine if the predicted meteorology involves wind speeds sufficiently high and predictable to justify an upwind displacement of the spray lines and, if so, calculate the extent of such displacement. In situations where it can be reasonably predicted that the wind direction will not vary more than 45 degrees from that predicted, upwind displacement of the spray lines

can be justified if the product of the desired release height and predicted wind speed exceeds 6,000 foot-knots.

(2) *Target areas.* From a map or overlay, determine the dimensions of the target area. From these dimensions, select the required number of spray tanks, and the flight pattern most likely to be effective: one aircraft displaced upwind; two aircraft parallel; two aircraft parallel and displaced upwind; two aircarft flying X pattern; four aircraft parallel; four aircraft parallel and displaced upwind; or six or more aircraft. See FM 3–10B for illustrations of possible flight patterns. Finally, lay out spray lines on the map or overlay and identify prominent terrain features in reference to the points at which spray is to be initiated.

★*b. Chemical Bombs and Dispensers.* Procedures for computing release lines and area coverages for these munitions are similar to those used for computing effects from aircraft spray. Chemical bombs, and dispensers may be used against point targets as well as area targets. See FM 3–10B for data on weapon effects for these munitions.

Section II. ESTIMATION OF CHEMICAL CASUALTIES

63. General

Estimation of casualties from chemical agents is based on knowledge of chemical munitions effects and on capabilities to evaluate those factors that affect the production of casualties, such as the defensive posture of target troops. The estimate is expressed as a percentage of chemical casualties expected among troops in the target area. The method of agent dissemination, meteorological conditions, type of terrain, breathing rate, and reaction and masking time were discussed in paragraphs 12 through 21 as factors that affect chemical casualty production. Other significant factors are discussed in this section.

a. Initial Estimate. When chemical munitions are first employed in combat, individual judgment

and common sense should be used by the target analyst in estimating casualties. If surprise is attained in the initial GB attack against enemy troops equipped with masks, the maximum percentage of chemical casualties expected among target troops is estimated to be equivalent to the percentage of the target area covered with a casualty-producing dosage (ICt_{50} or higher) of GB.

b. Subsequent Estimates. For subsequent chemical attacks, experience factors gained from post-chemical attack analysis should provide a basis for making casualty estimates that are more accurate than the initial estimate.

64. Effects of Munitions Expenditures

Multiple-point-source weapon systems randomly distribute chemical munitions in a target area. Some of these systems have unique impact patterns (FM 3–10B). The various cannon artillery have different probable errors, and projectiles are distributed within an area in accordance with normal probability tables (FM 6–40). Munition expenditures of cannon artillery are calculated as the number of rounds required to cover a portion—normally 50 percent—of a target area under the predicted meteorological conditions.

a. Chemical Effects. In estimating casualties from a chemical attack, see paragraph 67 for GB casualties and paragraph 69 for HD casualties.

b. Fragmentation Effects. The fragmentation effects of explosive-type chemical munitions cause casualties in addition to those caused by the effects of the chemical agent. The fragmentation effects from cannon artillery-type chemical projectiles are estimated to equal about one-half the effects of the corresponding HE projectiles bursting under similar conditions. However, in casualty estimation, HE and chemical effects are not additive.

65. Effects of Protection

Enemy troops can be expected to take advantage of any available cover for protection, such as protective shelters and field fortifications.

a. Overhead Cover. Troops with overhead cover normally will be protected adequately from direct contamination by liquid chemical agents. Surprise dosage effects are approximately one-half as great inside *covered* field fortifications as in the open. Total dosage effects are essentially the same inside or outside covered field fortifications.

b. Protective Masks. Enemy troops equipped with protective masks and well trained in their use will suffer fewer chemical casualties from a surprise nonpersistent chemical attack than troops who lack this training. Some chemical casualties will occur even among troops skilled in the use of protective masks because of poorly fitted, damaged, or leaking masks or because of late masking or early unmasking.

c. Protective Clothing. If enemy troops are equipped with protective clothing that provides protection against liquid effects of chemical agents, increased munition expenditures will be required to produce significant effects.

66. Effects of Breathing Rate and Reaction and Masking Time

The intelligence estimate of the defensive posture of troops, including the expected activities of enemy troop units, is an important factor in estimating chemical casualties.

a. Breathing Rate. For troops breathing rapidly and wearing poorly fitted masks in the attack, the casualty percentage is expected to be about four times that for masked troops breathing normally. In extremes of temperature, the breathing rate is increased among active troops.

b. Reaction and Masking Time. In cold weather the wearing of bulky clothing increases the reaction and masking time; consequently, a higher percentage of casualties can be expected from GB attack.

67. Estimation of Casualties from GB Attack

Pending the development of experience factors from post-chemical attack analysis, use the following criteria to estimate casualties from GB attack. See paragraph 7 for a description of GB casualty effects.

a. Against Troops Equipped With Masks. An average of 10 to 15 percent chemical casualties is

expected among all troops equipped with masks but not wearing them at the initiation of a surprise casualty-producing-dosage attack covering 50 percent of the target area. About a fourth of these casualties will die unless they receive medical treatment, and the remainder will probably be incapacitated. These chemical casualties will result even from well-trained troops because of some delayed masking, mask leakage, defective or missing masks, and early unmasking. In addition, an average of 10 to 15 percent of the troops in the target area are expected to suffer lesser, threshold effects. The following estimates apply for TOT surprise dosage attack against troops who are not wearing masks at the initiation of the attack and who are in the open, in hasty field fortifications, or in ventilated vehicles:

Percent coverage of target area			Remarks
20	50	80	
Average percent casualties			
5–10	10–15	15–25	Troops engaged in mild activity.
10–20	20–40	40–50	Troops operating under unfavorable conditions. See (2) below.
3	5	8	Troops operating under favorable conditions. See (3) below.

(1) For troops in covered field fortifications, reduce estimates given above by one-half. For troops in tanks operating in close combat, see FM 3–10B.

(2) The estimates for troops operating under unfavorable conditions apply to those known or predicted to be operating under conditions that increase their breathing rate. This category includes operations in extremes of temperature, troop fatigue or mental stress, and troops in the attack or crawling along the ground.

(3) The estimates for troops operating under favorable conditions apply to those in units with good detection and warning systems and good mask discipline and with some troops already masked or in protective shelters.

b. Against Troops Not Equipped With Masks. From a total dosage attack with a casualty-producing dosage covering 50 percent of the target area, an average of 50 percent chemical casualties is expected among all troops not equipped with masks.

68. Estimation of Casualties from VX or BZ Attack

Casualties can be expected from contact with liquid VX even among troops protected by masks. See FM 3–10B for data on casualty effects of VX and BZ.

69. Estimation of Casualties from HD Attack

The following data on chemical casualties from HD attack are based upon actual post-chemical attack analysis and upon analysis of field experiments. See paragraph 9 for data describing the casualty effects of HD.

a. HD and VX Liquid Contamination Effects. Because of the many variables involved, it is difficult to make a valid estimate of the percentage of casualties expected among troops exposed to direct or indirect liquid contamination.

(1) The number of chemical casualties depends on what protective equipment troops wear, what protective action exposed troops take after the attack, and other factors relating to their behavior in the contaminated area.

(2) More chemical casualties can be expected from troops traversing a contaminated area on foot than from those in vehicles. A delay of 2 to 12 hours after exposure can be expected before chemical casualties develop.

b. HD Vapor Effect. For 50-percent coverage of a target with a casualty-producing vapor in accordance with table XIV (app XIII), an average of 50-percent casualties is expected among all troops who remain in the target area for the times specified. Note that the exposure time of troops to HD vapor is an important factor in casualty production.

CHAPTER 8

TROOP SAFETY IN EMPLOYMENT OF CHEMICAL MUNITIONS

70. General

When analyzing a target for attack with chemical munitions, potential hazards to friendly troops must be carefully evaluated. Consideration is given primarily to those hazards created downwind of the target area and, secondarily, to those caused by weapon system errors. Troop safety considerations may preclude the employment of certain chemical munitions or may influence the selection of the agent, delivery system, location of center of impact, or planned time of attack.

a. Even though the employment of chemical munitions may not present an immediate hazard to friendly troops, the following factors must be considered:

(1) Chemical agents can interfere with continued or future operations.

(2) A certain margin of safety may be desired for noncombatant populations or friendly forces in enemy territory.

b. The methods for calculating safety distances are conservative to the extent that there is a high degree of assurance that predicted downwind effects will not be exceeded. Friendly units located near the perimeter and downwind of the hazard area must be warned and prepared to adopt protective measures. When the degree of risk to friendly troops is determined to be significant, recommendations for the employment of chemical munitions should be based on the urgency of the situation, on the importance of the target, and on the choice of alternate munitions. Under such circumstances, protective measures to be taken by friendly units will be directed.

71. Liquid Contamination Hazard

Troops in an area contaminated with chemical agents are exposed to a hazard that varies according to the amount and type of agent disseminated, method of dissemination, existing meteorological conditions, terrain condition, duration of exposure, and time elapsed after contamination. Friendly troops should not be ordered to enter an area that has been attacked with chemical agents unless they use protective equipment, unless the area has been decontaminated, or unless sufficient time has elapsed to permit weathering of the contamination to safe limits. It is recognized that the urgency of the tactical situation may override these troop safety considerations.

a. Nerve Agents GB and VX.

(1) While GB is disseminated mainly as a vapor for nonpersistent effect, some liquid GB will remain in chemical shell or bomb craters for periods of time varying from hours to days, depending on the weather conditions and type of munition. Friendly troops should avoid craters until tests with the detector kit prove the absence of hazardous contamination.

(2) VX, an agent of very low volatility, presents a persistent hazard that varies considerably, depending on the nature of the terrain, local climatic conditions, and type of munition. See FM 3–10B for data on persistency.

b. Blister Agent HD. When HD is disseminated as a liquid, it contaminates terrain and materiel

and creates a vapor hazard as well as a liquid contact hazard (table II). Contaminated terrain presents a hazard to troops that varies from hours to days depending on the nature of the terrain, local climatic conditions, and type of munition. HD freezes in temperatures below 60° F. and can present a delayed hazard to troops when the temperature rises.

Table II. Duration of Hazard in an HD-Contaminated Area[1]
(Negligible Risk)

Task	Type of Terrain	Approximate Time after Contamination that Prescribed Tasks May Be Safely Performed			
		Wearing protective clothing and masks		Not wearing protective clothing	
		Weather			
		Warm, 16°–27° C. (60°–(80° F.)	Hot, above 27° C. (80° F.)	Warm, 16°–27° C. (60°–80° F.)	Hot, above 27° C. (80° F.)
Traversal[2] (Walking across area, 2 hr or less.)	Bare soil, sand, or short grass.	0	0	Wearing masks[3]	
				36 hr	36 hr
	Low vegetation.	4 hr	2 hr	36 hr	36 hr
	High vegetation, including jungle and heavy woods.	12 hr	6 hr	4 days	2 days
Advance under Fire (Contact with ground, 1 hr; total time in area, 2 hr).	Bare soil or low vegetation.	24 hr	8 hr	Not wearing masks[4]	
				3 days	2 days
	High vegetation, including jungle and heavy woods.	2 days	24 hr	6 days	4 days
Occupation (Without hitting ground, 24 hr.)	Bare soil or low vegetation.	1 hr	1 hr	4 days	3 days
	High vegetation, including jungle and heavy woods.	1 hr	1 hr	4 days	3 days
Occupation (Involving advance under fire, 24 hr).	Bare soil or low vegetation.	24 hr	8 hr	4 days	3 days
	High vegetation, including jungle and heavy woods.	2 days	24 hr	6 days	4 days

[1] Based on an average expenditure of 240 to 1,200 pounds of HD per hectare (10,000 square meters).

[2] For men wearing protective clothing, when traversal is made in daylight and areas of heavy contamination can be avoided or decontaminated, the times can be reduced to about one-half of those given.

[3] For men walking in a contaminated area for 2 hours without protective clothing, the limiting factor is the vapor hazard. If the traversal requires only a few minutes, it can be accomplished at earlier times than those given.

[4] The approximate times at which troops could occupy areas without having to wear masks apply to men with or without protective clothing. The vapor hazard is the limiting factor.

72. Downwind Vapor Hazard

Chemical agents present a vapor or an aerosol hazard to troops for a predictable distance downwind of the munitions impact area. The actual downwind distance covered by the toxic clouds will depend on the type and amount of agent disseminated on the target, method of dissemination, meteorological conditions, contour of the terrain, and wind speed and direction.

a. GB Hazard. Refer to appendix IV for a method of estimating the downwind hazard area from GB vapor and to appendix V for an example of a downwind hazard prediction message. Vapor dosages less than 5 mg-min/m³ are a *negligible* hazard.

b. HD Hazard. Refer to table III for estimation of the downwind hazard distance from HD vapor. Except under unusually favorable meteorological conditions, the downwind vapor hazard is not significant. Vapor dosages less than 25 mg-min/m³ are a *negligible* hazard.

c. VX Hazard. Refer to FM 3–10B for estimation of VX vapor hazard. The downwind vapor hazard is comparable to that for HD.

Table III. Downwind Vapor Hazard from HD
(To Negligible Risk Level)

Type of Terrain[1]	Downwind Dimension of Target Area (in meters)	Distance Downwind of HD-Contaminated Area that Vapor Hazard May Exist (in meters)[2, 3, 4]	
		Hot, humid weather above 27°C. (80° F.)	Warm weather 16°–27° C. (60°–80° F.)
Open Grassland	200	900	1,600
	500	2,200	4,100
Barren Soil or Sand	200	1,100	2,100
	500	2,700	5,200

[1] For wooded terrain, multiply the above "open grassland" distances by 0.5.

[2] These distances apply only over relatively flat terrain, unobstructed by any breaks due to the presence of trees or houses or abrupt changes of contour of the land.

[3] Distances are based on HD ammunition expenditures given in tables XIV and XV and are measured from the downwind edge of the target area. The time at which 50 percent of the contamination will have evaporated is given in table XV.

[4] Stability conditions favorable to extensive downwind travel are rarely found at high temperatures because the atmosphere under these conditions tends to diffuse and dissipate the toxic cloud before it has a chance to travel a considerable distance downwind of the target area. HD freezes at temperatures below 60° F.; consequently, there is little vapor hazard under cold climatic conditions.

73. Delivery System Error

All weapon systems have a probable error in the accuracy of delivery. When chemical agents are to be delivered close to friendly troop dispositions, this error must be considered in order to prevent the inadvertent delivery of a chemical agent on friendly troops. This degree of expected error is generally small for cannon artillery but of significant size for rockets, missiles, and air-delivered munitions. Delivery error is obtained primarily from appropriate firing tables but can also be obtained from the delivery unit. For troop safety purposes, the minimum safe distance from the munitions impact area is 200 meters plus 3.5 times the largest probable error, or 2.5 CEP's.

74. Commander's Risk Criteria

Because of the toxicity of nerve agent vapors and aerosols, the commander must decide the degree of risk that he will accept for unwarned friendly troops downwind of the target area. Risks are defined in terms of effects that can influence unit effectiveness. The following criteria are used as a guide for establishing the degree of risk for exposure of unmasked friendly troops (table IV):

a. Negligible Risk. Troops are reasonably safe though there may be some threshold effects. The combat effectiveness of units will not be impaired.

b. Moderate Risk. Anticipated effects are tolerable or, at worst, a minor nuisance. There may be a few mildly incapacitated casualties and a slight reduction in unit combat effectiveness, but units will be able to perform assigned missions.

c. Emergency Risk. Anticipated effects may cause some casualties and may significantly reduce the unit's combat effectiveness.

75. Possible Courses of Action

When the distance from the target to friendly troop dispositions is less than the minimum safe distance required, one or more of the following courses of action may be considered.

a. Use another weapon system.

b. Use a different chemical agent.

c. Increase troop protection.

d. Withdraw friendly troops.

e. If feasible, change the time of chemical attack to coincide with more favorable meteorological conditions.

★APPENDIX I
REFERENCES

JCS Pub 1	Dictionary of United States Military Terms for Joint Usage (UD).
AR 310–50	Authorized Abbreviations and Brevity Codes.
(C) FM 3–10B	Employment of Chemical Agents (U).
FM 6–20–1	Field Artillery Tactics.
FM 6–20–2	Field Artillery Techniques.
FM 6–40	Field Artillery Cannon Gunnery.
(C) FM 6–141–1	Nonnuclear Employment of Field Artillery Weapons Systems (U).
FM 7–10	The Rifle Company, Platoons, and Squads.
FM 7–20	The Infantry Battalions.
FM 7–30	The Infantry Brigades.
FM 19–15	Civil Disturbances and Disasters.
FM 20–32	Landmine Warfare.
FM 21–30	Military Symbols.
FM 21–40	Chemical, Biological, Radiological, and Nuclear Defense.
FM 30–5	Combat Intelligence.
FM 30–16	Technical Intelligence.
FM 30–102	Handbook on Aggressor Military Forces.
FM 31–10	Denial Operations and Barriers.
FM 31–11/NWP 22/LFM 01	Doctrine for Amphibious Operations.
FM 31–12	Army Forces in Amphibious Operations (The Army Landing Force).
FM 31–21	Special Forces Operations—U.S. Army Doctrine.
(S) FM 31–21A	Special Forces Operations—U.S. Army Doctrine (U).
FM 61–100	The Division.
FM 100–5	Operations of Army Forces in the Field.
FM 101–5	Staff Officers' Field Manual; Staff Organization and Procedure.
FM 105–5	Maneuver Control.

TM 3-215/AFM 355-7	Military Chemistry and Chemical Agents.
TM 3-240/AFM 105-7	Field Behavior of Chemical, Biological, and Radiological Agents.
TM 9-1300-203	Artillery Ammunition.
NAVWEPS 8589	Effectiveness of V-Agent Spray.
NAVWEPS 8628	Tactical Air-to-Surface Weapons Program, Current Summary Report.
NWIP 10-3 (series)	Naval Terminology.
AFM 11-1	Air Force Glossary of Standardized Terms and Definitions.

★APPENDIX II
CHARACTERISTICS AND EFFECTS OF CHEMICAL AGENTS

Type of agent	Military symbol	Effects	Use	Route of entry	Average time to incapacitate	Duration of incapacitation	Duration of hazard
	GB	Produces casualties quickly, usually within 5–10 minutes after inhalation of casualty-producing dosage. Causes muscles to contract, breathing stops, and death occurs.	Quick-acting casualty agent.	Primarily by inhalation.	5–10 minutes.	1–5 days.	10 minutes.
Nerve agents	VX	Produces delayed casualties by skin absorption. Causes muscles to contract, breathing stops, and death occurs. Very high toxicity; much greater through eye than through skin.	Delayed-acting casualty agent.	Primarily by liquid droplets through the skin.	See FM 3–10B.	See FM 3–10B.	See FM 3–10B.
Blister agent	HD	Produces delayed casualties. Affects the eyes and lungs and blisters the skin. Primarily used to produce disabling effects.	Delayed-acting casualty agent.	Vapor in eyes; liquid and vapor on skin; inhalation of vapor.	4–24 hours.	2 days to months.	36 hours to several days.
Incapacitating agent.	BZ	Produces incapacitating physical and mental effects. Prevents exposed personnel from performing their mission.	Delayed-acting temporarily incapacitating agent.	Inhalation.	See FM 3–10B.	See FM 3–10B.	See FM 3–10B.
	CS	Produces immediate effects; burning of the eyes; copious flow of tears; coughing; difficulty in breathing and chest tightness. Heavy concentration causes nausea.	Training and riot control agent.	Eyes and inhalation.	Seconds.	5–10 minutes.	10 minutes.
Riot control agents.	CN	Produces immediate effects; burning of the eyes; copious flow of tears; and irritation of the respiratory passages.	Same as for CS.	Eyes.	Seconds.	5 minutes.	5 minutes.

Note. For comprehensive details see TM 3–216.

APPENDIX III

SAMPLE OF OPERATIONAL CBR WEATHER FORECAST* (OBSERVATION)*

(Available Data from Air Weather Service or Fleet Weather Service)

Date/Time_____

Valid Forecast Time (T_f)_____

1. Area forecasted—Division Area of Influence
(Other)_____
_____
_____

	Time T_f	Time T_f + 3 Hr	Time T_f + 6 Hr
2. Wind (on the surface) Direction from: (to nearest 10° increment of azimuth, speed to nearest 5 knots at 2, 15, 50, and 100 meters)			
3. Vertical temperature gradient (inversion, neutral, or lapse) between 0.5 and 4.0 meters above ground			
4. Height of inversion bases and tops between ground and 1,000-ft altitude			
5. Temperature (to nearest 5° F. at 5-foot level)			
6. Relative humidity (nearest 10%)			
7. Precipitation (rain or snow) (light, moderate, heavy) (depth of snow)			
8. Cloud cover (clear, scattered, broken, overcast) and height: Low (below 6,500 ft), Middle (6,500–20,000 ft), High (above 20,000 ft)			

9. Fallout winds (T_f through T_f + 6 Hr) Direction and speed (altitude - 1,000's of units) (to nearest 10°/100 mils and to nearest 5 knots)

*Ft**	*Meters**	*Ft**	*Meters**
5 _____	2	55 _____	22
10 _____	4	60 _____	24
15 _____	6	65 _____	26
20 _____	8	70 _____	28
25 _____	10	75 _____	30
30 _____	12	80 _____	32
35 _____	14	85 _____	34
40 _____	16	90 _____	36
45 _____	18	95 _____	38
50 _____	20	100 _____	40

10. Height of tropopause _____ (ft/meters*)

Note. For additional 18-hour *PLANNING FORECAST*, see following page.

* Strike out as applicable.

CBR WEATHER PLANNING FORECAST

Valid (T_t + 7 Hr through T_t + 24 Hr): _____/_____ to _____/_____
(date/time)

1. Surface wind

   (same parameters as preceding format)

2. Vertical temperature gradient

   Inversion ( ) Neutral ( ) Lapse ( )

   Time: _____/_____ _____/_____ _____/_____

3. Temperature

   Maximum_____° F. at_____/_____; Minimum_____° F. at_____/_____
   (Time) (Time)

4. Relative humidity

   Maximum_____% at_____/_____; Minimum_____% at_____/_____
   (Time) (Time)

5. Cloud cover

   Clear ( ) Scattered ( ) Broken ( ) Overcast ( )

6. Precipitation

   No ( ) Yes ( ): Rain ( ) Snow ( )

   Beginning_____ End_____
   (Time) (Time)

7. Fallout winds

   Significant changes?

   No ( )

   Yes ( ), as follows:

	Ft*	Meters*	Ft*	Meters*
(Direction and speed as in preceding format)	10	4	40	16
	20	8	50	20
	30	12	60	24

8. Height of tropopause _____(ft/meters*)

* Strike out as applicable.

APPENDIX IV
ESTIMATION OF DOWNWIND G-AGENT HAZARD

Section I. GB HAZARD FROM ATTACK BY FRIENDLY FORCES

1. General

This section describes a simplified method for estimating the downwind hazard from the travel of a cloud of GB vapor to determine the safe distance from the target area for unmasked friendly troops. It is emphasized that the travel of the GB cloud is not in a straight line because of the normal shifting of the wind, variations in terrain conformation, and air turbulence. In addition, other factors that affect cloud travel, such as wind speed and temperature gradient, will not be constant throughout the entire time of cloud travel. Therefore, this method is designed to give quick estimates of downwind hazard distances within the degree of accuracy of the data that will be obtainable. The following data are used:

a. Wind. Estimate the mean wind direction. If the wind speed is unknown, assume an *average* speed of 10 kilometers per hour.

b. Temperature Gradient. Obtain the predicted average temperature gradient, expressed as inversion, neutral, or lapse (para 16). An overestimate of favorable meteorological conditions will increase the calculated downwind hazard distance and is more desirable from a troop safety standpoint than an underestimate. Therefore, if the CB cloud is expected to travel downwind during periods of neutral *and* inversion temperature gradients, use inversion data. Thus, the more stable extreme is used to "safeside" the estimate of the maximum downwind danger distance.

c. Approximate Width of Target Area. Using the target dimension that is perpendicular to the wind direction, estimate the width of the target in kilometers.

d. Total Weight of Agent on Target. Estimate the total weight, in pounds, of GB on the target.

e. Center of Impact of Munitions. Determine the point from which downwind distances will be measured.

2. Procedure

The downwind hazard distance is estimated by the following procedure in conjunction with table IV.

a. Determine the width of the target in kilometers, using the target dimension that is perpendicular to the wind direction.

★*b.* Determine the weight of GB on the target area. To do so, multiply the number of rounds to be fired on the target by the weight of the agent filling per munition, using the following weights:

Munition	*Weight of agent (GB) (in pounds)*
105-mm cartridge	1.8
115-mm rocket (BOLT)	11.0
155-mm projectile	6.5
8-inch projectile	15.8
762-mm warhead (HONEST JOHN)	478.0
Bomb MC-1	220.0
Bomb MK94	110.0

Classified munitions (see FM 8–10B)

c. Divide the total weight of agent (in pounds) by the width of the target (in kilometers).

Table IV. Estimated GB Vapor Downwind Hazard Distances

Weight of agent [1] per kilometer of target width (lb/km)	Estimated downwind hazard distance in kilometers [2]			
	Negligible risk		Moderate risk [3]	
	Temperature gradient [4]			
	Inversion	Neutral	Inversion	Neutral
110	8	1	2	1
220	26	2	9	1
330	50	4	16	2
440	85	5	30	2
550	93	7	50	3
660	100	8	70	4
770	100	10	85	5
880	100	12	100	6
990	100	14	100	7
1,100	100	15	100	8

[1] If the actual weight of agent per kilometer of target width falls between tabulated values, interpolate or use the next higher value.

[2] An average wind speed of 5 knots (9 km/hr) is assumed.

[3] An emergency risk will exist at any downwind distance less than that given for moderate risk.

[4] The downwind hazard distance under lapse temperature gradient will be ½ to 1 kilometer.

d. Using the value calculated in *c* above, enter table IV in the first column and read the downwind hazard distance in the applicable column depicting the degree of risk established by the commander—*normally negligible*—and the predicted temperature gradient.

3. Example

a. Given.

(1) Target area about 40 hectares, approximately 800 by 500 meters (0.8 × 0.5 kilometer).

(2) Temperature gradient: neutral.

(3) Wind speed and direction: about 5 knots (9 kilometers per hour), generally perpendicular to the 800-meter dimension of the target area.

(4) Munition to be fired: Sixty 155-mm rounds of GB, random distribution.

b. Problem. Estimate the downwind hazard distance to the *negligable* risk.

c. Procedure.

(1) Find the total weight of agent 60 × 6.5 = 390 pounds.

(2) Divide the agent weight by the target width:

$$\frac{390}{.8} = 487 \text{ pounds.}$$

(3) Enter the first column of table IV and find that the nearesdt figures to 487 are 440 and 550. In the column headed "neutral" under *negligible* risk, find the figures 5 and 7 kilometers opposite 440 and 550 pounds. Since 487 is almost halfway between 440 and 550, the applicable figure would be halfway between 5 and 7, making the answer 6 kilometers.

d. Solution. About 6 kilometers.

4. Graphic Illustration

To be meaningful to the commander and his staff, the downwind hazard area is graphically illustrated on a situation overlay (fig 4), as follows:

a. Orient overlay paper on the appropriate map and, from the center of impact of the target area, measure off the maximum distance (6,000 meters) in the direction of the actual or forecast wind.

b. Study the general area of interest on the map (color contoured, preferably) and consider the effects of the contour of the terrain, such as hills and valleys, that could channel the chemical cloud in a direction different from that of the wind.

c. Draw a radial line from one edge of the target area downwind at an angle of 20 degrees *more or less* (if indicated by *b* above) in the direction of the prevailing wind; do the same from the other edge of the target as may be appropriate.

d. Draw an arc between the radial lines at the maximum downwind distance (6,000 meters), and label the area inside the arc as the downwind hazard area.

e. Estimate the time of arrival of the toxic cloud at the maximum downwind distance and at any place where friendly troops may be affected. Label

these points on the overlay. The following equation may be used:

$$\frac{\text{Distance (in kilometers)}}{\text{Wind speed (in kilometers per hour)}} \times 60 \text{ minutes} = \text{time in minutes.}$$

For example:

$$\frac{6 \text{ kilometers}}{9 \text{ kilometers per hour}} \times 60 \text{ minutes} = \text{about 40 minutes}$$

Note. To convert knots to kilometers per hour, multiply knots by 1.8.

5. Refinement of the Estimate

Table IV gives the estimated distance that a GB cloud can travel downwind under a constant temperature gradient condition. However, there will be times when the temperature gradient will change during the time of travel of the toxic cloud. This paragraph describes a method for refining the downwind hazard distance estimate when changes in temperature gradients are predicted or can reasonably be expected. For example, an inversion condition may occur from 1 hour after sunset to 1 hour before sunrise, a lapse condition from 1 hour after sunrise to 1 hour before sunset, and a neutral condition from 1 hour before to 1 hour after sunrise and from 1 hour before to 1 hour after sunset under certain conditions. Based upon these typical changes in temperature gradients, the following method illustrates a refinement of the downwind hazard distance estimate:

a. Given.

(1) A GB nonpersistent attack will be made against an enemy target at 0400 under inversion temperature gradient.

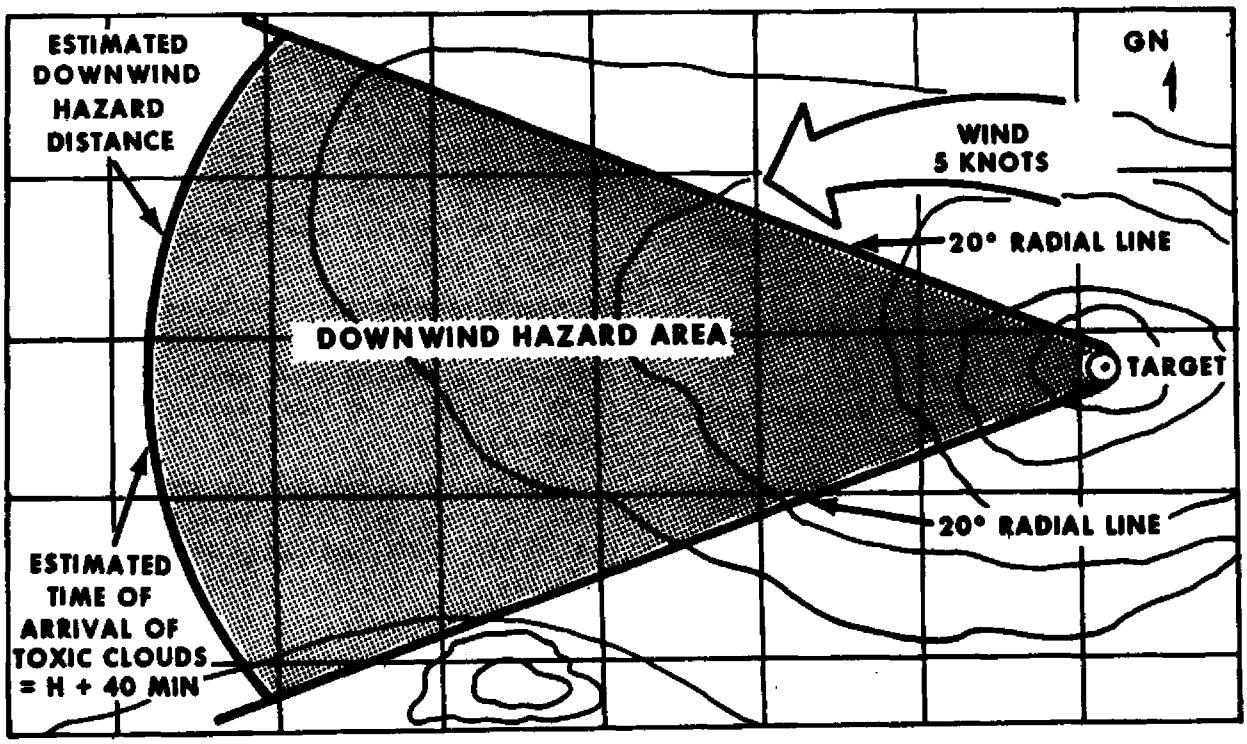


Figure 4. Downwind GB hazard distance overlay.

(2) Predicted meteorological conditions: sunrise at 0600, lapse temperature gradient during the day with neutral temperature gradient 1 hour before to 1 hour after sunrise, and an average wind speed of about 6 kilometers per hour.

(3) The agent weight in pounds per kilometer of target width will be about 660/km.

b. Basic Method. Using table IV and considering the downwind travel based *only* on the inversion temperature gradient existing at the time of attack, estimate the downwind hazard distance to be 100 kilometers.

c. Refinement Procedure. A more accurate estimate of the downwind hazard distance can be obtained by considering the predicted changes in temperature gradients during the downwind travel of the toxic cloud. This method is illustrated below—

(1) The temperature gradient at the time of firing is expected to be inversion. Since this inversion condition is expected to affect the toxic cloud for about 1 hour (from 0400 to 0500) in a wind speed of 6 kilometers per hour, the cloud will travel about 6 kilometers from 0400 to 0500.

(2) The temperature gradient at 0500 is expected to change from inversion to neutral. From table IV it is estimated that under a neutral temperature gradient the same cloud would then travel a remainder of only 8 kilometers.

(3) The downwind hazard distance, therefore, is estimated to be about 14 kilometers (6 + 8 = 14).

Section II. G-AGENT HAZARD FROM ATTACK BY ENEMY FORCES

6. General

It is not practicable to estimate the amount of G-agent used by the enemy in a chemical attack on friendly units. In lieu of table IV, the following method may be used to estimate the downwind area that the toxic cloud could cover. This method involves solving a simplified cloud travel problem.

a. Estimate the wind direction and speed by any appropriate method.

b. Estimate the temperature gradient condition (para 16).

(1) For lapse condition, consider the downwind travel time to be 1 hour.

(2) For neutral condition, consider the downwind travel time to be 2 hours.

(3) For inversion condition, consider the downwind travel time to be 10 hours.

c. Estimate the downwind hazard distance to the negligible risk level produced by travel of the toxic cloud at the estimated wind speed for the appropriate period of time.

d. Estimate, by any appropriate method, the target area depth and width; consider the cloud length to be equivalent to the target depth. On the basis of the estimated wind speed, convert the cloud length to the time of travel downwind.

e. Add a safety factor of 20 percent to the cloud length, in time.

f. On an overlay sketch of the area of interest, draw radial lines downwind at 20-degree angles from the edges of the target area to allow for possible deviation in the wind direction (para 4, this appendix).

g. In accordance with the unit SOP, warn downwind units on the unit warning/broadcast net (AM/FM) of the possibility that they may be subjected to a toxic cloud attack.

7. Example

a. Given. The enemy attacks during the daytime an area *estimated* to be 1 by 2 kilometers. The wind is estimated to be from the west at 5 knots (9 kilometers per hour). A lapse temperature gradient is predicted.

b. Procedure.

(1) Since the wind speed is 9 kilometers per hour, the toxic cloud can arrive at a point 9 kilometers downwind at H plus 1 hour.

(2) Since the cloud length is 2 kilometers (or about one-fifth of the estimated downwind distance of 9 kilometers), the cloud length when converted to time is about 12 minutes (one-fifth of 60 minutes travel time).

(3) Add 2.4 minutes (20-percent safety factor) to 12 minutes, for a total of approximately 15 minutes.

c. Solution. The area downwind to 9 kilometers *could* receive the toxic cloud at about H plus 1 hour; if so, the cloud should clear the area at about H plus 1 hour and 15 minutes.

APPENDIX V
DOWNWIND HAZARD PREDICTION MESSAGE AND EXAMPLE OF USE

★1. General

Information pertaining to the predicted downwind hazard area produced by a chemical attack by friendly forces is disseminated to subordinate and adjacent units in the form of a prediction message. The message follows the format specified in STANAG 2103 (NBC 3). It consists of a series of lines of groups of letters and digits preceded by the phrase, "Downwind Chemical Hazard Prediction Message." Any inapplicable line may be omitted.

2. Example of Message

a. Downwind Chemical Hazard Prediction Message.

Delta 250800Z
Echo 250830Z
Foxtrot LB 206300 (actual)
Golf 155-mm
Hotel GB
India 100
Papa LB 208320, LB 210320, LB 206310
Zulu 014

b. Significance. The significance of each line of the message is indicated below—

(1) *Delta.* This line is the date/time of the attack, with 25 being the day and 0800 being the hour in Greenwich Civil Time (GCT).

(2) *Echo.* This line is the date/time the attack ends.

(3) *Foxtrot.* This line provides the coordinates of the location of the attack (center of impact of the munitions), with LB representing the two letters of the appropriate 100,000-meter grid square and 206300 representing the coordinates within the grid square.

(4) *Golf.* This line gives the delivery means.

(5) *Hotel.* This line gives the agent symbol.

(6) *India.* This lines gives the number of shells, if applicable.

(7) *Paper.* This line gives the UTM coordinates of points that outline the area of vapor hazard.

(8) *Zulu.* This line gives the effective wind speed in kilometers per hour.

APPENDIX VI

OUTLINE OF A PREPLANNED CHEMICAL TARGET ANALYSIS

Note. The following five-paragraph outline is a *guide* for preparing a preplanned chemical target analysis. The data to be included in the paragraphs listed below may be brief or detailed. Any of the subparagraphs may be omitted if inappropriate or if data are unavailable. See appendix VII for an example of a U. S. Army division preplanned chemical target analysis.

1. Mission

Paragraph 1 states the purpose of the chemical attack. Pertinent guidance may be obtained from the operations officer or from the statement of results desired by the commander. It may also be deduced from the commander's concept of operations and from the mission of the command. The results desired by the commander may be stated in a number of ways. He may indicate the length of time an enemy action is to be delayed, what enemy unit is to be neutralized, or the results desired or acceptable (immediate or delayed casualties or incapacitated troops); or he may merely state that casualties are desired among enemy troops.

2. The Situation and Considerations

Paragraph 2 is concerned principally with descriptions of selected targets and all factors that can influence the selection of a target for attack with chemical munitions.

a. Intelligence Situation.

(1) *Characteristics of the area of operations (para 15–19).*

(*a*) *Weather.* Extract pertinent weather data from the intelligence estimate. Analyze, in general, the predicted weather and its effects on the employment of chemical munitions.

(*b*) *Terrain.* Extract pertinent terrain characteristics from the intelligence estimate. Analyze, in general, the effect of terrain on the employment of chemical munitions.

(2) *Enemy situation.* Extract pertinent information about the enemy from the intelligence estimate. Analyze the chemical defense situation that can affect the employment of chemical munitions.

b. Tactical Situation.

(1) *Friendly situation.* Extract pertinent information about the unit and adjacent friendly forces from the situation overlay.

(2) *Possible courses of action.* If appropriate, list the possible courses of action for the command.

(3) *Weapons available.* List the ground weapons and units and the air weapons and units available.

c. Logistical Situation. From data provided by the logistics officer, list the chemical munitions available to the command by weapon and filling. Consider the available supply rate, amounts expended, and credits available.

d. Target Situation. List the significant characteristics of each potential target (para 49). Consider the following:

(1) *Target description.* Describe the target, including the type and the estimated troop strength.

(2) *Physical location and altitude.* Give the grid references and altitude, the location with respect to friendly troops, and the

terrain characteristics, and indicate how accurate this information is.

(3) *Size and shape of target area.* Give the approximate dimensions and shape of the target area and the size in hectares or as the diameter (in meters) of a circular area.

(4) *Vulnerability.* Give the type and amount of cover, the apparent mobility of the target, and the density of troops, if available.

(5) *Weather and terrain.* If appropriate, list any special weather and terrain features of the target area.

(6) *Target capabilities.* Indicate the capability of the target to affect the unit's mission.

3. Analysis

Paragraph 3 is concerned principally with an examination of the capabilities of the command for chemical attack of selected targets while considering enemy capabilities. The capabilities of enemy targets to interfere with the mission of the command are very important considerations.

a. *Target Attack Capabilities.*

(1) *Chemical munitions available.* Tabulate the number of rounds of ammunition or spray tanks by weapon and filling as of a specific time and date.

(2) *Area coverage capabilities.*

(a) *GB.* Tabulate the area coverage capabilities of chemical munitions and the type of attack (surprise dosage or total dosage) by the weapon systems available. Use data in table I as the yardstick. Analyze the deployment limitations of artillery units and aircraft units.

(b) *HD.* Tabulate data as shown in (a) above. Consider an appropriate attack time and the effect desired—vapor or liquid contamination.

(c) *VX.* Tabulate data as shown in (a) above.

b. *Target Analysis.* Analyze the effects of a chemical attack on each of the proposed targets, considering the target characteristics, intelligence and logistical situations, and target capabilities. Consider the following:

(1) *Urgency of the attack.* Consider the type of target (static or mobile) and the target capabilities.

(2) *Enemy countermeasures.* Consider the ability of the enemy to minimize the effects of chemical agents, to prevent effective delivery, and to take countermeasures after the attack.

(3) *Enemy troop discipline and morale.* Consider the effects of this factor on the type and quantity of chemical munitions required, time of attack, and duration of attack.

(4) *Creation of obstacles.* Consider whether the resulting contamination will create any obstacles to the friendly unit scheme of maneuver.

(5) *Surprise.* Consider measures available to obtain surprise, including the least expected time of attack, means of delivery, and restrictions on registration fire.

(6) *Time.* Consider the scheduled time for the chemical attack as it affects ammunition expenditures.

(7) *Delay in casualty production.* Consider the delay in casualty production that is acceptable and its influence on agent selection.

(8) *Civilian casualties.* Consider the number and status of civilians in the target area and any special implications involved.

(9) *Troop safety.* Consider the effects of downwind vapor hazard and contamination hazard upon friendly troops.

4. Evaluation and Conclusions

Paragraph 4 is concerned principally with an evaluation of the advantages and disadvantages of the chemical attacks under consideration and of

the relative worth of each in terms of results desired. Compare the advantages and disadvantages of attacking with chemical munitions each of the targets under consideration. Determine which type of chemical attack will best assist the commander in accomplishing the command's mission. The dominant factors to consider are target capabilities and troop safety. For each target selected, determine the following:

a. Priority of attack.

b. Type of fires/strikes (scheduled or on-call) and any special factors.

c. Type of weapon system for maximum effect.

d. Estimation of results in percent casualties.

e. Estimation of ground contamination or obstacles created.

f. Estimation of downwind hasard.

g. Effect of proposed chemical attack on future operations.

5. Recommendations

Paragraph 5 lists all the information required for consideration by the commander and his staff: whether to accept all or part of the recommendations of the chemical target analyst for implementing the command's plan of operation. Submit a recommended plan for chemical fire/strike support according to the SOP of the command. For example—

a. GB (surprise dosage or total dosage effects).

(1) *Scheduled fires/strikes.* List the targets and any special recommendations as the situation dictates.

(2) *On-call fires/strikes.* List the targets and any special recommendations.

b. HD (liquid contamination or vapor effects).

(1) *Scheduled fires.* List the targets and any special recommendations.

(2) *On-call fires.* List the targets and any special recommendations.

c. VX (liquid contamination effects).

(1) *Scheduled fires/strikes.* List the targets and any special recommendations.

(2) *On-call fires/strikes.* List the targets and any special recommendations.

APPENDIX VII

EXAMPLE OF A U. S. ARMY DIVISION PREPLANNED CHEMICAL TARGET ANALYSIS

The following example of a preplanned chemical target analysis includes more detail than would normally be included in such an analysis during combat operations. Much of this information can be found in the intelligence estimate and the commander's estimate of the situation and need not be repeated in the chemical target analysis. However, this example illustrates the type of data that must be considered in the preplanned analysis, whether accomplished manually or by a computer. The amount of detail included in the unit preplanned chemical target analysis, therefore, is determined by the policies of the unit chemical officer, based on the personnel and equipment available and on the scope of operations in the CBRE of the tactical operations center of a U.S. Army division or a similar unit.

21st Inf Div
LOHR ( )
180500Z May

REFERENCE: Map, GERMANY, 1:100,000, WURZBURG

1. Mission

Employ chemical munitions on enemy assault formations, assembly areas, and reserve positions to assist in delaying in present positions for 48 hours.

2. The Situation and Considerations

a. Intelligence Situation.

(1) *Characteristics of area of operations.*

(*a*) *Weather.* Period 19 to 22 may be clear and moderately cool. Visibility unrestricted. Wind from SW during the day at 5 to 7 knots and not exceeding 2 to 4 knots at night. Temperature range, 55° to 75° F. On clear days, inversion and neutral conditions existing at night and during early morning normally change to lapse condition about 2 hours after BMNT. Weather conditions during this period will not preclude the use of GB, VX, or HD, although the use of HD for vapor effect will be somewhat limited. Wind direction favors our use of chemical munitions and imposes no troop safety problems from downwind effects. For planning ammunition requirements based on the chemical ammunition expenditure tables in appendix XIII, use the following average meteorological conditions:

Temperature: 30° to 60° F.
Wind speed: 5 knots.
Temperature gradient: neutral.

(*b*) *Terrain.* The terrain throughout the area of operations is rolling, with heavily wooded hilltops. The area in the south of the division sector is less wooded and has fewer cross-compartments than the area in the north. Areas of broken and wooded terrain will reduce the downwind cloud travel by approximately one-third.

(2) *Enemy situation.* All enemy forces opposing this division have been identified as elements of the 22d Mechanized Rifle Division. Committed forces consist of 5 mech rifle bns, 2 medium tank bns equipped with 64 medium tanks, and 2 recon companies with 10 amphibious tanks. Number

of enemy committed personnel is estimated to be 4,700. Fire support units consist of one mortar bn with 18 × 160-mm mortars, one gun bn with 18 × 55-mm guns, one how bn with 18 × 122-mm how, and one AAA regt with 24 × 57-mm SP guns. In addition, the above units can be reinforced by 4 mech rifle bns and 4 medium tank bns, with approximately 128 medium tanks, 10 × 122/152-mm assault guns, and 10 amphibious tanks. Key terrain features are the ridges formed by hills 201 and 247, and by hills 378 and 402. The enemy has excellent concealment for concentrating his attack forces in woods at coordinated 330450. Avenues of approach to our position are valleys (_____) and (_____). Terrain now held by the enemy favors an attack along (_____)—(_____) and (_____). Latest intelligence indicates that the enemy can complete his concentration for an attack by 201000Z.

(a) *Weapons and munitions.* Shortages in chemical ammunition limit its employment.

(b) *Chemical defense discipline.* Morale and chemical defense discipline are excellent.

(c) *Chemical protective equipment.* Chemical equipment is generally similar to that of U.S. forces.

(3) *Friendly situation.* This division defends in place the high ground from (_____) to (_____) with 7 battalions on the FEBA and 3 in blocking positions. Terrain in our present position does not favor defense against armored attack. Mission of the division along our left flank is to attack along (_____) of the division on corps order. Mission of the division along our right flank is to defend along (_____) and (_____). Employment of chemical and nuclear munitions can assist this division in delaying the enemy attack. *Division Artillery*—

105-mm Units:

1st Bn (105-mm Towed), 45th Arty
1st Bn (105-mm Towed), 46th Arty
1st Bn (105-mm Towed), 47th Arty

155-mm/8-in. Units:

1st Bn (155-mm/8-in. Towed), 48th Arty (3 btrys 155-mm and 1 btry 8-in.)

HONEST JOHN Units:

1st Bn (HONEST JOHN), 49th Arty

4.2-in. Mortar Sections:

4 mortars per inf bn.

M91 115-mm Rocket Launchers:

These are carried as class II items in the service battery of DS 105-mm how bns. The basis of issue is three launchers per 105-mm how bn. When required for a mission, rocket launchers are issued to designated firing batteries.

b. *Tactical Situation.*

(1) *Possible courses of action.* Defend in place or delay in successive positions.

(2) *Weapons available.*

(a) *Ground.* 601st FA Gp reinforces the fires of division artillery—

2d Bn (155-mm SP), 630th Arty (3 btrys)
2d Bn (155-mm SP), 631st Arty (3 btrys)
2d Bn (155-mm SP), 632d Arty (3 btrys)
2d Bn (8-in. SP), 650th Arty (3 btrys)

(b) *Air.* Four aircraft sorties. Each sortie can deliver sufficient GM munitions to attack target areas of about 60 hectares.

c. *Logistical Situation.*

(1) *Supply.* Available supply rate (rounds or other units per weapon per day) for the

period 18 to 21 (includes corps reinforcing artillery).

Agent	Mortar	105-mm How	155-mm How	8-in. How	M23 Mine	115-mm Rocket	762-mm Rocket
GB	—	12	8	5	—	90	2
HD	10	12	8	—	—	—	—
VX	—	—	4	2	40	45	—

(2) *Status of expenditures.*

GB—available ammunition has been fired daily so that no reserve credits exist.

HD—ammunition has not been used in current operations so that 4-day supply is now available.

VX—munition has not been used in current operations so that 4-day supply is now available.

d. Target Situation.

(1) Estimated mechanised rifle battalion consisting of about 1,800 troops and 180 vehicles dispersed in assembly area.

(*a*) Located in woods (coordinates), altitude (meters), 1,500 meters from our right flank. Accuracy, 100 percent.

(*b*) Target is roughly circular in shape, with a radius of about 350 meters, covering approximately 40 hectares.

(*c*) Target is partly covered by high canopy of trees but is vulnerable to chemical agents. Troops can seek shelter from HE fragments inside armored vehicles and in foxholes.

(2) Estimated two companies of infantry in fortified positions. (List same type of data as in (1) above.)

Note. Repeat for each target under consideration.

3. Analysis

a. Target Attack Capabilities.

(1) *Chemical ammunition available as of 200001Z (rounds or other units).*

Weapon	No.	Ammunition supply rate			Days of supply available			Total rounds available		
		GB	VX	HD	GB	VX	HD	GB	VX	HD
4.2-in. Mortar	40	—	—	10	—	—	4	—	—	1,600
105-mm How	54	12	—	12	2	—	4	1,296	—	2,592
155-mm How	72	8	4	8	2	4	4	1,152	1,152	2,304
8-in. How	16	5	2	—	2	4	—	160	128	—
M23 Mine	—	—	40	—	—	4	—	—	160	—
115-mm Rocket	9	90	45	—	2	4	—	1,620	1,620	—
762-mm Rocket	2	2	—	—	2	—	—	8	—	—

(2) *Area coverage capabilities.*

(*a*) *GB.*

1. Surprise dosage attack.

Note. Column 6 equals $\frac{\text{column 4}}{\text{column 5}}$

1	2	3	4	5	6
Weapon	Wpn/ btry	Rate of fire (15 sec)	Rounds/ btry (15 sec)	Rounds required/ hectare	Area coverage/ btry/15 sec (hectares)
105-mm How	6	3	18	18	1.0
155-mm How	6	1	6	5	1.2
8-in. How	4	1	4	3	1.3
115-mm Rocket	1	45	45	(See FM 3–10B)	
762-mm Rocket	2	1	2	(See FM 3–10B)	

2. *Total dosage attack.* Prepare data similar to that in *1* above, as required, for total dosage attack.

3. *Deployment limitations.*

(a) *Range.* Targets E4 and F3 are beyond range of light artillery.

(b) *Massing capability.* Slightly more than 50 percent of the available cannon artillery can mass GB fires on any target because of lateral deployment of division and corps artillery. Shifting of fires will permit successive GB attacks on two or more targets. Surprise dosage attacks will generally be limited to only two targets.

(*b*) *HD.*

1. Liquid contamination effect or vapor effect attack.

Weapon	Rounds available	Liquid contamination effect (480 lbs/hectare)		Vapor effect (1 hour exposure of masked troops in dry weather)	
		Rounds/hectare	Area coverage capability in 15 minutes (hectares)	Rounds/hectare	Area coverage capability in 15 minutes (hectares)
4.2-in. Mortar	1,600	96	16.6	95	16.8
105-mm How	2,592	160	16.0	174	14.9
155-mm How	2,304	42	55.0	56	41.0

2. *Deployment limitations.*

(a) *Range.* Targets E2, E4, and F3 are beyond range of mortars and light artillery.

(b) *Massing capability.* Targets can be attacked deliberately without the need for surprise effect. By preplanning, chemical ammunition can be shifted to firing units within range of targets.

(*c*) *VX.* Liquid contamination effect. Prepare data similar to that in (*b*) above, using classified data in FM 3–10B.

b. Target Analysis. The potential targets most affecting the schemes of maneuver under consideration are as follows:

(1) BRAVO 1, mechanized rifle battalion (coordinates).

(*a*) The battalion can outflank our right flank via (_____) and (_____).

(*b*) The battalion is highly mobile and can quickly move to another area or can launch an attack against the division by 201000Z.

(*c*) Although troop morale and chemical defense discipline are excellent, a surprise chemical attack at mealtime could produce between 20- and 40-percent casualties.

(*d*) Surprise can best be achieved by restricting registration fire and by attacking the target with TOT artillery fire. Minimum ammunition expenditures will be required for the chemical attack at night and during the first hour after sunrise or the last hour before sunset.

(*e*) The target is within range of 105-mm and 155-mm howitzer units. GB ammunition requirements are:

105-mm ..... (_____) rounds.
155-mm ..... (_____) rounds.

(2) CHARLIE 2, two companies of infantry (coordinates). (Same type of data as in (1) above.)

Note. Repeat for each target selected.

4. Evaluation and Conclusions

a. PRIORITY 1. BRAVO 1, the mechanized rifle battalion, has the highest priority for chemical attack because it presents the greatest threat to

accomplishing the division mission. Since the battalion is dispersed over a relatively large area partly in woods, it does not present a good nuclear target. The vehicles are protected from HE attack by the canopy of trees, and troops can take shelter inside the armored vehicles. A surprise GB attack at 200500Z should result in 10- to 15-percent casualties, possible contamination of some vehicles, and some disorganization of the unit. This should delay the participation of the battalion in a possible attack at full strength until it can be reorganized. If the battalion does participate in an attack before reorganization, it will do so at reduced strength. The battalion should be attacked without delay before it moves to another area where it may not be detected or to an area that is less favorable for attack. The wind is favorable and will impose no downwind hazard to friendly troops. The chemical attack will create no ground contamination or obstacles to planned future operations of friendly troops. The target should be attacked—

(1) Without delay.

(2) With delayed fuze.

(3) TOT at 200500Z.

(4) With surprise dosage artillery fire.

b. PRIORITY 2. CHARLIE 2, the two infantry companies, have a high priority. (List same type of data as in *a* above.)

Note. Repeat for each target selected.

5. Recommendations

Attack the following targets with chemical munitions as indicated.

a. GB.

(1) *Scheduled fires.* BRAVO 1 and CHARLIE 2.

(2) *On-call fires.* DELTA 1 and 2. If used in conjunction with nuclear strike, attack with chemical ammunition not less than 1 minute following nuclear strike those areas not destroyed.

b. HD.

(1) *Liquid contamination.* CHARLIE 3 and ECHO 2.

(2) *Vapor effect on call.* ALFA 1 and 2.

c. VX.

(1) *Scheduled fires.* CHARLIE 1.

(2) *On-call fires.* CHARLIE 2 and ECHO 1.

APPENDIX VIII

EXAMPLE OF A U. S. ARMY DIVISION TARGET OF OPPORTUNITY CHECKLIST

The following example of a target of opportunity checklist illustrates an abbreviated target analysis aid that can be used during periods of active combat when time does not permit detailed preplanned target analysis. Since the checklist is based on predicted meteorological conditions in the target area, ammunition requirements and area coverage capabilities of the artillery batteries may change from day to day.

1. Meteorological Conditions

Ammunition expenditures are based on the following meteorological conditions for the period ending (_____).

a. Temperature: 70° F.

b. Temperature gradient: neutral.

c. Wind speed: 8 knots.

d. No precipitation.

2. GB Area Coverage Capabilities

a. Surprise Dosage Attack.

Weapon	Wpn/btry	Rate of fire (15 sec)	Rounds/ btry (15 sec)	Rounds required/ hectare	Area coverage/ btry/15 sec (hectares)	Remarks
105-mm	6	3	18	11	1.6	—
155-mm	6	1	6	3	2.0	—
8-in.	4	1	4	1.5	2.6	—
115-mm	1	45	45	NA	Variable*	*Classified
762-mm	2	1	2	NA	Variable*	*Classified

b. Total Dosage Attack.

Weapon	Wpn/btry	Rate of fire (15 min)	Rounds/ btry (15 min)	Rounds required/ hectare	Area coverage/ btry (hectares)
105-mm	6	66	396	5	79
155-mm	6	24	144	1	144
8-in.	4	10	40	1	40

3. HD Area Coverage Capabilities

a. Liquid Contamination Attack.

Weapon	Wpn/btry	Rate of fire (15 min)	Rounds/ btry (15 min)	Rounds required/ hectare	Area coverage/ btry (hectares)
4.2-in.	4	105	420	96	4.4
105-mm	6	66	396	160	2.4
155-mm	6	24	144	42	3.4

b. Vapor Attack to Incapacitate Masked Troops After 1 Hour's Exposure.

Weapon	Wpn/btry	Rate of fire (15 min)	Rounds/ btry (15 min)	Rounds required/ hectare	Area coverage/ btry (hectares)
4.2-in.	4	105	420	81	5.1
105-mm	6	66	396	156	2.5
155-mm	6	24	144	54	2.6

4. VX Area Coverage Capabilities, Liquid Contamination Attack

Weapon	Wpn/btry	Rate of fire (15 sec)	Rounds/ btry (15 sec)	Rounds required/ hectare*	Area coverage/ btry* (hectares)	Remarks
115-mm	1	45	45	Variable	Variable	*Classified. Varies according to contamination level required.
155-mm	6	24	144	Variable	Variable	
8-in.	4	10	40	Variable	Variable	

APPENDIX IX

EXAMPLE OF A U. S. ARMY DIVISION CHEMICAL FIRE PLAN APPENDIX TO THE FIRE SUPPORT PLAN

1. General

The fire support plan is an annex to the unit operations order and is the basic document for planning, coordinating, and integrating all available fire support for ground operations. Normally, all details of chemical fire support are stated in the chemical subparagraph of the fire support plan, with targets graphically portrayed on the artillery fire support plan. However, when a major chemical attack is planned against many targets, a chemical fire plan may be prepared by the CBRE as an appendix to the division fire support plan. The format of the chemical fire plan is similar to that of the artillery fire plan: a graphic overlay showing target concentrations, target list, and schedule of fires.

2. Composition

The chemical fire plan (fig. 5) includes a heading, references, target list and schedule of fires, acknowledgment, and signature. Information normally included in the fire support plan is not repeated in the chemical fire plan. The following information appears in the chemical fire plan:

a. Graphic Portrayal of Targets. Targets are shown as tick marks, the center of the tick being the center of the target. Targets are outlined in size and shape, and concentrations are numbered in the upper right-hand corner of the tick.

b. Target List. This list contains the planned concentrations. The FSE designates the firing units.

c. Schedule of Fires. This schedule shows the concentrations to be fired (above the horizontal bar), the time to begin firing and the time it will be completed (on the column headings), and the munitions expenditures for each unit (below the horizontal bar).

d. Additional Information. The chemical fire plan may include the following additional information:

(1) A table listing the groups of fires planned to cover a single tactical locality too large to be covered by a single concentration.

(2) Marginal information on the overlay that is considered pertinent and necessary.

Figure 5. Example of a chemical fire plan.
(Located in back of manual.)

★APPENDIX X

EXAMPLE OF A U.S. MARINE CORPS CHEMICAL FIRE SUPPORT PLAN ANNEX TO AN OPERATIONS ORDER

This example of a U.S. Marine Corps Chemical Fire Support Plan Annex to an operations order illustrates a method of planning, coordinating, and controlling chemical fires during an amphibious landing on a hostile shore. Overlays which would accompany this fire plan are omitted. Abbreviated Appendix 1, Chemical Aircraft Spray Munitions Availability, and Appendix 2, Plan of Chemical Fires, to the fire support plan illustrate the formats used.

Copy _____ of _____ copies
_____ Marine Amphibious Force
and Landing Force (TF33)
c/o FPO _____
201200Z March 1965

Annex _____ (Chemical Fire Suppor Plan) to Opn Plan 4-65

Ref: (a) MAP: _____

(b) FMF PAC ORDER _____ (Chemical Employment SOP)

Time Zone: G

★1. SITUATION

a. Enemy Forces—See Annex—(Intelligence) to Operation Plan 4-65.

b. Friendly Forces.

(1) TF 35 (Attack Carrier Striking Force) on order employs chemical munitions against designated targets in accordance with appendix 2 (Plan of Chemical Fires) and appendix 3 (Chemical Employment Overlays).

(2) TG 31.3 (Support Carrier Group) on order employs chemical munitions against designated targets in accordance with appendix 2 (Plan of Chemical Fires) and appendix 3 (Chemical Employment Overlays).

(3) TG 31.4 (Fire Support Group) on order employs chemical munitions against designated targets in accordance with appendix 2 (Plan of Chemical Fires) and appendix 3 (Chemical Employment Overlays).

★2. MISSION

Chemical delivery agencies employ chemical munitions contingent upon necessity and resultant authorization for employment in support of Landing Force Units (TF 33) in seizing, occupying, and defending positions in the objective area.

★3. EXECUTION

a. Concept of Operations

(1) Based on necessity and time of receipt of authorization, employment of chemical munitions will be as follows:

(a) Lethal, nonpersistent chemical munitions on D—1 day and D-day.

(b) Lethal, persistent chemical munitions on D-day.

(c) Nonlethal, nonpersistent chemical munitions on D-day.

(d) Individual or collective munitions in above categories as situation dictates subsequent to D-day.

(2) Employment of chemical munitions is scaled from nonuse on a continuum through total employment.

b. TG 33.1 (3d Mar Div (Reinf)). On order provide chemical fire support in accordance with appendix 2 (Plan of Chemical Fires).

c. TF 33.5 (RLT-7). On order establish chemical barriers in accordance with appendix 2 (Plan of Chemical Fires) and appendix 3 (Chemical Employment Overlays).

d. TG 33.7 (Landing Force Artillery). On order provide on-call chemical fires and be prepared to deliver designated chemical fires against targets of opportunity in accordance with appendix 2 (Plan of Chemical Fires).

e. TG 33.6 (U.S. Army Airborne Brigade). On order deliver designated chemical fires on targets of opportunity in accordance with appendix 2 (Plan of Chemical Fires).

f. TG 33.2 (Landing Force Aviation) (1st MAW). Approximately on D—2 days, be prepared to deliver on order chemical fires in accordance with appendix 2 (Plan of Chemical Fires).

g. Coordinating Instructions.

(1) See reference b.

(2) Delivery of chemical fires, except chemical agent CS, by landing force delivery means on order of Landing Force Commander only.

(3) TG 33.1 coordinate use of agent CS in accordance with reference b.

(4). Troop safety in accordance with appendix 4 (Troop Safety) and reference b.

(5) Reports in accordance with reference b.

(6) Warning procedures in accordance with reference b and Annex _____ (Communications-Electronics).

4. ADMINISTRATION AND LOGISTICS

See Administrative Plans 4-65.

5. COMMAND AND COMMUNICATIONS-ELECTRONICS

See Annex ____ (Communications-Electronics).

BY COMMAND OF MAJOR GENERAL LEATHER:

W. L. DONE
Colonel, U.S. Marine Corps
Chief of Staff

APPENDIXES:

1. Chemical Aircraft Spray Munitions Availability
2. Plan of Chemical Fires
3. Chemical Employment Overlays 1–5 (Omitted)
4. Troop Safety (Omitted)

DISTRIBUTION: Annex (Distribution) to Opn Plan 4–65.

OFFICIAL:

★APPENDIX 1. (CML AIRCRAFT SPRAY MUNITIONS AVAILABILITY) TO ARMY—(CML FIRE SUPPORT PLAN) TO OPN PLAN 4–65

Line No.	Spray munitions		Delivered by	Location		Event
	GB	VX		Afloat	Ashore	
1.	1-14B		TG 81.3	CVA-61		DELTA
2.	1-14B					
3.	1-14B					
4.	1-14B					
5.	1-14B					
6.	1-14B					
7.	1-14B		TG 81.3	CVA-61		GOLF
8.	1-14B					
9.	1-14B					
10.	1-14B					

★Appendix 2. (PLAN OF CML FIRES) TO ANNEX (CML FIRE SUPPORT PLAN) TO OPN PLAN 4–65
201200Z MARCH 1965

1	2	3	4	5	6							7
		Time of delivery	Target	Type agent	Delivery means							
					Air				Artillery			
Event	Delivery unit	Scheduled fires (Execute on Order Only)	Description	Location overlay No.	CML	Aero-14B	MK-94	MK-116	M4 Disp	8-in. How	155 How	105 How	Munitions wpns allocation
•		•	•	•				•				•	•
	(TARGET SYSTEM SEVEN)												
Tango:	TG 33.3	D—Day at H—4 hrs	Inf Regt CP, Arty Pos	4	GB		X	X					18 MK94, 6 MK116
Uniform:	TG 33.3	do	do	5	VX	X							8 14B.
X Ray:	TG 33.5	D—Day at H+2 hrs until canceled.	do								X		1050 155-mm How
	ON-CALL FIRES												
	TG 33.7	ON CALL	OBJ No. 5 and 6	1	GB					X			50 8-in. How per objective.
	TG 33.1	When occurring—On order.	Guerrillas, rioters, etc.	As dsg	CS				X				Troops: M25A2, M7A1, F.T. W/E46.
LANDING FORCE WEAPONS FOR CONTROL OF ENEMY REINFORCING CAPABILITY													
	TG 33.7		Tgt of opportunity	As dsg	GB					X	X	X	150 8-in. How, 270–155 How, 600–105 How
	TG 33.6			do	GB							X	250–105 How
	TG 33.7			do	VX						X		330–155 How
	TG 33.1	(TG 33.2 Approx D+2 days and after).		do	GB	X	X	X					72 14B, 216 MK94
	do			do	VX	X							72 14B
	do			do		X							2 14B
	do			do		X							4 14B
	do			do									10 14B
	LANDING FORCE RESERVE WEAPONS												
	TG 33.1	(AIR MUNITIONS)			GB	12	18			25	50	100	AIR-DELIVERED WPNS REVERT TO TG 33.2 ON ORDER.
	TG 33.7	(GROUND MUNITIONS).			VX	8		19					
						2							
					CS				X				Bulk 640 pounds

APPENDIX XIII
CHEMICAL AMMUNITION EXPENDITURE TABLES

General

Chemical ammunition expenditure tables (VI–VIII and XI–XV) for unclassified GB weapons and HD weapons are included in this appendix. See chapter 7, section I, for an explanation of the use of these tables, appendix XIV for examples, and paragraph 67 for information on converting area coverage into percentage of GB casualties expected.

Table VI. GB Ammunition Expenditures for the 105-mm Howitzer [1]
(Cartridge M360, PD fuze)

Temperature gradient	Wind speed (knots)	Rounds per hectare for 50-percent coverage [2] of a target area with a casualty-producing dosage [3] (Against troops in open or lightly wooded terrain) [4]					
		Surprise dosage attack [5]			Total dosage attack		
		0°–30°F	31°–60°F	Above 60°F	0°–30°F	31°–60°F	Above 60°F
Lapse	3	79	73	66	9	7	6
	5	37	31	28	14	11	9
	8	36	24	18	20	17	14
Neutral	3	38	38	32	2	2	1
	5	22	18	16	5	3	2
	8	22	12	11	9	6	5
	14	39	17	13	19	12	9
	28	73	37	24	42	27	20
Inversion	3	29	25	22	1	1	1
	5	19	15	13	2	1	1
	8	20	11	8	5	3	2

[1] Weapon rate of fire (6 wpns/btry): 3 rds/15 sec; 30 rds/3 min; 66 rds/15 min.
[2] For 30-percent coverage, multiply by 0.7. For 80-percent coverage, multiply by 1.6.
[3] See paragraph 67 for estimate of casualties.
[4] For jungle or heavily wooded terrain, use data for a 3-knot wind speed.
[5] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 58b.

★*Table VII. GB Ammunition Expenditures for the 155-mm Howitzer* [1]
(Projectile M121, PD fuse)

Temperature gradient	Wind speed (knots)	Rounds per hectare for 50-percent coverage [2] of a target area with a casualty-producing dosage [3] (Against troops in open or lightly wooded terrain)[4]					
		Surprise dosage attack [5]			Total dosage attack		
		0°–30°F	31°–60°F	Above 60°F	0°–30°F	31°–60°F	Above 60°F
Lapse	3	20	19	17	3	2.5	2.5
	5	11	9	7	5	4	3
	8	13	8	6	8	7	5
Neutral	3	10	9	9	1	1	1
	5	6	5	5	1	1	1
	8	6	5	3	2	1.5	1
	14	10	5	3	5	3	2
	28	22	10	5	11	7	5
Inversion	3	9	7	6	1	1	1
	5	5	4	4	1	1	1
	8	5	3	2	1	1	1

★[1] Weapon rate of fire (6 wpns/how btry): 1 rd/15 sec; 12 rds/3 min; 24 rds/15 min.
[2] For 30-percent coverage, multiply by 0.7. For 80-percent coverage, multiply by 1.6.
[3] See paragraph 67 for estimation of casualties.
[4] For jungle or heavily wooded terrain, use data for a 3-knot wind speed.
[5] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 55b.

Table VIII, GB Ammunition Expenditures for the 8-Inch Howitzer [1]
(Projectile M426, PD fuse)

Temperature gradient	Wind speed (knots)	Rounds per hectare for 50-percent coverage [2] of a target area with a casualty-producing dosage [3] (Against troops in open or lightly wooded terrain)[4]					
		Surprise dosage attack [5]			Total dosage attack		
		0°–30°F	31°–60°F	Above 60°F	0°–30°F	31°–60°F	Above 60°F
Lapse	3	14	14	13	2	2	1
	5	7	6	5	3	3	2
	8	6	4	3	4	3	3
Neutral	3	9	8	6	1	1	1
	5	4	3	3	1	1	1
	8	3	2	1.5	1	1	1
	14	4	2	1.5	2	2	1
	28	9	4	2	5	2	1
Inversion	3	6	6	5	1	1	1
	5	3	3	3	1	1	1
	8	2	1.5	1.5	1	1	1

[1] Weapon rate of fire (4 wpns/btry): 1 rd/15 sec; 4 rds/2 min; 10 rds/15 min. One USMC battery contains 6 howitzers.
[2] For 30-percent coverage, multiply by 0.7. For 80-percent coverage, multiply by 1.6.
[3] See paragraph 67 for estimation of casualties.
[4] For jungle or heavily wooded terrain, use data for a 3-knot wind speed.
[5] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 88b.

Tables IX and X rescinded

Table XI. ★GB Ammunition Expenditures for the 155-mm Howitzer Battery in the Attack of a One-Hectare or Smaller Target Containing Fortifications with Overhead Cover or Tanks

Temperature gradient	Wind speed (knots)	Rounds per hectare for 50-percent coverage with a casualty-producing dosage				
		Surprise dosage attack [1]				Total dosage attack
		Dosage effects in 15 seconds		Dosage effects in 30 seconds		
		0–30°F [2]	Above 30°F	0–30°F [2]	Above 30°F	0–Above 30°F
Lapse	All [3]	N.S. [4]	36	N.S.	24	15
Neutral	Below 10	N.S.	36	N.S.	24	12
	Above 10	N.S.	36	N.S.	30	24
Inversion	All	N.S.	36	N.S.	24	6

[1] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 58b and *c*.
[2] Snow-covered terrain.
[3] Strong lapse or inversion temperature gradient can be expected only at low to moderate wind speeds, since high wind speeds eliminate stratification.
[4] Not suited. Munition requirements are unacceptably high, or agent cloud cannot be depended upon to develop significant casualties inside fortifications within this time interval.

Table XII. GB Ammunition Expenditures for the 105-mm Howitzer Battery [1] in the Attack of a One-Hectare or Smaller Target Containing Fortifications with Overhead Cover or Tanks

Temperature gradient	wind speed (knots)	Rounds per hectare for 50-percent coverage with a casualty-producing dosage				
		Surprise dosage attack [2]				Total dosage attack
		Dosage effects in 15 seconds		Dosage effects in 30 seconds		
		0–30°F [3]	Above 30°F	0–30°F [3]	Above 30°F	0–Above 30°F
Lapse	All [4]	N.S. [5]	108	N.S.	60	36
Neutral	Below 10	N.S.	108	N.S.	60	24
	Above 10	N.S.	132	N.S.	72	48
Inversion	All	N.S.	108	N.S.	60	18

[1] Munition expenditures for 105-mm howitzer batteries alone may be considered too high for attack of hard targets. However, 105-mm howitzer batteries can be used to augment fires of higher caliber batteries.
[2] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 58b and *c*.
[3] Snow-covered terrain.
[4] Strong lapse or inversion temperature gradient can be expected only at low to moderate wind speeds, since high wind speeds eliminate stratification.
[5] Not suited. Munition requirements are unacceptably high, or agent cloud cannot be depended upon to develop significant casualties inside fortifications within this time interval.

Table XIII. GB Ammunition Expenditures for the 8-Inch Howitzer Battery in the Attack of a One-Hectare or Smaller Target Containing Fortifications with Overhead Cover or Tanks

Temperature gradient	Wind speed (knots)	Rounds per hectare for 80-percent coverage with a casualty-producing dosage				
		Surprise dosage attack[1]				Total dosage attack
		Dosage effects in 15 seconds		Dosage effects in 30 seconds		
		0-30°F.[2]	Above 30°F.	0-30°F.[2]	Above 30°F.	0-Above 30°F.
Lapse	All[3]	N.S.[4]	16	N.S.	12	8
Neutral	Below 10	N.S.	16	N.S.	12	4
	Above 10	N.S.	16	N.S.	16	8
Inversion	All	N.S.	16	N.S.	12	4

[1] TOT fire is recommended for maximum effectiveness; if not practicable see paragraph 88b and c.

[2] Snow-covered terrain.

[3] Strong lapse or inversion temperature gradient can be expected only at low to moderate wind speeds, since high wind speeds eliminate stratification.

[4] Not suited. Munition requirements are unacceptably high, or agent cloud cannot be depended upon to develop significant casualties inside fortifications within this time interval.

Table XIV. HD Ammunition Expenditures for Vapor Effect
(50-percent coverage of target area)[1]

Desired effect[2]	Exposure time (hours)	Temperature (°F.) 55° 70° 85° 100°	Rounds required per hectare: 4.2-Inch mortar (Cartridge M2A1)[3] — Wind Speed: 3 knots; 5 knots; 8 knots; 14 knots — Temperature gradient[4]: L N I	105-MM Howitzer (Cartridge M60)[3] — Wind Speed: 3 knots; 5 knots; 8 knots; 14 knots — Temperature gradient[4]: L N I	155-MM Howitzer and gun (Projectiles M110 and M104)[3] — Wind Speed: 3 knots; 8 knots; 14 knots — Temperature gradient[4]: L N I
Cause eye irritation to troops without masks.	1	½ ¼ ⅛	16 14 10 | 22 21 11 | 26 22 15 | 29 24 20	27 24 22 | 39 34 24 | 46 44 39 | 65 53 32	10 10 8 | 12 11 9 | 13 12 10 | 16 14 11
	2	1 ½ ¼	9 8 6 | 14 12 8 | 16 13 12 | 24 21 17	23 22 18 | 27 22 20 | 34 32 29 | 51 39 26	9 8 6 | 11 10 8 | 12 11 9 | 14 12 10
	4	2 1 ½	8 6 6 | 10 9 8 | 13 10 9 | 20 16 13	20 17 16 | 20 18 17 | 24 22 20 | 39 29 22	6 5 4 | 9 8 6 | 10 9 8 | 12 10 9
	8	4 2 1	6 6 4 | 9 8 6 | 11 9 8 | 15 13 12	17 15 12 | 17 12 13 | 22 20 15 | 36 27 18	5 5 4 | 8 6 5 | 9 8 6 | 11 9 8
	16	8 4 2	5 5 4 | 9 8 5 | 10 8 8 | 13 11 10	13 12 10 | 15 11 10 | 20 17 12 | 34 24 15	4 4 4 | 6 5 4 | 8 6 5 | 10 8 5
Disable masked troops (sweating in humid weather).	1	½ ¼ ⅛	52 46 35 | 63 53 39 | 80 63 46 | 108 77 59	108 83 70 | 121 95 77 | 166 123 95 | 242 157 108	30 28 20 | 36 32 23 | 44 39 26 | 58 46 32
	2	1 ½ ¼	33 29 20 | 40 35 24 | 56 45 30 | 69 59 41	63 54 42 | 84 63 47 | 102 89 66 | 192 108 82	20 17 12 | 24 22 15 | 34 27 18 | 46 36 24
	4	2 1 ½	24 21 15 | 33 27 17 | 42 35 24 | 65 47 30	45 38 27 | 62 47 32 | 84 64 48 | 162 88 64	16 13 10 | 20 18 11 | 27 20 15 | 33 29 18
	8	4 2 1	18 17 11 | 26 21 13 | 38 28 17 | 63 45 27	34 29 18 | 47 38 24 | 76 53 33 | 138 83 54	12 10 6 | 16 13 9 | 24 17 12 | 33 23 16
	16	8 4 2	16 14 9 | 22 18 11 | 33 24 16 | 58 42 24	27 23 15 | 42 32 18 | 66 51 30 | 120 72 48	11 9 5 | 15 11 8 | 22 15 11 | 29 20 15
Disable masked troops (dry weather).	1	½ ¼ ⅛	95 83 64 | 114 95 72 | 144 113 86 | 198 144 108	174 154 128 | 212 174 144 | ... ... 189 | 202	53 48 36 | 63 56 41 | 78 66 46 | 105 83 59
	2	1 ½ ¼	58 52 36 | 72 62 44 | 101 81 57 | 125 120 71	128 98 75 | 147 113 89 | 180 156 111 | 288 198 148	33 28 21 | 41 36 26 | 62 54 38 | 84 66 42
	4	2 1 ½	41 35 26 | 56 46 30 | 76 62 45 | 119 86 57	81 64 50 | 111 86 59 | 153 118 88 | 256 165 117	26 21 15 | 33 28 18 | 45 36 26 | 66 50 33
	8	4 2 1	30 27 18 | 44 35 23 | 68 50 32 | 114 81 50	58 50 33 | 84 65 45 | 138 95 62 | 240 154 101	18 16 11 | 26 21 13 | 40 33 22 | 56 42 28
	16	8 4 2	26 21 13 | 40 30 18 | 60 46 29 | 108 72 42	45 39 26 | 72 56 34 | 120 84 54 | 198 132 84	15 12 9 | 21 18 11 | 36 30 18 | 46 36 24

[1] For open terrain. For heavily wooded terrain or jungle, multiply the figure obtained by 0.5 to obtain the appropriate expenditure.
[2] See paragraph 69 for estimation of casualties.
[3] Weapon rate of fire:
(4 wpns/sec) 4.2-inch mortar—50 rds/3 min; 105 rds/15 min.
(6 wpns/btry) 105-mm howitzer—30 rds/3 min; 66 rds/15 min.
(6 wpns/btry) 155-mm howitzer—12 rds/3 min; 24 rds/15 min.
(4 wpns/btry) 155-mm gun—4 rds/3 min; 10 rds/15 min.
[4] Temperature gradient abbreviations used are as follows: L—lapse; N—neutral; and I—inversion. Blank spaces indicate excessive expenditures.

Table XV. HD Ammunition Expenditures for Liquid Contamination Effect[1]

A. AMMUNITION EXPENDITURES FOR INITIAL CONTAMINATION

(50-percent coverage of target area)

AMMUNITION	4.2-INCH MORTAR[2]	105-MM HOWITZER[2]	155-MM GUN OR HOWITZER[2]
Number of rounds required per hectare	96	180	42

B. RATE FACTORS TO DETERMINE WHEN TO REPLENISH CONTAMINATION

TERRAIN FACTOR		multiplied by	WIND SPEED FACTOR (at 2 meters in the open)		multiplied by	GROUND SURFACE TEMPERATURE FACTOR		multiplied by	TEMPERATURE GRADIENT FACTOR (in the open)		EQUALS
OPEN GRASSLAND	1		1 knot	3.1		30° F.	12.5		LAPSE	0.7	TIME (HOURS) IN WHICH ABOUT 50% OF CONTAMINATION WILL HAVE EVAPORATED.[3]
FOREST OR JUNGLE	1		2 knots	1.8		40°F.	7.0		NEUTRAL	1.0	
BARREN SOIL OR SAND	2		3 knots	1.3		50°F.	4.0		INVERSION	1.3	
			4 knots	1.0		60°F.	2.5				
			5 knots	0.8		70°F.	1.6				
			6 knots	0.7		80°F.	1.0				
			7 knots	0.6		90°F.	0.6				
			9 knots	0.5		100°F.	0.4				
			11 knots	0.4		110°F.	0.3				
			14 knots	0.3		120°F.	0.2				
			18 knots	0.2							

[1] For estimation of casualties, see paragraph 68.

[2] Weapon rate of fire:

4.2-inch mortar-105 rds/15 min.

105-mm howitzer-60 rds/15 min.

155-mm howitzer-24 rds/15 min.

155-mm gun-10 rds/15 min.

[3] Terrain, wind speed, ground surface temperature, and temperature gradient factors multiplied together give the time (number of hours) in which about 50 percent of the contamination will have evaporated.

APPENDIX XIV

SAMPLE CANNON ARTILLERY AND MORTAR PROBLEMS; COMPUTATION OF AMMUNITION REQUIREMENTS

1. General

This appendix contains examples of computing ammunition expenditures for attack of targets with cannon artillery and mortars. See chapter 7, section I, for an explanation of the methods used; appendix XIII for ammunition expenditure tables for cannon artillery and mortars; and paragraph 67 for information on converting area coverages into percentage of GB casualties expected.

2. Nonpersistent Chemical Attack

a. Data Given.

(1) Meteorological forecast: neutral temperature gradient, 8-knot wind speed, and temperature 40°–50° F.

(2) Terrain: lightly wooded.

(3) Weapons to fire: 155-mm howitzers.

(4) Size or target: about 300 by 200 meters.

b. Surprise Dosage Attack Problem. To obtain casualties by covering 50 percent of the target area with a casualty-producing dosage.

(1) Find total number of rounds required.

(*a*) Use table VII to find that 5 rounds are required per hectare, from the following columns and entries: temperature gradient, neutral; wind speed, 8 knots; and surprise dosage attack; temperature, 31°–60° F.

(*b*) Multiply the number of hectares (6) in the target by the number of rounds required per hectare (5), for a total of 30 rounds.

(2) Find the number of artillery units needed to fire the mission. One 155-mm howitzer can fire 1 round within 15 seconds. Therefore, it takes 30 howitzers to fire a surprise dosage attack. Since there are 6 howitzers in a 155-mm battery, it takes 5 batteries to fire the mission within 15 seconds.

c. Total Dosage Attack Problem. To obtain casualties by covering 80 percent of the target area with a casualty-producing dosage, firing 105-mm howitzers.

(1) Find total number of rounds required.

(*a*) Use table VI to find that 6 rounds are required per hectare, from the following columns and entries: temperature gradient, neutral; wind speed, 8 knots; and total dosage attack; temperature, 31°–60° F. Multiply 6 by 1.6 (80-percent coverage factor) to obtain 9.6, the corrected number of rounds per hectare.

(*b*) Multiply the number of hectares (6) in the target by the number of rounds required per hectare (9.6), for a total of 58 rounds.

(2) Find the number of artillery units needed to fire the mission. By following the procedure outlined in *b*(2) above, it is found that one battery can cover the target area in about 2 minutes of firing.

3. Persistent Chemical Attack

a. HD Vapor Effect Problem. To disable masked troops in dry weather.

(1) Data given.

(*a*) Meteorological forecast: inversion tem-

perature gradient, 5-knot wind speed, and temperature 50°–60° F.

(*b*) Estimated duration of exposure: 1 hour.

(*c*) Terrain: heavily wooded.

(*d*) Weapon and duration of fire: 4.2-inch mortars, firing for about 15 minutes.

(*e*) Size of target area: about 800 by 200 meters.

(2) Find total number of rounds required.

(*a*) Use table XIV to find that 72 rounds are required per hectare, from the following columns and entries: 4.2-inch mortar; wind speed, 5 knots: inversion temperature gradient; desired effect, to disable masked troops (dry weather); and 1 hour of exposure at 55° F. Multiply 72 by 0.5 (heavily wooded terrain factor) to obtain 36, the corrected number of rounds per hectare.

(*b*) Multiply the number of hectares (16) by number of rounds per hectare (36), for a total of 576 rounds.

(3) Find the number of 4.2-inch units needed to fire the mission. One 4.2-inch mortar can fire 105 rounds in 15 minutes. Therefore, it takes about 6 mortars (576 divided by 105) to fire the mission in 15 minutes. Since there are 4 mortars in a section, it takes 1 section about 20 minutes to fire the mission or 2 sections about 10 minutes to fire it.

b. HD Liquid Contamination Problem. To contaminate a target with liquid HD.

(1) Data given.

(*a*) Meteorological forecast: lapse temperature gradient, 2- to 4-knot wind speed, and temperature 65°–75° F.

(*b*) Terrain: open grassland.

(*c*) Weapon and duration of initial fire: 155-mm howitzers, firing about 15 minutes.

(*d*) Size of target: very irregular shape, taken as a 400-meter square for fire planning.

(2) Find number of rounds required for initial contamination.

(*a*) Use part A of table XV to find that 42 rounds are required per hectare.

(*b*) Assign a value of 16 hectares (400 × 400 meters). Multiply the number of hectares (16) by the number of rounds required per hectare (42), for a total of 672 rounds.

(3) Find the number of artillery units needed to fire the initial mission. One 155-mm howitzer can fire 24 rounds in 15 minutes. Therefore, it takes 28 howitzers (672 divided by 24) to fire the mission in 15 minutes. Since there are 6 howitzers in a battery, 5 batteries can fire the mission in about 15 minutes, or 3 batteries can fire it in 25 minutes.

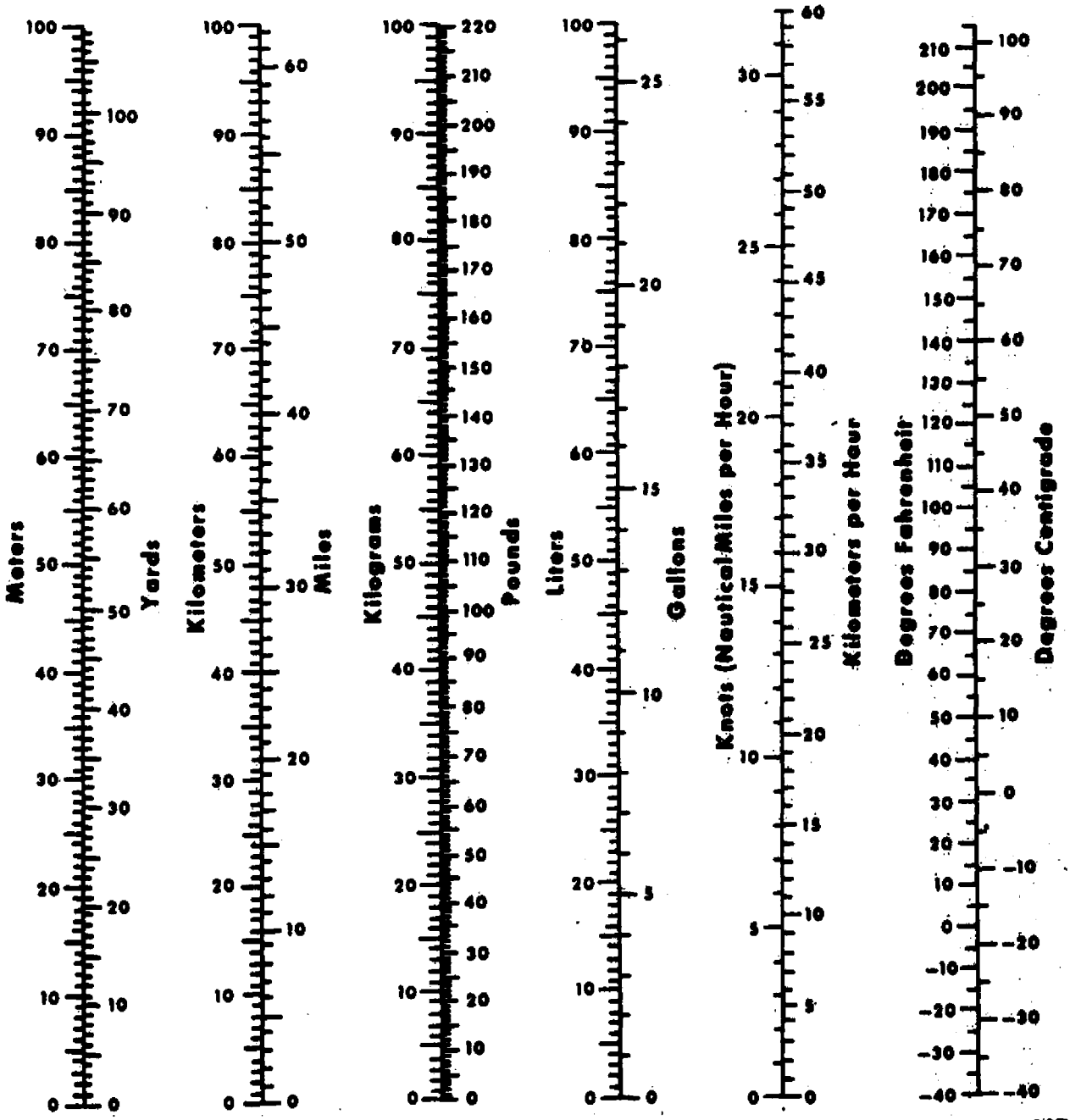
(4) Determine when to replenish the initial contamination. Use part B of table XV to find that the initial contamination must be replenished every 1¾ hours, by converting the data given into factors and multiplying them together: open grassland (1), multiplied by wind speed (1.3), multiplied by temperature (1.6), multiplied by lapse temperature gradient (0.7) equals 1.45 hours.

APPENDIX XV

CONVERSION SCALES

APPENDIX XV

CONVERSION SCALES



APPENDIX XVI

TABLE OF CONVERSION FACTORS

The following conversion factors are useful for quick reference:

1 meter	39.4 inches 1.1 yards
1 Kilometer	1,000 meters 0.62 miles 0.54 nautical mile
1 mile	1.6 kilometers 0.87 nautical mile
1 knot	1.15 miles per hour 1.0 nautical mile per hour
1 nautical mile	1.15 miles 1.85 kilometers
Mach (speed of sound)	660 knots at sea level (1,200 kilometers per hour)
1 square yard	0.8 square meter
1 hectare	10,000 square meters
1 square kilometer	1,000,000 square meters 100 hectares
1 square mile	259 hectares
1 milligram	.001 of 1 gram
1 ounce	28.35 grams
1 pound	453.6 grams
Degrees Fahrenheit	9/5 °C. + 32°
Degrees Centigrade	5/9 (°F. — 32°)

★GLOSSARY

AEROSOL—Consists of a solid or a liquid, not vaporized, but divided into particles small enough to float in the air for extended periods of time. (A vapor is the gaseous form of any substance that is normally a solid or a liquid.)

CASUALTY THREAT LEVEL—The percent casualties expected among unprotected troops who are exposed to a chemical attack.

CHEMICAL GB CASUALTY-PRODUCING DOSAGE—Consists of lethal dosages in the vicinity of the munition burst and of incapacitating dosages downwind.

CHEMICAL CASUALTY—A person who has been affected sufficiently by a chemical agent to make him incapable of performing his duties or continuing his mission.

a. *Immediate chemical casualty*—A person who becomes a casualty within one hour after being subjected to a chemical attack.

b. *Delayed chemical casualty*—A person who becomes a casualty more than one hour after being subjected to a chemical attack.

CUTANEOUS—Affecting the skin.

DOSAGE—A measure of the amount of agent in a given volume of air to which troops are exposed for a period of time.

Chemical dosage—The product of the concentration of the agent in milligrams per cubic meter of air multiplied by the time of exposure in minutes (mg-min/m^3).

DOSE—The amount of agent that is taken into or absorbed by the body. Chemical dose is measured in milligrams.

HECTARE—10,000 square meters in any configuration.

MEDIAN DOSAGE

a. *Median Lethal dosage*—The dosage that will kill 50 percent of a large group of unprotected and exposed troops if they do not receive medical treatment in time.

b. *Median incapacitating dosage*—The dosage that will incapacitate 50 percent of a large group of unprotected and exposed troops.

PERCUTANEOUS—Means "through the skin." Percutaneous effects are achieved by penetration of a person's skin by a chemical agent liquid, vapor, or aerosol.

PERSISTENCY—Pertains to duration of effectiveness; refers to the length of time a chemical agent remains effective in the target area after dissemination by a particular agent-munition combination.

SURPRISE DOSAGE ATTACK—A GB chemical fire/strike establish a dosage sufficient to produce the desired casualties before troops can mask.

TOTAL DOSAGE ATTACK—A GB chemical fire/strike mission that is not time-limited so as to build up the dosage over an extended period of time. This type of attack normally is employed against troops who have no protective masks available.

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17–22 (5)

NG: State AG (3): units same as active Army except allowance is one copy each unit.

USAR: Same as active Army except allowance is one copy each unit.

For explanation of abbreviations used, see AR 320–50.

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MANES
Maj Gen

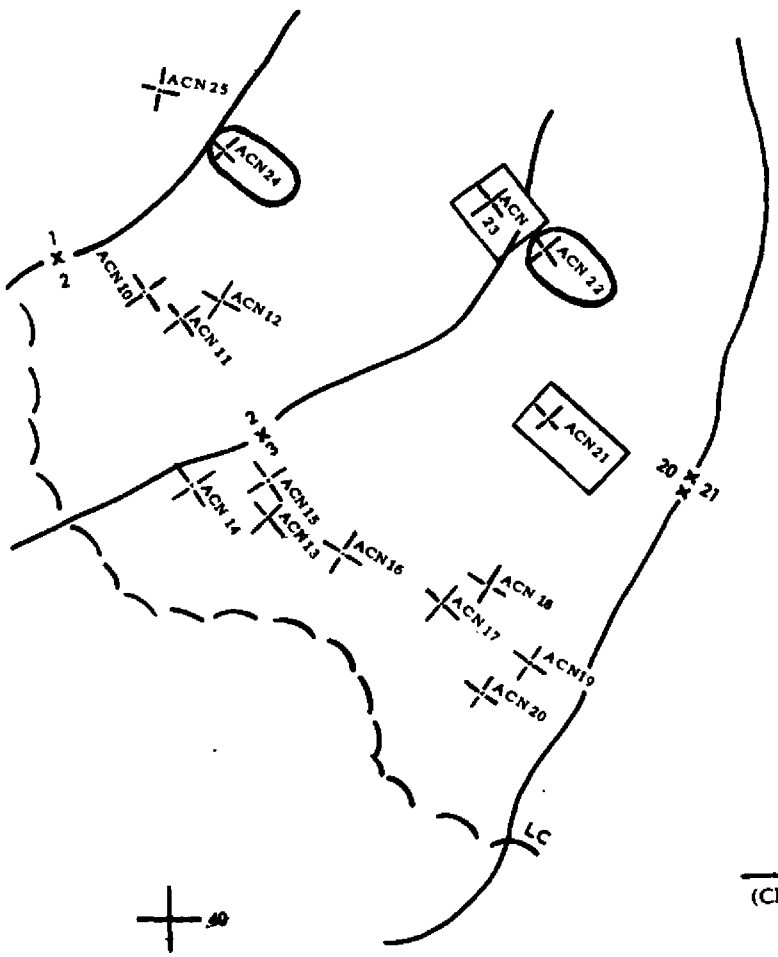
Distribution: A

OFFICIAL:

G3

Target No.	Des
ACN-10	Trp in
ACN-11	Trp in
ACN-19	Trp in
ACN-20	Trp in
ACN-21	Entren
ACN-27	Trp in
ACN-28	Trp in

Bn	Batte
1st How Bn	A
	B
7th Arty	C
4th How & 8-in. How Bn	A
	B
8th Arty	C
	D



(Classification)

TAGO 6664 A

Figure 5. E

cation)

Munition Computations Based on Avg Weather Conditions
(Recompute if Conditions Change at Firing Time)

Temperature gradient	Neutral
Wind speed and direction	4 knots SW
Temperature	65° F

CHEMICAL TARGET LIST

cription	Coordinates (center)	Alt (meters)	Bearing (mils grid north)	Target size Meters	Wpn/munitions	Firing unit(s)	Remarks/effects desired
foxholes	25457770	423	2580	200x100	24 rd - GB - 105 How	A/1/7 Arty	Immed casualties
foxholes	26307705	430	2580	150x100	24 rd - GB - 105 How	B/1/7 Arty	Immed casualties
foxholes	34246905	410	2040	200x200	12 rd - GB - 155 How	B/4/8 Arty	Immed casualties
foxholes	34056845	380	2140	300x100	12 rd - GB - 155 How	C/4/8 Arty	Immed casualties
chment	35607440	510	2400	1400x700	2 lchr M91 w/M55 rkt	A/3/5 Arty	Immed casualties
tanks	22559090	740	1420	100x100	4 rd - GB - 8-in. How	D/4/8 Arty	Immed casualties
tanks	23709180	730	1250	100x100	4 rd - GB - 8-in. How	D/4/8 Arty	Immed casualties

CHEMICAL SCHEDULE OF FIRES

The heading is blocked out in 2-minute time intervals with respect to H-hour.

ry	-18	-16	-14	-12	-10	-8	-6	-4	-2	H	+2
	ACN10 24										
	ACN11 24										
	ACN12 12	ACN18 12		ACN25 12							
	ACN16 12	ACN19 12						ACN24 42			
	ACN17 12	ACN20 12	ACN22 12								
								ACN26 4	ACN27 4	ACN28 4	

xample of a chemical fire plan.

BIOLOGICAL AGENTS

General

Biological agents are microorganisms that produce disease in man, animals, or plants or cause deterioration of materiel. Although these agents have varying effects and act on different targets, the ultimate objective of biological agent employment is to reduce man's ability to wage war. This manual considers the employment of antipersonnel biological agents only.

a. Antipersonnel Biological Agents. These agents can be used to incapacitate or kill enemy troops through disease. They may cause large numbers of casualties and could require the enemy to use large numbers of personnel and vast quantities of supplies or equipment to treat and handle the casualties. FM 3-10A contains classified information on biological agents and weapon systems.

b. Hypothetical Biological Agents. Refer to FM 30-102 and FM 105-5 for an unclassified system of biological agents useful for instruction and training on an unclassified level, and to appendix II of this manual for a hypothetical biological target analysis system.

Characteristics of Biological Agents

Biological agents consist of living organisms, too small to be seen by the unaided eye. On the basis of structural and behavioral characteristics, microorganisms are grouped as follows (in order of decreasing size): fungi, protozoa, bacteria, rickettsiae, and viruses. The laboratory identification of most microorganisms is difficult and time-consuming; consequently, quick identification of biological agents in the field is not yet feasible. Some of the more important characteristics of microorganisms are described below-

a. Pathogenicity. The capability of a microoganism to produce disease.

b. Virulence. The relative infectiveness of a microoganism; its ability to overcome or break down the defensive mechanism of the body.

c. Viability. The ability to survive in a hostile environment. The following factors influence the viability of microorganisms

(1) Moisture. Wet biological agents require moisture in the immediate environment to prevent the death of the microorganisms.

(2) Temperature. Stored biological agents are quite sensitive to temperature variations. Storage at approximately 41° F. appears to be the optimum for preserving viability in most agent preparations. Agents die more rapidly at high temperatures. Some agents are degraded considerably by freeze-thaw cycles; however, the useful life of other agent preparations can be prolonged by extremely low temperatures.

(3) Light. Microorganisms are destroyed by prolonged direct exposure to ultraviolet rays.

FACTORS THAT INFLUENCE THE EFFECTS OF ANTIPERSONNEL BIOLOGICAL AGENTS

General

a. The casualty-producing effectiveness of an antipersonnel biological weaponsystem is a composite of the following factors that are extremely variable:

(1) type of biological agent, munition, and weapon system.

(2) meteorological and terrain conditions.

(3) method of dissemination.

(4) natural or acquired immunity of target troops.

(5) health status of exposed troops.

(6) use of preventive medicine.

(7) individual and collective protection afforded troops.

b. Meteorological conditions generally have the same effects on biological and chemical cloud travel. However, the effects of meteorological conditions on the biological agents themselves are dissimilar.

Biological Agent and Weapon System

a. Type of Biological Agent Used. The following factors influence casualty production by antipersonnel biological agents:

(1) Median infective dose. The number of microorganisms that will infect 50 percent of the exposed troops

(2) Aerosol decay rate. The rate at which microorganisms die after dissemination in the air. Decay in the aerosol cloud varies with the biological agent used and with the sunlight and relative humidity in the target area.

(3) Storage decay rate. The rate at which microorganisms die during storage prior to dissemination. Decay of the agent while in storage varies with the storage temperature.

(4) Effective source strength. The number of infective doses released at the source.

b. Type of Munition. The biological munition may consist of bomblets, spray tanks, or generators. The effectiveness of the munition varies with the following:

(1) Dissemination efficiency. The percentage of the agent fill actually disseminated from the munition as an effective aerosol.

(2) Functioning efficiency. The percentage of the munition that actually functions in the field.

c. Type of Weapon System Used to Deliver the Biological Munitions. The effectiveness of a weapon system varies with the following:

(1) Range, accuracy of delivery, and area coverage.

(2) Reliability of components and susceptibility to countermeasures.

(3) Density of munition distribution in the target area.

Methods of Dissemination

The basic methods of disseminating antipersonnel biological agents are the generation of aerosols and the use of insect vectors. The method used will influence area coverage, persistency, number of troops affected, and circumvention of protective measures.

a. Aerosols. To be effective as aerosols, biological agents must be disseminated so that a high percentage of them are viable and in the correct particle size to be drawn into and retained within the respiratory tract. The optimum particle size is 1 to 5 microns. Aerosols are generated by explosive bomblets, generators, and spray devices.

(1) Explosive bomblets consist of a burster surrounded by the biological agent fill. The heat and shock from the explosion kill some of the microorganisms. The advantages of bomblets are their mechanical simplicity, low cost, and high reliability.

(2) Generators utilize a source of pressure, an agent fill, and a nozzle device. In comparison to explosive bomblets, generators produce an aerosol with more of the particles in proper size, kill fewer of the microorganisms, and are

relatively quiet. The high cost and mechanical comlexity are the main disadvantages of the generator-type bomblet.

(3) Spray devices carried by aircraft contain a large quantity of agent and are capable of producing effective aerosols over extremely large areas.

b. Vectors. Insect vectors can be delivered to the target area in bomblets by aircraft. The vector will seek a host in the area and transmit disease through the skin of the host. Dissemination by vectors can circumvent the protection given by a mask and produce casualties over the life span of the infected vector.

Temperature

Moderately cool temperatures are desirable for the employment of wet biological agents because they favor the survival of the microorganisms in aerosols. Temperature gradient conditions affect biological and chemical aerosols in similar manner. The height of the inversion top, if available, is important in planning a biological spray attack, since biological spray will not reach ground level if released above the inversion top.

Wind

Biological agents can be employed effectively at various wind speeds. Downwind area coverage is greater in high winds.

Sunlight

Exposure to sunlight increases the decay rate of biological agent aerosol and thereby reduces its area coverage. Unfavorable temperature gradients normally exist on sunny days. Therefore, night is the preferable time for a biological attack. To decrease the downwind travel of a biological aerosol as a troop safety measure, an attack is made near sunrise. Conversely, to extend the downwind cloud travel and the area coverage, a biological attack is made soon after sundown.

Relative Humidity (RH)

The amount of moisture in the air determines the decay rate of most aerosolized agents; at fairly high RH the decay rate decreases. Although viability of some agent

preparations is quite independent of the RH, other agent preparations die rapidly at certain precentages of moisture in the air.

Terrain

A biological agent cloud is affected by terrain characteristics in the same general manner as a chemical agent cloud. Because of the short life most viable agents, ground contamination after a biological aerosol attack is not generally a hazard to troops crossing or occupying the terrain. Vegetation may remove some aerosol particles from the atmosphere by impaction. Terrain and vegetation, together with weather conditions, will affect the employment of an agent-vector combination, since the vector will usually need a favorable environment in order to survive.

TYPES OF BIOLOGICAL MUNITIONS

General

Antipersonnel biological agents can be delivered to targets by ground, air, or sea launched weapon systems. FM 3-10A contains classified data on weapon systems of the Army, Navy, Air Force, and Marine Corps.

Multiple-Point-Source Biological Munitions

Multiple-point-source munitions are designed to distribute biological bomblets over a large target area.

a. **Missile-delivered Biological Munitions.** Each munition consists of a warhead that contains biological bomblets. The warhead is shipped separately for assembly to a missle at the launching site. Such warheads are used for attack of large-area targets. A typical biological missile system consists of the following components:

(1) A missile vehicle and its launching equipment.

(2) A warhead that can be opened at a predetermined height to release biological bomblets over the target area.

(3) A warhead shipping container equiped with a heating-cooling element and a temperature control unit.

(4) Biological bomblets consisting of an agent container and a central burster that functions on impact. The bomblets have outside vanes that cause them to rotate in flight, thereby achieving lateral dispersion during their free fall and resulting in random distribution in the target area.

b. **Cluster-Bomb-Delivered Biological Munitions.** These munitions consist of cluster bombs containing biological bomblets (a(4) above). A preset time fuze causes the release of bomblets at a predetermined height above the target.

Line-Source Biological Munitions

Line-source munitions are delivered by aircraft and disseminate biological agents over a large area downwind of

the line of release.

a. **Elevated-Line-Source Biological Munitions.** These weapon systems consist of spray tanks mounted on aircraft. A typical spray tank consists of th following components:

(1) An agent reservoir section that is shipped seperately in an insulated shipping and storage container equiped with a heating-cooling element and a temperature control unit.

(2) A discharge nozzle assembly that can be mechanically adjusted to vary the agent flow rate.

(3) A pressurization system that insures controlled delivery of the agent to the nozzle.

b. **Ground-Line-Source Biological Munitions.** These weapon systems consist of dispensers mounted on aircraft. The dispenser ejects, at controlled rates, bomblets in a line that burst on impact with the ground.

BIOLOGICAL MUNITIONS EMPLOYMENT CONCEPTS

General

The choice of biological munition to be used against enemy troops depends on the mission and objective of the commander, his plan of operations, the effects desired, and the availability of the munition. Biological munitions complement other munitions. They can also be used as a promary means to engage large target areas and to produce more selective effects than any other munition.

Biological Munitions Used in Military Operations

Factors that should be considered in the conduct of biological operations are-

a. Search Capability. Antipersonnel biological agents can be disseminated in casualty-producing concentrations over extremely large areas. Many square kilometers can be effectively covered from a single aircraft or missle. The search capability of biological agent clouds and the relatively small dose required to cause infection among troops give biological munitions the capability to cover large areas where targets are not precisely located but where intelligence indicates enemy troops may be present.

b. Lack of Warning. A biological attack can occur without warning since biologicalagents can be disseminated by relatively unobtrusive weapon systems functioning at a considerable distance from the target area and relying upon air movement to carry the agent to the target. Biological agents cannot be detected by the unaided senses. Detection and positive identification will usually require appreciable time and complicated laboratory techniques.

c. Delayed Effect. Biological agents do not produce effects immediately. An incubation period is required from the time the agent enters the body until it produces disease. Some agents produce the desired casualty levels within a few days after infection, whereas others may require more time to produce useful casualty levels. Accordingly, plans must be made to assure delivery of the agent in sufficient time to achieve the desired results.

d. Gradation of Effects. The potential number and type of biological agents available provide the commander with the means to select a variety of effects, varying from incapacitation with few deaths to a high percentage of

deaths. This selectivity provides the commander with the means to produce the effects required to accomplish his mission.

e. Penetration of Structures. Biological agent clouds can penetrate fortifications, dwellings, and other structures not having effective particulate filters. This capability provides a means for attacking troops in a fortification that presents a difficult target to high-explosive munitions or to low-yield nuclear munitions.

f. Nondestruction of materiel and structures. Antipersonnel biological agents accomplish their effects on targets with little or no physical destruction. This constitutes an advantage both in combat operations, where it may be essential to save facilities for future use by friendly forces, and-from a longer range viewpoint-in postwar rehabilitation, where overall rebuilding requirements would be decreased.

Tactical Objectives

Plans for the employment of biological munitions are integrated into the unit scheme of maneuver. These munitions are particularly effective in the preparatory phase of a large-scale coordinated attack, such as in advance of airborne, airmobile, or amphibious operations. Biological attacks must be timed sufficiently in advance of the planned coordinated exploitation to allow for the incubation period of the disease-produceing agent.

a. To Weaken Enemy Positions. Biological munitions are used against strongly defended enemy positions to weaken them by producing casualties among defending enemy troops.

b. To Hinder Support of Enemy Operations. Biological munitions are used to produce casualties among enemy troops in reserve, assembly areas, and logistic bases. They can also be employed against enemy troops in rear artillery and missile positions, observation posts, logistical instalations, and communications facilities, thereby hindering the support of enemy combat units.

Offensive Operations

Biological munitions are effective when employed to support offensive operations on relatively deep targets such as reserves of army and corp-type forces when a delay in casualty production is acceptable. Enemy targets near the forward edge of the battle area (FEBA) are not normally attacked with biological munitions unless such a delay is acceptable.

Defensive Operations

In defensive operations that are characterized by successive delaying positions, biological munitions can be used against targets within close range of the FEBA. Biological casualties may not be produced in time to affect the defense of each delaying position, but are produced eventually at some delaying position. By taking into consideration this delay in casualty production, casualties can be planned for the time friendly forces initiate offensive operations.

INTRODUCTION TO BIOLOGICAL TARGET ANALYSIS

Section I. TARGET ANALYSIS PROCEDURES

General

Biological target analysis is a process of examining existing and potential targets to determine their vulnerability and suitability for biological attack and the capability of available biological munitions for such attack. Refer to appendix II for hypothetical biological agents and munitions useful for training and instruction on an unclassified level. Biological target analysis consists essentially of the following activities, but not necessarily in the same sequence:

a. Obtain essential target information.

b. Identify the targets suitable for biological attack, in consonance with the commander's concept of operation.

c. Select a suitable agent for producing the desired effects.

d. Determine the delivery means available for and capable of disseminating the selected agent.

e. Determine the biological munitions requirements.

f. Determine troop safety requirements.

g. Prepare recommendations for the employment of biological munitions, including time of attack.

h. Estimate the precentage of casualties that can be expected from the biological attack.

i. Make post-attack analysis.

Methods of Biological Attack

The two general methods of attacking a target with biological munitions are described below:

a. On-Target Attack. This method of attack provides the maximum degree of operational control because the biological agent is disseminated directly over a reasonably defined target area. Since the agent is distributed somewhat

uniformly over the target area, wind direction and speed are not concidered to be critical factors.

b. Off-Target Attack. In this method of attack, the biological agent is disseminated upwind of an ill-defined large target area. The agent, once released, is transeported over the target area by the wind. Meteorological conditions are important factors in this type of attack, and operational control is more difficult than with the on-target attack. However, there is less likelihood that the enemy will detect an off-target attact.

Methods of Disseminating Biological Agents

The following three general methods are used to disseminate biological agents:

a. Point-Source Release. A point source disseminates the agent from a single point, as from a bomblet or a generator. The wind is relied upon to carry the aerosol over the target area. The agent aerosol drifts with the wind, diffusing both horizontally and vertically. Figure 1 illustrates the distribution of an aerosol resulting from the release of a biological agent from a single point-source munition. The peak dosage occurs at ground level directly downwind from the point of release. The aerosol cloud generally reaches its maximum width (crosswind dimension) beyond the middle of the downwind distance. The pattern of the various casualty threat contours consist of a series of symmetrical ellipses inside of one another, with the highest casualty contour being innermost. The casualty threat contour lines marked 70, 50, and 30 precent indicates the casualty rates among unprotected troops that can be expected at various locations within the target area. Contour lines are not drawn to scale. They will vary with the type of munition used and with the source of strength of the agent.

b. Multiple-Point-Source Release. A multiple-point-source release is accomplished by the random distribution of point-source munitions, such as bomblets, over a target area. Each point-source bomblet forms an aerosol that merges with others. Thus, the agent distribution throughout the impact area is built up by a complex of point-source aerosols and the results of their mutual reinforcement. The agent concentration over the target area is expressed as an average dosage. The casualty threat level based on the agent distribution is expressed as an integrated casualty threat level that can be expected among unprotected troops.

c. **Line-Source Release.** A line source disseminates the agent either from a moving point source, such as a spray tank on aircraft, or from a series of point-source munitions in line, such as a ground-level line of bomblets. Figure 2

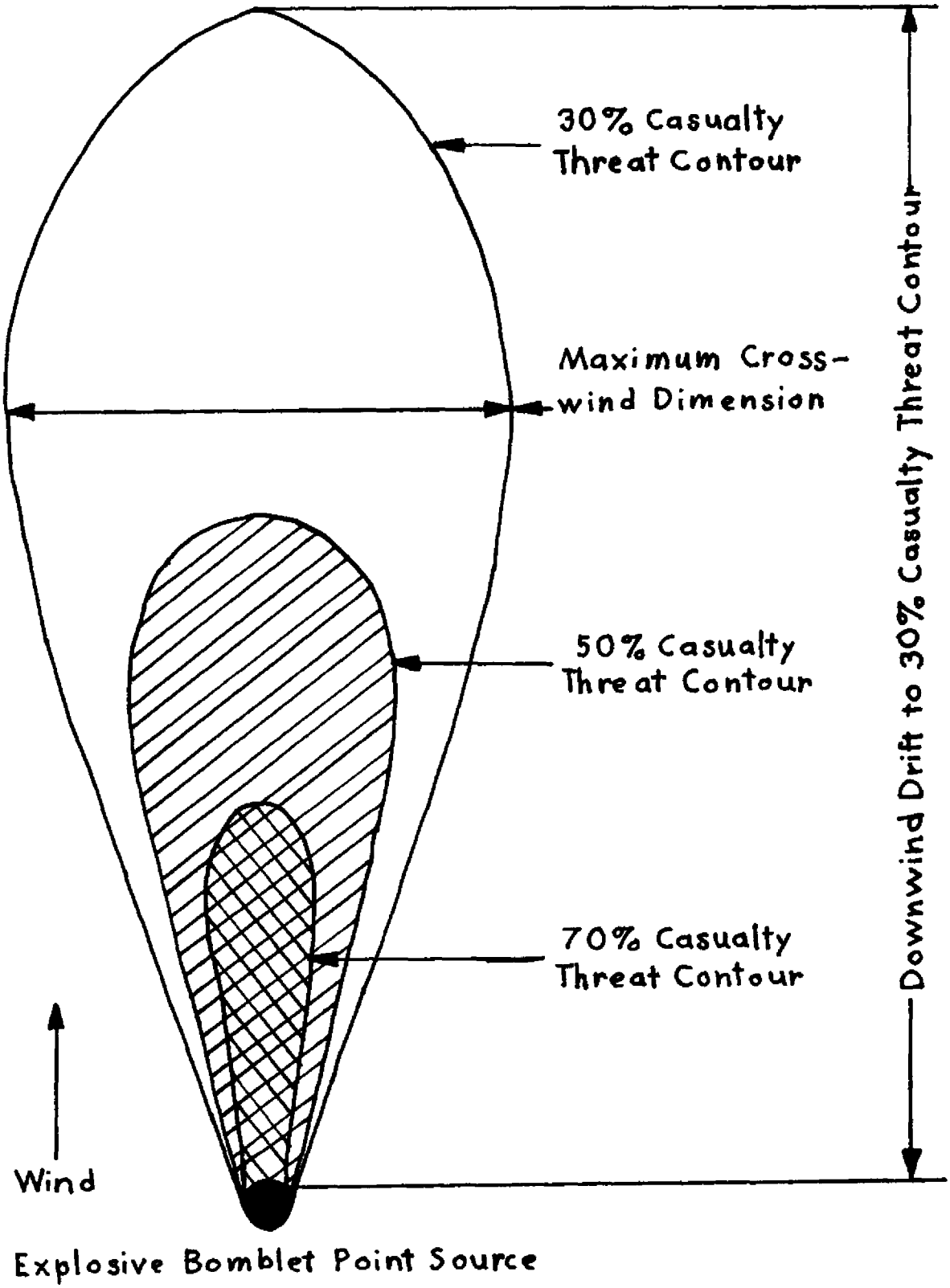

30% Casualty Threat Contour
Maximum Cross-wind Dimension
50% Casualty Threat Contour
70% Casualty Threat Contour
Downwind Drift to 30% Casualty Threat Contour
Wind
Explosive Bomblet Point Source

Figure 1.

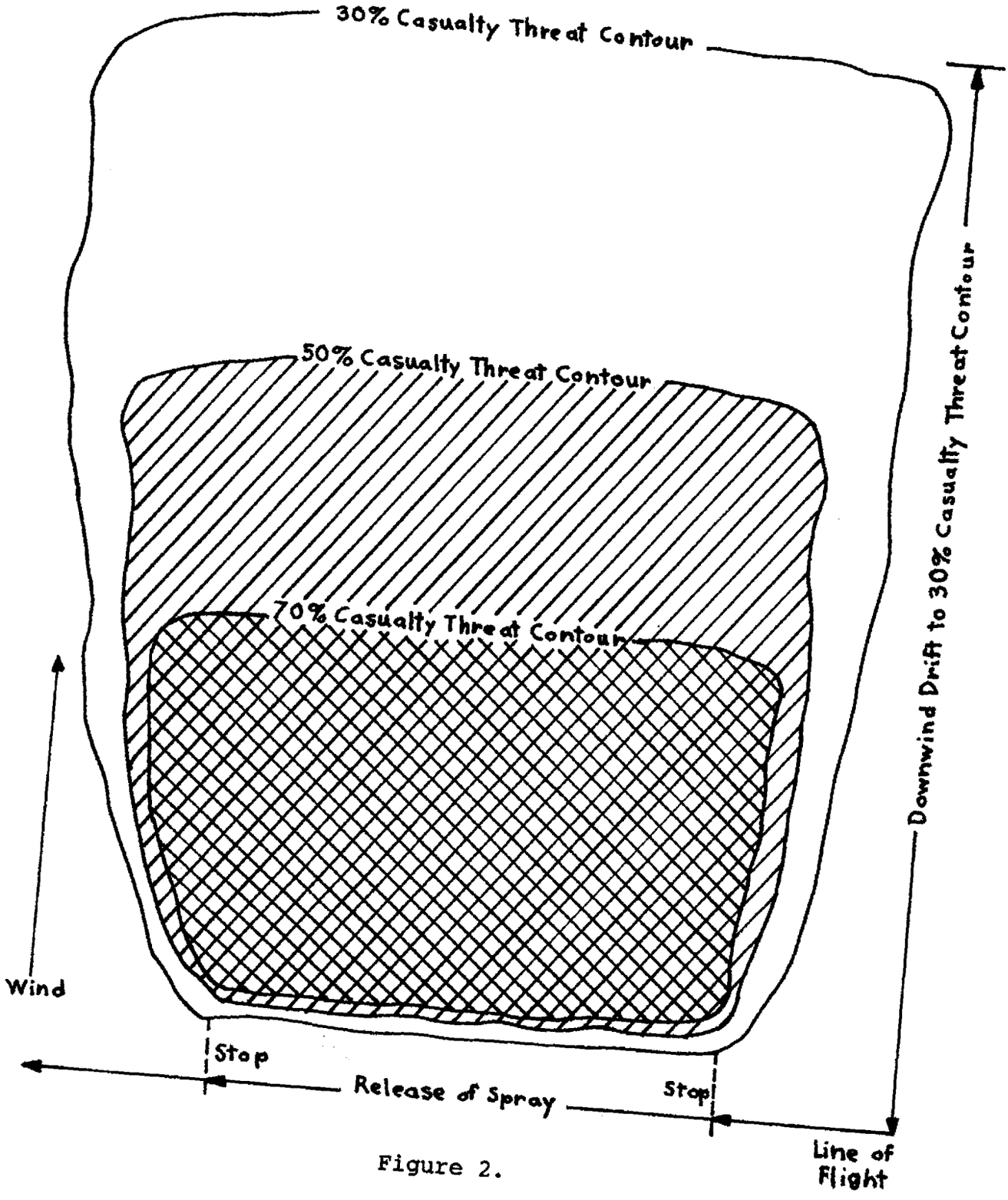

30% Casualty Threat Contour
50% Casualty Threat Contour
70% Casualty Threat Contour
Downwind Drift to 30% Casualty Threat Contour
Wind
Stop
Release of Spray
Stop
Line of Flight

Figure 2.

illustrates the distribution of an aerosol resulting from an elevated line-sourc aircraft spray tank. In order to reach ground level, the aerosol must be released below an inversion top. The aerosol diffuses as it travels horizontally with the wind and touches ground at some distance downwind; the peak dosage occurs directly downwind from the line of release. The casualty threat contour lines marked 70, 50, and 30 percent indicate the casualty rates among unprotected troops that can be expected at various locations within a target area. Contour lines are not drown to scale.

Essential Target Information

Specific targets for consideration in biological target analysis may be designated by the commander or his staff. To allow the efficient employment of biological munitions as well as the selection of appropriate targets, staff planners must obtain current information on all enemy areas, installations, and troops within the zone of operations. Information on targets may be obtained from the following sources:

a. Intelligence reports, including technical intelligence reports.

b. Situation reports.

c. Special studies.

Identification of Suitable Targets

The target characteristics that influence the employment of biological munitions are described below-

a. Composition. Biological munitions are employed primarily against enemy troops. However, a combination of enemy troops and civilians may be the target. The composition of the target will influence the biological agent. Against military targets containing a large percentage of civilians, an agent that produces incapacitating effects is used when delayed onset of these effects is acceptable. Against targets containing military units that present an immediate threat, a more rapid onset of lethal or incapacitating effects is required.

b. Location. The location of the target will influence the choice of weapon systems from the standpoint of range capabilities, accuracy of delivery systems, and hazard to friendly troops or civil populations. If friendly troops are near the target area, the protective measures available to them (including medical support) may dictate the selection of a delivery system sufficiently accurate to insure that the

desired troop safety standard will be met. The location of the target with respect to friendly positions and wind direction will determine the area or line of agent release as well as the selection of an agent with regard to the incubation period. The distance of the target from the agent source may require a consideration of decay rate.

c. Size and Shape. The size and shape of the target will influence the choice of the weapon system. The size will dictate the amount of agent necessary for adequate coverage. The configuration will influence the number and location of individual munition coverage patterns.

d. Permanence. Targets having little permanence, such as troops massing for attack on a beachhead, will require the use of munitions that are readily available. Although small troop units may move freaquently, they are often restricted to the mission area of a larger unit. Frequency of movement is reduced in larger units; army-size targets may be considered relatively static. The large-area-coverage capability of biological munitions enables the commander to engage ill-defined targets of division size or larger.

e. Level of Protection. The susceptibility of target troops to biological agents may influence the selection of the biological agent to be employed. The level of protection varies with the previous exposures of target troops to biological agents and with the protective equipment available. Troops who have survived a previous attack by a particular agent are less susceptible to the same agent on subsequent exposre.

f. Density of Population. The density of population in large target areas will vary from section to section within the area. Therefore, this factor may influence the selection of biological weapon systems. It may be more profitable and appropriate to launch seperate, but simultaneous, attacks against individual subsections of the target.

Selection of Biological Agent.

The selection of the agent to be used for biological attack of a target is based on the commander's concept of operations and on the effects desired. It is limited by the number of agent/munitions available for use in the theater of operations. Selection will depend primarily on the type of casualty, the time of onset of casualties, and the duration of effects desired by the commander. These factors for the standard biological agents are presented in FM 3-10A. The effects desired by the commander may require modification because of enemy defensive measures and the hazard to friendly forces. Applicable biological agent and target characteristics are grouped below for guidance in planning.

Target Characteristic	Agent Characteristic
Primarily enemy troops	Lethal or incapacitating.
Enemy troops and high precentage of civilians	Incapacitating.
Close proximity to friendly troops	High decay rate.
Large area	Low decay rate.

Selection of Weapon Delivery System

In selecting the weapon system to deliver the biological agent to a target, the range and accuracy of the system and the method of agent dissemination should be considered. In recommending the weapon system , consideration is given to the capabilities and availability of the agent/munition and to any requirements for concealing the nature of the attack from enemy troops.

a. Depending upon the agent/munitions available in the theater, the dissemination methods indicated below should be considered for delivery of biological agents against targets having the following characteristics:

Target Characteristic	Dissemination Method
Small area	Multiple-point source.
Large area	Elevated line source.
Off-target attack perferred or required	Elevated or ground-level line source.
On-target attack preferred or required	Multiple-point source.
Wind direction predicted within 45 degrees	Line or multiple-point source.
Wind direction unpredictable	Multiple-point source.
Poor alert system	Multiple-point or line source.
Good alert system	Elivated or ground-level line source.

b. The selection of a weapon system capable of

disseminating the selected agent on the target consists of the following steps:

(1) Single out the systems that can disseminate the selected agent.

(2) Consider only those systems that are within range of the target.

(3) Consider only those systems whose casualty level contour patterns and release methods are appropriate for the target size and shape.

(4) Consider only those systems with the required accuracy.

(5) On the basis of the target size and shape, enemy protection level, and weather and terrain conditions, determine the munitions requirements for the desired casualty effect and area coverage.

(6) For each of the systems still under consideration, determine its capability to accomplish the mission or a part of the mission.

(7) Consider limiting logistical and operational factors.

(8) Compare (5) and (6) above and tentatively select a weapon system or systems for employment.

Determination of Biological Munitions Requirements

Biological munitions requirements have been determined from data derived from field tests. Munitions requirements data contained in the weapon effects table in FM 3-10A consider the predicted meteorological conditions and the unique characteristics of each agent/munition combination.

Determination of Hazard to Friendly Troops

The release of biological agents can cause a hazard to friendly troops because of downwind effects and delivery system error. To be meaningful to the commander and his staff, the downwind hazard to the negligible casualty threat contour should be graphically illustrated on an overlay. See TROOP SAFETY.

Recommendations for the Employment of Biological Munitions

Based on the biological target analysis, recommendations for the employment of biological munitions are submitted to the commander or his staff. As a minimum the recommendations will include-

a. Location and type of targets to be attacked.

b. Biological agent to be used.

c. Type of attack and number of munitions required.

d. Time of attack.

e. Limitations on time for completion of delivery.

f. Estimated casualty effect.

g. Estimated time to produce casualties.

h. Troop safety considerations and coordination required with adjacent units.

i. Request for collection of data for post-attack analysis.

Post-Attack Analysis

To determine biological attack effectiveness and to accumulate experience data for future biological operations, post-attack analysis should be performed. Chemical post-attack analysis methods are applicable here. Possible sources of information are intelligence agents and line crossers.

Section II. Estimation of Biological Casualties

General

Estimation of casualties from biological agents is base on knowledge of biological munitions effects and capabilities to evaluate those factors that affect production of biological casualties. The estimate is expressed as a percentage of biological casualties expected among troops in the target area. Estimation of casualties requires intelligence on meteorological conditions in enemy terrain and on the defensive posture of enemy troops, such as:

a. The quality and type of protection available to enemy

troops.

b. The status of enemy biological defensive training and morale.

c. The efficiency of the enemy biological agent detection and identification devices and systems in operation.

d. The efficiency of the enemy biological attack warning system in operation.

Effects of Munitions Expenditures

The effects of biological munitions expenditures are predictable to the following extent: the size of the target area that will be covered with a casualty-producing dosage to a specified casualty threat level.

a. Bomblets. Except when disseminated by line source weapon systems, bomblets are uniformly distributed over the target area. The dispersion characteristics of the bomblets from a guided missile may result in a doughnut-shaped impact pattern with a relatively greater density of bomblets at the circumference.

b. Spray. In low-level spray attacks, the highest casualty threat level occurs downwind near the release line. Meteorological and terrain conditions affect the aerosol cloud as it travels downwind, and dilution of the biological aerosol into surrounding air decreases the casualty threat level.

Effects of Agent Decay

The effective source strength of the biological munition is a factor used in calculating casualty effects. Biological agents die (decay) at predictable rates after dissemination. Since decay reduces the downwind effectiveness of the agent, it will also affect area coverage and biological casualty estimation.

Effects of Protection

Troops who are masked when exposed to biological aerosols or who are in protective shelters have a certain amount of protection. However, the intelligence estimates can assist in predicting the precentage of troops who will not be protected by either masks or shelters.

Effects of Time of Attack

Since exposure to sunlight will increase the decay rate of most microorganisms in a biological aerosol, a night attack will give the greatest area coverage. Biological attacks initiated during the early night hours cover a larger area downwind than those initiated later in the night. This is an important factor to consider when friendly troops are downwind.

Estimation of Casualties from Specific Biological Agents

If surprise is achieved in a biological attack against enemy troops, it is estimated that casualties can approximate the casualty threat levels given in the weapon effects tables for specific biological agent/munitions in FM 3-10A. After enemy troops have once been subjected to a biological attack, a percentage of them may be protected by masks in future attacks; but others will probably become casualties as a result of faulty, ill-fitting, or lost masks or faulty protective mask discepline.

TROOP SAFETY IN EMPLOYMENT OF BIOLOGICAL MUNITIONS

General

The employment of biological munitions can produce downwind areas of hazard in which friendly troops are required to operate. There is little risk involved to friendly troops with normal protection and adequate warning. However, the commander may be required to employ his troops in a hazardous area even though he is unable to warn all troops of the hazard. The command decision to accept a calculated risk depends upon the urgency of the tactical situation. The commander is advised of the probable effects of exposure to this hazard by target analyst and the medical officer. The degree of risk that can result in incapacitated casualties among unwarned friendly troops must be kept so low that there will be no significant effect on the morale of friendly units in the path of the biological cloud. A degree of risk that can result in lethal casualties among unwarned friendly troops is undesirable.

Commander's Risk Criteria

The commander may decide the maximum degree of risk that he will accept as a downwind hazard to unwarned friendly troops, using the following criteria as a guide:

a. Negligible Risk. Troops are completely safe and need not be required to mask or to take any precautions. A negligible risk distance is measured from the target area downwind to a distance that gives less than 1-percent casualty threat contour to provide positive assurance that troops are safe.

b. Moderate Risk. The anticipated effects are tolerable, or, at worst, a minor nuisance; and troops should be required to mask. A moderate risk distance is measured from the target area downwind to the 1-percent casualty threat contour to provide a reasonable assurance that no more than 1-percent incapacitated casualties may result among unmasked troops.

c. Emergency Risk. Troops are required to mask because the anticipated effects may cause some casualties among unmasked troops. The emergency risk distance is measured from the target area downwind to a distance that gives more than the 1-percent casualty threat contour.

Downwind Hazard

The downwind hazard from biological aerosols can be estimated when certain meteorological conditions are known or can be predicted. Some biological aerosols, in suitable weather and terrain, retain a potential casualty-producing effectiveness for extensive distances downwind. Guidence on the downwind hazard distances to the negligible casualty threat level is given in FM 3-10A. The following factors affect downwind travel of biological aerosols:

a. Agent. Type of agent, median infective dose, source strength, length of time in storage, and aerosol decay rate.

b. Meteorological Conditions. Temperature, temperature gradient, relative humidity, wind speed and direction, cloud cover, and sunlight.

c. Terrain. Open, built-up, or heavily wooded.

Minimum Safe Distance

The minimum safe distance is the sum of the downwind hazard distance to the negligible casualty threat level, or as may be otherwise designated by the commander, and a buffer distance based on the probable error of the weapon system.

a. Buffer Distance. The buffer distance is 2.5 times the CEP of the weapon system used. The buffer distance is added to the downwind hazard distance to provide assurance or high probability of not exceeding the specified risk.

b. Line Source. The downwind hazard distance is measured from the release line in the direction of the predicted wind, with consideration given to the location of friendly troop units. To provide a safety factor for possible wind shifts, the downwind hazard area includes a 20-degree area on each side of the release line.

c. Multiple-Point Source. The downwind hazard distance is measured from the downwind side of the bomblet impact area in the direction of the predicted wind, with consideration given to the location of friendly troop units. To provide a safety factor for possible wind shifts, the downwind hazard area includes a 20-degree area on two sides of the impact area.

Safe Entry Time

An area subjected to a biological attack by aircraft spray or bomblets may retain lingering casualty-producing aerosols, depending on the agent employed. Hazard from

secondary aerosol-those aerosol particles that have settled to the ground and aerosolized a second time-is not significant except, possibly, on dusty roads and in jungle terrain. Safe entry of friendly unmasked troops into a target area attacked with certain biological aerosols at night or on an overcast day can normally be made about 8 hours after the attack or 2 hours after daylight. Exceptions are-

a. Jungle-type terrain where an aerosol could remain suspended for a considerable period of time.

b. Vegetated areas where aerosols have settled out under bushes and short trees that could give protection to the agent from ultraviolet rays of the sun.

Possible Courses of Action

When the distance from a friendly troop disposition to the agent release point is less than the minimum safe distance required for the desired degree of risk, one of the following courses of action may be considered:

a. Change the time of the attack to one that affords more favorable metorological conditions.

b. Move the release point to a more favorable distance.

c. Move friendly troop units involved.

d. Use a different biological agent.

e. Increase the protection of the troops involved. The commander may order friendly troops to wear protective masks for a specified period.

f. Use an alternate munition to engage the target.

APPENDIX I

OUTLINE OF A PREPLANNED BIOLOGICAL TARGET ANALYSIS

Note. The following five-paragraph outline is a guide for preparing a preplanned biological target analysis. The data to be included in the paragraphs listed below should be as detailed as required. A biological fire/strike support plan, when required, may be similar to the chemical fire/strike plan.

Mission

Paragraph 1 states the purpose of the biological attack. Pertinent guidance may be obtained from the operations officer or from the statement of results desired by the commander. It may also be deduced from the commander's concept of operations and from the mission of the command. Normally, the commander indicates how biological munitions will be employed. For example, he may state: "Biological munitions will be employed in prelanding operations, with priority to enemy tactical air forces and armored forces."

The Situation and Considerations

Paragraph 2 is concerned principally with descriptions of selected targets and all factors that can influence the selection of a target for attack with biological munitions.

Analysis

Paragraph 3 is concerned principally with an examination of the capabilities of the command for biological attack of selected targets while considering enemy capabilities.

Evaluation and Conclusions

Paragraph 4 is concerned principally with an evaluation of the advantages and disadvantages of attacking with biological munitions each of the targets under consideration while while considering the results desired. Determine which type of biological attack will best assist the commander in accomplishing his mission. The dominant factors to consider are target capabilities and troop safety. For each target under consideration, determine the following:

a. Priority of attack.

b. Type of agent/munition for the effects desired.

c. Type of attack (schedule or on-call) and any special factors.

d. Time of attack.

e. Estimation of effects in percent casualties and time/date casualties will be produced.

f. Estimation of downwind hazard and troop safety requirements.

g. Effect of proposed biological attack on future operations.

Recommendations

Paragraph 5 lists all the information required for consideration by the commander and his staff: whether to accept all or part of the recommendations for implementing the command's plan of operations.

a. Scheduled Fires/Strikes. List the targets and any special recommendations as the situation dictates.

b. On-call Fires/Strikes. List the targets and any special recommendations.

c. Troop Safety Measures. List any necessary troop safety measures.

APPENDIX II

HYPOTHETICAL BIOLOGICAL AGENTS AND MUNITIONS

General

To fulfill a requirement for teaching biological target analysis on an unclassified level, an assortment of hypothetical biological agents and delivery systems has been devised for use in training and instruction. Three hypothetical biological agents are used for instructional purposes only: toledo infection, a lethal agent; and lugo fatigue and september fever, primarily incapacitating agents. Hypothetical data for these agents and hypothetical munitions are listed in table I.

Selection of Hypothetical Biological Agent and Delivery System

The following criteria are used in selecting biological agents and delivery systems in an unclassified biological target analysis system.

a. Selection of Agent. Selection of a hypothetical biological agent is selected on the basis of the percentage of deaths and/or incapacitation produced, the time required to produce casualties, and the length of incapacitation desired.

b. Selection of Delivery System. After preliminary selection of the hypothetical biological agent, a hypothetical delivery system is selected. The main criteria to be considered are the area coverage capabilities and the casualty rates obtainable by agent/delivery system.

Determination of Biological Agent/ Munitions Requirements

Hypothetical area coverage and casualty rates obtainable for a given agent/munition combination are listed in table I. An increase in the number of munitions employed against a target will give greater assurance of casualties but will not significantly increase the casualty rate. Therefore, the only variable in target analysis is the number of munitions required to cover a given target area. Munitions requirements can can be determined dy dividing the target area by the area coverage of the munition delivery system. The following examples illustrate the procedure:

a. Problem 1.

(1) Situation. A communications center in an area of 100 square kilometers is in an aggressor-occupied country. Aggressor has headquarters units, depots, and security troops in the area. Friendly civilians are also present. In 5 days friendly forces are planning an airborne attack on this communications center.

(2) Requirement. The Army commander desires a high percentage of casualties and long period of incapacitation among aggressor troops, with minimum deaths among friendly civilians. What biological agent and munition delivery system should be used?

(3) Answer. Lugo fatigue and one medium guided missile should be used.

b. Problem 2.

(1) Situation. The situation is the same as that in problem 1.

(2) Requirement. The Army commander desires a low percentage of deaths and a short period of incapacitation among target troops. What agent/munition combination should be used?

(3) Discussion. September fever would be the first choice because it has a short period of incapacitation (6 to 10 days) and produces a low percentage of deaths (2 to 3 percent). Lugo fatigue would be the second choice. Toledo infection is not considered for use because it produces a high percentage of deaths. A medium guided missile containing a warhead filled with september fever and delivered with a high HOB will produce 25-percent casualties over a 100-square-kilometer area; a heavy guided missile containing the same agent and delivered with a low HOB will produce 50-percent casualties over such an area. A medium guided missile containing a warhead filled with lugo fatigue and delivered with a high HOB will produce 70-percent casualties over a 100-square-kilometer area.

(4) Answer. September fever and one heavy guided missile delivered with a low HOB should be used for maximum effectiveness.

Table I.
Hypothetical Antipersonnel Biological Agents and Delivery Systems

A. HYPOTHETICAL ANTIPERSONNEL BIOLOGICAL AGENTS

Agent AA
Lugo fatigue
Time required to produce casualties: 2-5 days
Precentage of deaths: 0-10
Length of incapacitation: 3 months
Time of effectiveness-Day: 2 hr
-Night: 3 hr
Physiological effects: Incapacitating disease of long duration; sores in the nose and throat.

Agent BB
September fever
Time required to produce casualties: 1-3 days
Precentage of deaths: 2-3
Length of incapacitation: 6-10 days
Time of effectiveness-Day: 1 hr
-Night: 3 hr
Physiological effects: High fever, muscular aches, vomiting, diarrhea, and extreme prostration.

Agent CC
Toledo infection
Time required to produce casualties: 1-3 days
Precentage of deaths: 90-100
Length of incapacitation: NA
Time of effectiveness-Day: 10 hr
-Night: 10 hr
Physiological effects: High fever, glandular swelling, coughing, pneumonia, and sores on the skin.

B. HYPOTHETICAL DELIVERY SYSTEMS

Guided missile (medium)
Max range (km): 75

HOB:	High	Low
Area coverage-Sq km:	100	50
-Dimensions (km):	5.7 (radius)	3.5 (radius)
Percentage of casualties-		
-Lugo fatigue:	70	90
-September fever:	25	50
-Toledo infection:	60	80

Guided missile (heavy)
Max range (km): 150

HOB:	High	Low
Area coverage-Sq km:	200	100
-Dimensions (km):	8 (radius)	5.7 (radius)

Table I. Coninued.

	High	Low
Percentage of casualties-		
-Lugo fatigue:	70	90
-September fever:	25	50
-Toledo infection:	60	80
Fighter aircraft (spray)		
Max range (km): variable		
HOB: NA		
Area coverage-Sq km: 1000		
-Dimensions (km):	50x20	
Percentage of casualties-		
-Lugo fatigue: 60		
-September fever: 25		
-Toledo infection: 50		

Troop Safety

Most biological agents are sensitive to ultraviolet light and humidity changes which can shorten the life span of the microorganisms upon release from the munition. For correction of the above variables in calculations, the line headed "Time of Effectiveness" in table I gives the lenght of time after release that an agent will maintain its casualty-producing capability.

a. Determination of Downwind Hazard Distance. To determine the downwind hazard distace produced by a biological attack, multiply the wind speed by the time of effectiveness. The product is the distance downwind of the target to which a hazard can be expected-

Wind speed (km/hr) X time of effectiveness = distance in kilometers.

or:

Wind speed (knots) X time of effectiveness X 1.85 = distance in kilometers.

To determine the time required for the agent cloud to clear the target area, divide the downwind length of the target area by the wind speed; then add a 10-minute safety factor to the result obtained. Also, the cloud will spread out to approximately 20-degrees on each side of the impact edge. The following method may be used for computing the clearance time:

$$\frac{\text{Downwind length of target (km)}}{\text{Wind speed (km/hr)}} = \text{hours of travel time}$$

Add a 10-minute safety factor to obtain the clearance time.

b. Example.

(1) Problem. A medium guided missile warhead, filled with lugo fatigue, was used to attack a target 5.6 kilometers in radius. The wind speed at the time of the attack was 10km/hr. The attack was made at 2200 hours. What is the extent of the downwind hazard in kilometers?

(2) Answer. The hazard extends for 50 kilometers downwind from the target.

(3) Solution. 10 km/hr X 5 (time of effectiveness, night) = 50 kilometers.

GLOSSARY

BIOLOGICAL CASUALTY-A person who has been infected sufficiently by a biological agent to make him incapable of performing his duties or continuing his mission.

BIOLOGICAL DOSAGE-The number of median doses per cubic meter of air (D)/(do), where D is the infective units per minute per cubic meter of air, and do is the median infective dose.