SUBCOURSE
CM7114

EDITION
B

US ARMY CHEMICAL SCHOOL

CHEMICAL AND BIOLOGICAL OPERATIONS

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

AIPD

READINESS/PROFESSIONALISM THRU GROWTH

CHEMICAL AND BIOLOGICAL OPERATIONS
Subcourse No. CM7114
EDITION B

U.S. Army Chemical School
Fort McClellan, Alabama 36205-5020

11 Credit Hours

Edition Date: January 1995

SUBCOURSE OVERVIEW

We designed this subcourse to teach you how to identify chemical and biological contamination or emplaced chemical mines; provide advice on biological defense; chemical agent characteristics and how wind and temperature affect chemical agents. Upon completion of this subcourse, you will have the basic knowledge required to advise your commander on chemical and biological operations.

There are no prerequisites for this subcourse.

This subcourse reflects the doctrine which was current at the time it was prepared. In your own work situation, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

TERMINAL LEARNING OBJECTIVE.

ACTION: Supervise marking of chemical and biological contamination. Provide technical advice on biological defense.

CONDITION: Given information about and illustrations related to identification, placement of chemical mines or chemical/biological contamination markers and protective clothing; fundamentals of biological defense, characteristics of biological agents and toxins, delivery means, detecting biological attacks, defense measures, and reporting procedures; and the effect of wind and temperature on chemical agents cloud travel.

STANDARD: To demonstrate competency of this task, you must achieve a minimum of 70% on the examination.

REFERENCE: FM 3-3

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LESSON 1

SUPERVISE MARKING CHEMICAL AND BIOLOGICAL CONTAMINATION

Critical Task: 031-503-3010

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn how to supervise the marking of chemically or biologically contaminated areas.

TERMINAL LEARNING OBJECTIVE

ACTION: Supervise marking chemical and biological contamination.

CONDITION: Given information and illustrations related to protective clothing, identification and completion of information to be posted, and placement of chemical mines or chemical or biological contamination markers.

STANDARD: Demonstrate competency of the task skills and knowledge by responding to the multiple-choice test covering the fundamentals of providing technical advice of biological defense.

REFERENCES: FM 3-3, FM 3-4, STP 3-54B1-SM, STP 3-54B2-SM, and TM 3-9905-001-10.

INTRODUCTION

With the threatened use of chemical weapons and the strong possibility of biological agents being employed on future battlefields, it is critical that commanders be prepared to operate in these environments. Just as the commander looks to the supply officer for advice on logistical matters, the commander will look to you for advice on operations in a chemical or biological environment. You can be expected to answer questions about the location, type, and expected duration of contamination, and the measures to be taken to protect personnel. In this subcourse, you will learn the procedures used to arrive at an answer to most of these questions.

PART A - NBC CONTAMINATION MARKERS

1. Contamination Markers.

Because of the potential effects posed by chemical or biological agents on personnel, markers have been devised to identify areas contaminated by these agents or areas which contain chemical mines. When a contaminated area has been identified, its boundaries are marked with contamination markers.

Signs used for marking contaminated areas are standard throughout North Atlantic Treaty Organization (NATO). A NATO marker is a right-angled isosceles triangle. The base is approximately 28 centimeters (11 1/2 inches) and the sides are 20 centimeters (8 inches). It has holes used for hanging. It may be placed on boundary fences, poles, trees, or rocks. Place a sign with the point of the triangle facing down.

The United States marks contaminated areas with the NBC Contamination Marking Set. It contains everything needed to mark an area - flags, ribbon, crayons, mounting stakes, and a carrying container. TM 3-9905-001-10 describes the kit and its use. A NATO NBC Marking Set is available and bears the stock number NSN 9905-12-124-5995. If units do not have the kit available, they can make the signs out of available metal, plastic, or wood. These field expedient signs must be of standard shapes, sizes, and colors.

Areas which are found to be contaminated with more than one type of contamination will be marked with markers of each type of contamination. The color and size permits easy identification. The color indicates the type of contamination. The primary or background color indicates the general hazard. The secondary color gives hazard specifics. Identified contaminated areas are marked unless they are to be abandoned to Threat Forces. Information concerning the contamination is printed on the front of the marker as shown in Figure 1-1.

When placing contamination markers in position, the markers should be placed at short intervals around the contaminated area. Markers should be prominently displayed on roads or paths leading into the contaminated area. Fluorescent paint used on the markers will make them more visible during hours of darkness.

Equipment evacuated from a contaminated area must be marked. The type of agent and current date and time should be posted on the markers with a marker placed on each side, the front, and rear of the equipment.

a. Chemical Contamination Marker.

The name of the agent, if known, and the date/time of detection are placed on the front of the marker with paint, marking or grease pencil, at the time of emplacement. The chemical contamination marker (Figure 1-1) is a yellow triangle. The word **GAS** in red 5-centimeter (2-inch) block letters is placed on the side of the marker facing away from the contamination (front). Fluorescent paint is used, if available.

b. Chemical Minefield Marker.

The chemical minefield marker is a red triangle. On the side facing away from the contamination (front), the words **GAS MINES** appear in yellow 2.5-centimeter (1-inch) block letters with a horizontal yellow 2.5-centimeter (1-inch) stripe underneath the lettering, fluorescent paint, if available. The chemical agent in the mines and the date of emplacement may be inscribed on the front of the marker, if desired by the commander (Figure 1-1).

c. Biological Contamination Marker.

The biological contamination marker is a triangle that is blue on both sides. The letters **BIO** in red (fluorescent paint, if available) 5-centimeter (2-inch) block letters are placed on the side of the marker facing away from the contamination (front). The name of the agent, if known, and the date and time of detection are placed on the front of the marker at the time of emplacement (Figure 1-1).

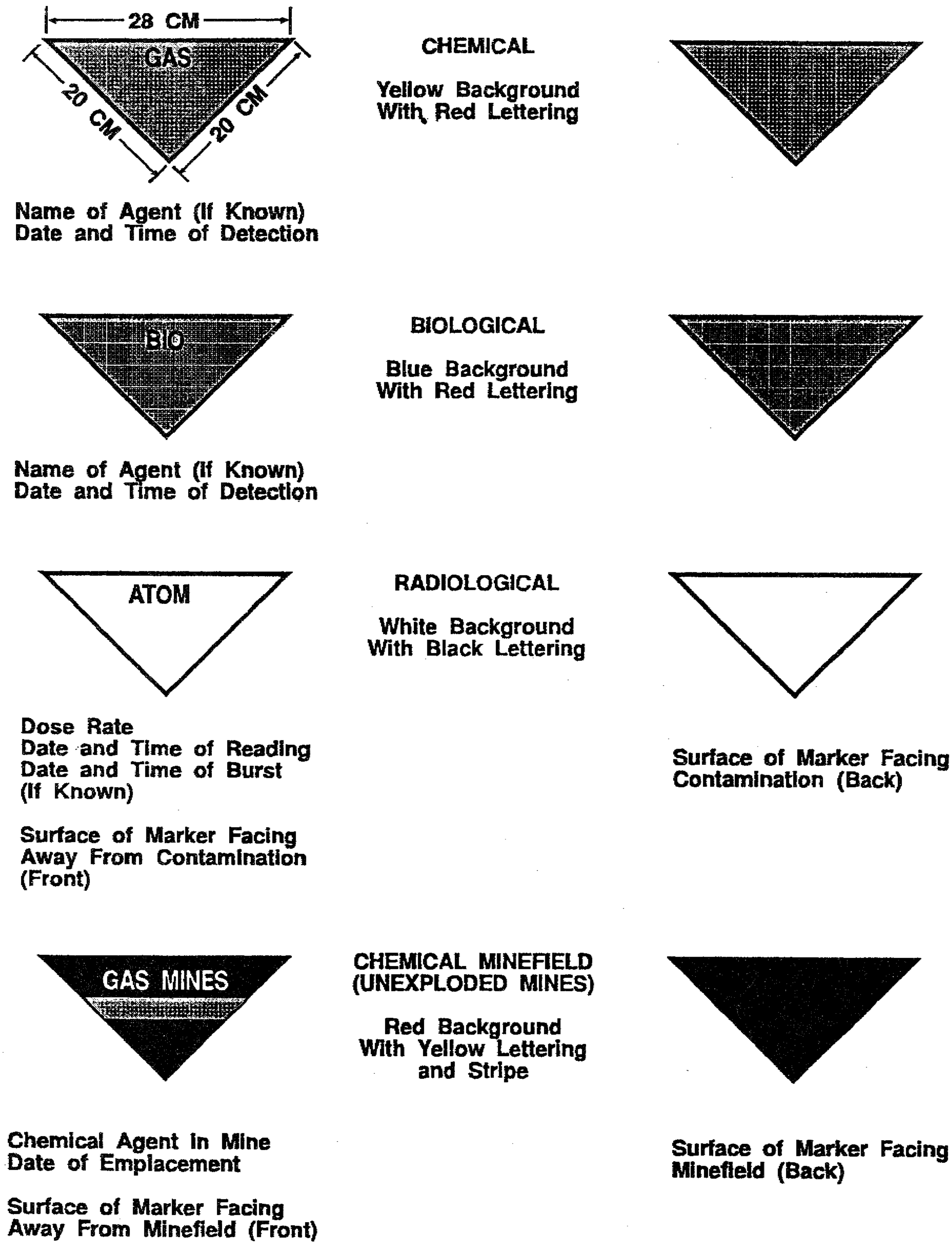

Figure 1-1. NBC Contamination Markers

PART B - CONTAMINATION PROTECTION

Forces on the move may encounter airborne vapor hazards or contaminated terrain even though the units were not directly attacked by CB agents. Contaminated areas may be the result of prior attacks by Threat Forces or attacks by friendly forces against the enemy.

1. Protection capabilities.

If chemical or biological agents have been used at all, soldiers must be prepared to defend against them at any time. Often, if agents have been used, commanders will have received NBC reports indicating the location of contaminated areas. The commander may have been informed that the unit is approaching a downwind hazard area. This is the area downwind of a chemical attack where the chemical cloud may still be dense enough to be hazardous to personnel. Contaminated areas may be marked by contamination markers.

NOTE

A contaminated area will not have a boundary line in the sense that all chemicals are on one side of the boundary and none are on the other side. Instead, contaminated areas will contain lesser amounts of agents in outlying areas. These amounts will decrease until an area is free of all chemical agent. Markers will be placed just outside the contaminated area.

Occasionally, however, a contaminated area will be encountered that has not been identified previously. When that happens, information about the area must be sent to higher headquarters in an NBC 1 Report. If time permits, the commander may direct the chemical detection teams to make a complete reconnaissance of the area to determine the extent of the contamination. Before beginning this reconnaissance, the personnel must put on their protective clothing and mask, if they have not already done so. The individual protective mask with the hood attached completes the protection required for personnel conducting reconnaissance.

2. Battle Dress Overgarment (BDO).

Standard A Battle Dress Overgarment (BDO) consists of the protective overgarment ensemble, footwear covers, protective gloves, and helmet cover. The BDO is issued to all soldiers as a combat uniform when under imminent threat of a chemical attack and after chemical operations have been initiated. The Battle Dress Overgarment (BDO) ensemble is permeable clothing. It is normally Worn over the duty uniform. The overgarment consists of one coat, also called a shirt, and one pair of trousers.

Both are expendable. The shirt and trousers are made of two layers of material. The outer layer is made of nylon cotton. The inner layer is charcoal-impregnated polyurethane foam. Some charcoal will be deposited on clothing worn under the overgarment. This will not detract from the chemical characteristics of the overgarment.

The BDO provides protection against chemical agent vapors and liquid droplets; biological agents; toxins, and radioactive alpha and beta particles. When the BDO is removed from its vapor-barrier bag and worn, its protective qualities last for a minimum of 30 days. It is recommended that the BDO be replaced after-30 days; however; the weartime may be extended by the commander when operationally necessary. The BDO that is worn longer than 30 days presents a slightly increased risk to the wearer; however, the key to its effectiveness at anytime during wear, is its serviceability. The slightly increased risk that is incurred by wearing the BDO beyond 30 days is discussed in FM 3-4, Chapter 3, Chemical Overgarment Risk Assessment. Weartime for the BDO begins then removed from its sealed vapor-barrier bag, and stops when the BDO is sealed into the vapor-barrier bag. If the original vapor-barrier bag is not available, return the BDO to a similar material bag and seal with common duct tape. Donning of the BDO regardless of the time, equates to a day of wear. Extending the weartime for the BDO affords additional flexibility for operational and logistical support planning. The BDO provides a minimum of 24 hours of protection against exposure to a liquid chemical agent. The BDO is not designed to be decontaminated or reimpregnated for reuse.

a. Coat/Shirt.

The shirt (Figure 1-2) has a short stand-up collar and a full-length zipper opening covered by a double protective flap. The cuff on the sleeves has elastic closures. Two outer pockets are located at the chest level.

b. Trousers.

The trousers (Figure 1-2) have two pockets and a fly-front with a protective flap. The waist has adjustable tabs plus suspender and belt loops. Each leg has a zipper closure on the lower outside section. The overgarment is available in eight sizes: XXX-small, SS-small, S-small, M-medium, L-large, X-large, XX-large and XXX-large. When sizing the overgarment remember that it is worn over the duty uniform. The overgarment is packaged in a vapor barrier bag. This bag protects the overgarment from possible contamination due to moisture, petroleum, oil, lubricant (POL) products, and solvents. General instructions and a sizing chart are printed on the bag. The overgarment provides protection to the soldier exposed to vapors, aerosols, and small liquid droplets of nerve and blister agents. The protective capabilities start with the opening of the vapor barrier bag and continues for up to 30 days, or until the overgarment becomes contaminated. When contaminated, the overgarment gives the soldier up to 24 hours of protection before it must be discarded.

c. Footwear Covers.

The footwear covers (Figure 1-2) are loose-fitting impermeable rubber. They have a non-slip sole. There are two models: one uses four eyelets to lace around the foot, the other uses five eyelets. The footwear covers are one-size-fits-all. They can be worn on either the right or left foot. The footwear covers are issued in a plastic bag with two pairs of laces and an instruction sheet. The footwear covers provide protection to the soldier from all known field concentrations of chemical agents. This protection is provided for a minimum of 30 days starting with the first day of wear. If the footwear covers are in good condition, they can be decontaminated and reused.

d. Protective Gloves.

The protective gloves (Figure 1-2) are issued as a set. The set consists of an outer glove and an inner glove to assist in absorption of perspiration. The outer gloves are made of an impermeable, black butyl rubber. The inner gloves are a thin, white cotton glove which can be worn on either hand. The gloves are available in four sizes: S-small, M-medium, L-large, and X-large. The gloves are issued in a plastic bag with an instruction sheet. The gloves provide protection from vapors, aerosols, and small droplets of chemical agents. It is good for a minimum of 30 days, starting the first day of wear. Gloves in good condition can be-reused if decontaminated. The standard issue leather gloves can be worn over the protective gloves. It is important to wear leather gloves when handling rough objects. This will protect the protective glove from punctures and tears.

Exposure of the rubber to DS2, break-free, antiseize compound or any other petroleum-based products attacks the rubber polymers in the gloves and makes them sticky. Avoid contact with these materials, if possible. However, replace the gloves if the rubber is sticky. Use bleach and water to remove these compounds from the rubber gloves as soon as possible.

e. Chemical Protective Helmet Cover.

The protective helmet cover (Figure 1-2) protects the Personnel Armor-System Ground Troop (PASGT) Helmet from chemical and biological contamination. The cover is a piece of butyl-coated nylon cloth gathered at the edge by an elastic web enclosed in the hem. It is an olive green cover, one size fits all. It is designed to keep chemical and biological agents from penetrating the Kevlar Helmet and the helmet cover.

f. Storage.

The Standard A Battle Dress Overgarment (BDO) ensemble should be stored in accordance with local unit standard operating procedures (SOP). The packaged overgarment should be inspected for tears and punctures before it is stored. Storage should be in a dry, sheltered area. The overgarments should be stored by size and in a protected damage-free environment. The overgarment has a shelf-life of five years after field testing.

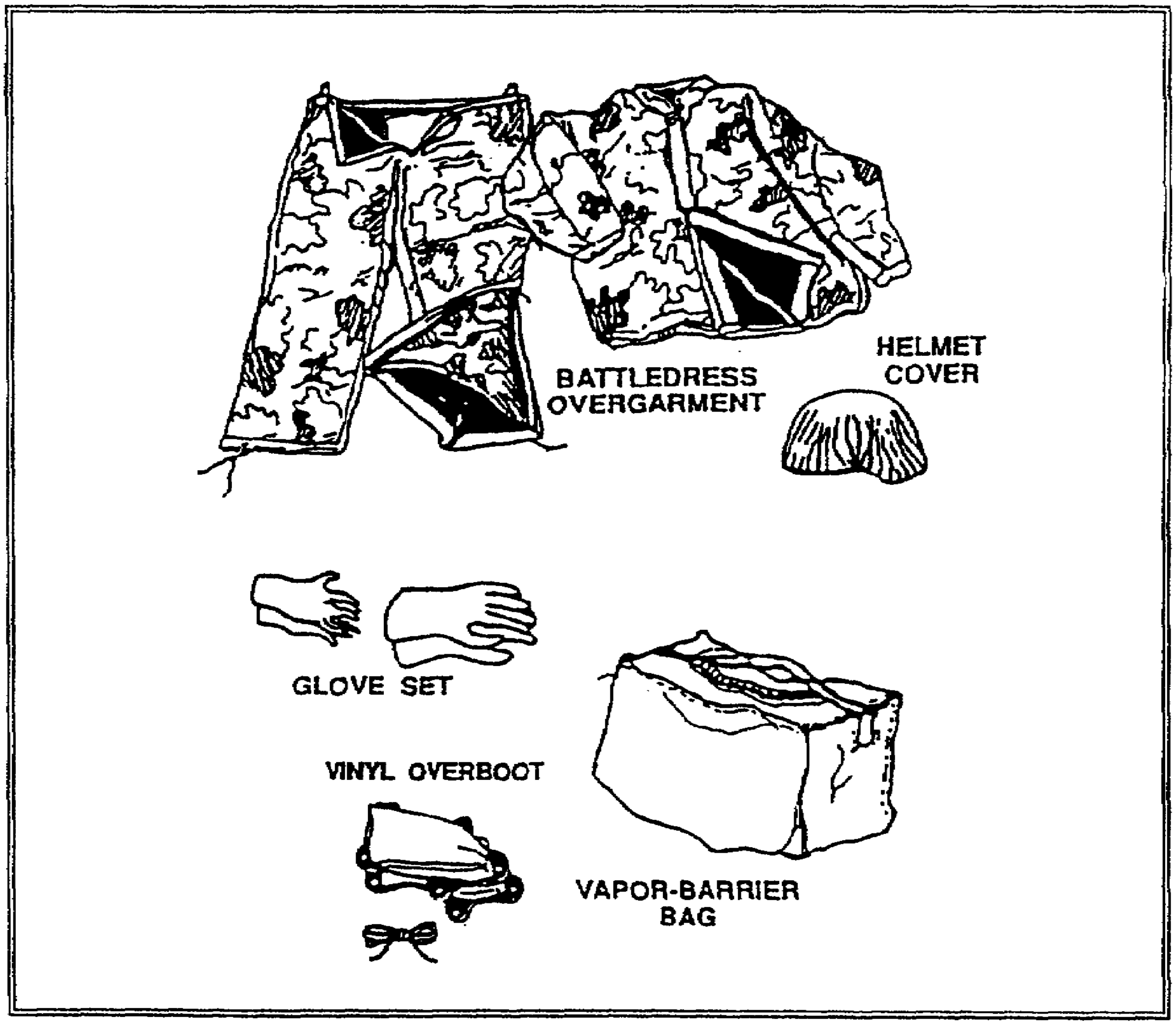

Figure 1-2. Components of Protective Clothing

LESSON 1

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. when you complete the exercise, check ;your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. Who specifies that contamination markers be a standard design?

   A. U.S. Defense Department
   B. United Nations
   C. North Atlantic Treaty Organization
   D. Australia, Canada, England, and Germany

2. Which would cause an area which is contaminated to be unmarked?

   A. If contaminant is non-lethal
   B. If area is just lightly contaminated
   C. If area is to be abandoned to the enemy
   D. If type of agent is unknown

3. Which data would be omitted on a chemical contamination marker?

   A. Persistency of the agent
   B. Name of the agent
   C. Date of detection
   D. Time of detection

4. Which is a characteristic of a chemical contamination marker?

   A. Black triangle
   B. Yellow triangle
   C. Red background
   D. The word "GAS" on back

5. The chemical minefield marker has the word "GAS MINES" printed on one side using block letters that are how many centimeter(s) high.

   A. 1.5
   B. 2
   C. 2.5
   D. 3

6. Who directs the reconnaissance of an area to determine the extent of contamination?

   A. Commander
   B. NBC 1 Report
   C. Squad Leader
   D. Team Leader

7. Which is worn as a combat uniform when under the threat of a chemical attack?

   A. BDO
   B. BDU
   C. Standard B Uniform
   D. TAP Suit

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LESSON 1
PRACTICE EXERCISE
ANSWER KEY AND FEEDBACK

Item		Correct Answer and Feedback
1.	C	North Atlantic Treaty Organization (NATO) Signs Used ... members. Page 1-2, Part A, para 2
2.	C	If area is to be abandoned to the enemy Identified areas ... Forces. Page 1-2; Part A, para 1
3.	A	Persistency of the agent The name ... emplacement. Page 1-2, Part A, para a
4.	B	Yellow triangle The chemical ... triangle. Page 1-3, Part A, para a
5.	C	2.5 On the side ... lettering. Page 1-3, Part A, para 1
6.	A	Commander If time ... contamination. Page 1-5, Part B, para 1
7.	A	BDO The BDO is ... initiated. Page 1-6, Part B, para 2

LESSON 2
PROVIDE TECHNICAL ADVICE ON BIOLOGICAL DEFENSE

Critical Task: 031-503-4002

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will be taught how to provide technical advice on biological defense measures. To provide proper advice on biological defense, you must be able to:

1. Describe the general characteristics of biological agents and toxins.
2. Identify detection methods for biological agents.
3. Describe defensive measures against biological agents.

TERMINAL LEARNING OBJECTIVE

ACTION: Provide technical advice on biological defense.

CONDITION: Given information about and illustrations related to the fundamentals of providing technical advice on biological defense.

STANDARD: Demonstrate competency of the task skills and knowledge by responding to the multiple-choice test covering the fundamentals of providing technical advice of biological defense.

REFERENCES: FM 3-3, FM 3-4, STP 3-54B1-SM and STP 3-54B2-SM.

INTRODUCTION

On every battlefield, the soldier has to fight disease as well as the enemy. Disease has proven to be a formidable antagonist, determining the outcome of many battles. Prior to the development of modern medicine, disease killed more soldiers than did actual combat. This was due to overcrowding, poor camp hygiene, inadequate medical support, and the physical stresses of combat. World War II was the first war in the history of the U.S. Army where deaths from combat exceeded those from disease. But death from disease is not the only problem. The fighting strength of the U.S. Army in World War II was significantly weakened by lost man-days due to sickness. The number of lost man-days due to naturally occurring disease was equivalent to 18

U.S. Army Infantry Divisions operating for a three-year period, 1942 to 1945.

The military potential of disease has not been overlooked. If naturally occurring disease can have a major military impact, how much greater could that effect be if disease-producing microorganisms were employed intentionally. Biological operations are not new. The contamination of water sources by corpses is an ancient technique. The popular notion was that foul odors and decaying material could cause disease. In the Middle Ages, this misconception led to the hurling of corpses and excreta into besieged cities by means of an immense machine called a trebuchet. A more sophisticated approach was used by the British against the Indians at Fort Pitt, Pennsylvania, in 1763. The British commander infected the local Indian tribe with smallpox by giving them blankets taken from smallpox patients. The Indians had a low biological resistance to the disease and many died.

In the 20th century, there have been numerous allegations about the use of biological agents. There is one case which is supported by substantive evidence. During World War I, Germany used a causative agent, glanders, to infect French and Romanian cavalry horses. Biological agent research was active in Germany and Japan during the 1930's. The threat that this effort posed to the Free World was evaluated in the United States by the National Academy of Sciences. This study determined that "the value of biological warfare will be a debatable question until it has been clearly proven or disproven by experiences. The wide assumption is that any method which appears to offer advantages to a nation at war will be vigorously employed by that nation. There is but one logical course to pursue, namely, to study the possibilities of such warfare from every angle, make every preparation for reducing its effectiveness, and thereby reduce the likelihood of its use." This report led to the development of the U.S. Army Biological Defense Research Program in 1942.

The ultimate objective of biological operations is to directly or indirectly reduce the enemy's ability to wage war. This objective might be achieved directly by attacking individuals. It also might be achieved directly by attacking food crops, domestic animals, or supplies, thereby limiting the means of support.

PART A - CHARACTERISTICS OF BIOLOGICAL AGENTS

1. General Characteristics of Biological Agents.

Biological weapon systems are technically feasible. They possess a mass casualty potential which cannot be safely ignored. It is imperative to be able to defend against biological attack.

The first step in preparing a sound defense is to understand the nature of the threat. This involves sweeping away some of the misconceptions associated with biological agents. These agents are not the ultimate weapons referred to by science fiction writers. Knowledge of the general characteristics of biological agents and toxins enables the soldier to place their threat in perspective.

a. Low Agent Requirement.

Biological weapon systems are unique in that the agents involved are alive. Only a small number of microorganisms are needed to establish infection. The agents reproduce in the host to bring about disease. A natural regional outbreak of a disease which affects many individuals and which can spread rapidly is called an epidemic. In such a situation there is an unusual increase in the number of cases of a disease in a limited time among a limited population. In nature, the spread of disease occurs from direct contact between individuals, contact with or ingestion of excreta and contaminated food, exposure to dusts and mists of infective material (aerosols), and from transmission by animal or anthropod vectors. Following large-scale dissemination of a biological agent, an initial outbreak of disease of epidemic proportion might occur. This depends upon the contagion of the agent, the presence or absence of favorable environmental conditions, and the level of medical support. Epidemics among the human population can be controlled or minimized by sanitation, immunization, quarantine, and treatment. Rapidly spreading epidemics are not considered to be the likely result of a biological attack in a civilized country so long as controlling factors remain at a high level of efficiency.

b. Large-Area Coverage.

Biological weapon systems have the potential to cover larger areas than other weapons. Extremely large numbers of infective doses of biological agents can be of small volume because the size of the organisms is microscopic. A single delivery vehicle can cover target areas up to thousands of square kilometers with a casualty-producing biological agent aerosol.

c. Dependence on Weather.

There are four significant weather conditions which directly affect a biological agent aerosol. These are sunlight (ultraviolet radiation), relative humidity, wind (both speed and direction), and air stability. Ultraviolet radiation is lethal to most biological agents; therefore, most biological attacks may be expected at night. Each potential biological agent, once aerosolized, has an optimum relative humidity. The importance of wind effects varies with the type of weapon system used to disseminate the agent. If dissemination is by a weapon that releases the agent directly on target, then Wind direction and speed have little effect on the target coverage; however, downwind effects from the target must be considered. If dissemination is by a weapon that releases the agent upwind of a target area, then the wind must carry it to the target area. Normally, the most effective wind speeds for effective target coverage with a biological agent aerosol involving downwind travel are from 8 to 18 knots.

d. Delayed Effect.

Biological agents do not cause casualties immediately. Time is required for the agent to reproduce. After the microorganisms have multiplied in sufficient quantity, they may overcome the body defenses and cause disease. There is a period of time from the time of entry of microorganisms into individuals to the time they become sick or casualties. This period of time-to-casualty, incubation period, is typical for each agent and varies from a few days to a few weeks or months.

e. Pervasive.

The particles of biological agent aerosols are so small and light that they are carried by wind currents into dug-in positions, fortifications, or other nonairtight shelters and structures. So-called hard targets for other weapon systems would not be considered hard targets for biological weapon systems. It is possible that the dose received inside a nonairtight structure may exceed that received on the outside. This is true because the structure, once penetrated, affords protection for the agent, and it will probably persist for a much longer period of time.

f. Nondestructive.

Since biological agents, other than antimateriel agents, affect only living things, equipment, facilities, and structures will be left intact after a biological attack has occurred. In addition, biological explosive munitions usually utilize very low order explosives for dissemination of the agent. Such explosions are not of sufficient force to produce any significant destruction. Spray weapon systems are completely nondestructive.

g. Difficult to Detect.

Biological agents that are disseminated as aerosols are not detectable by any of the five physical senses--sight, smell, taste, touch, and hearing. When someone comes in contact with such an aerosol, they inhale the organisms without suspecting they have been the target of an attack. Effects do not occur immediately, so the attack goes unnoticed. It is only with special instruments that the presence of biological agents can be detected. At present the capabilities of such instruments are very limited.

h. Decay of Agent.

Since biological agents are living microorganisms, they are affected by environmental conditions during storage and shipment and when disseminated. Refrigeration is necessary during storage and shipment to reduce the rate of loss of viability and virulence of the agent. The rate at which most microorganisms die is predictable and is referred to as the "decay rate".

i. Ease of Production.

Biological agents are the least expensive of the mass casualty weapons. Any enemy nation with a modest biological research or production base, such as in the pharmaceutical or brewing industry, can produce biological agents.

j. Severity of Effects.

Effects might be either lethal or nonlethal, incapacitating. Lethal or killing agents can produce death in susceptible individuals, but from a practical standpoint, death occurs only in a certain percentage of those exposed. The nonlethal pathogenic agents usually do not kill, but might produce infection or disease with militarily significant disability among susceptible exposed individuals. Food and industrial products can be tendered unsafe or unfit for use by contamination or by the effects resulting from contamination with biological agents.

2. General Characteristics of Toxins.

Generally, any poisonous substance of microorganism, vegetable, or animal origin is called a toxin. True toxins are of an unstable protein nature. They require a period of incubation or a latent period to produce symptoms and induce the formation of specific antitoxins in suitable animals.

Once a toxin-producing pathogen has entered the body, various toxins can disrupt the delicate physiochemical balance within the body's cells and disease can result. These toxins can be broadly classed into two types, depending upon their composition, resistance to heat, and method of release from the pathogen.

a. Exotoxins.

Exotoxins are proteins of varying molecular weight. Some of these are enzymes. Exterotoxins are exotoxins which are produced by certain staphylococci. Their primary action is upon the digestive tract. These toxins produce severe nausea, vomiting, and diarrhea, but the possibility of death is remote. Man normally acquires these heat-stable toxins following ingestion of contaminated food.

b. Endotoxins.

Endotoxins, a protein complex, are synthesized by the cytoplasmic membrane or by the introcellular membrane system and become a part of the cell wall of the microorganism. Since this toxin is part of the cell wall, it can only be released upon death and autolysis of the cell. Rickettsiae prowazekii, which causes typhus fever, produces an endotoxin which causes the rapid destruction of the red blood cells and increases the permeability of blood vessels, resulting in hemorrhage.

PART B -- BIOLOGICAL AGENT DETECTION METHODS

The detection of a biological agent attack is a requirement of an adequate defense system. Recognizing the means of delivery and symptoms of biological agents is very important, since it is the most likely detection method. Of primary concern is detection of biological agent aerosols which offer the most effective method of dissemination. Unlike nuclear weapons and chemical agents, biological agents are living. They are not detectable with the five physical senses.

Detection can be subdivided into phases that provide information upon which maximum individual and collective protective measures can be taken. These phases are:

- Rapid warning - To indicate an attack is taking place.
- Sampling - To provide the material necessary for identification and to help determine the extent of contamination.
- Identification - To identify the agent and help determine proper therapy for exposed personnel.
- Epidemiology - To determine the extent of agent effect throughout a unit or geographical area.

1. Rapid Warning.

Rapid warning requires the use of some type of automatic device or devices to give an immediate indication that biological agents have been used. A device of this nature must be extremely sensitive to detect very small amounts of agent, and reliable in order to reduce the possibility of false alarms. These could give the commander an indication that an attack is in progress.

A warning may be provided by other means, such as the pattern of established warfare or recognition of the delivery system used.

a. Pattern of Established Warfare.

After biological agents have been employed several times, a definite usage pattern could materialize. The time of attack, methods of dissemination, munitions, or the stage of the operation in which the agents are employed might be similar. This information will not give definite proof that a biological attack is occurring, however, if the suspected action closely parallels previous known attacks, a warning could be given.

b. Intelligence.

Intelligence can yield information useful in predicting a biological attack.

- Strategic intelligence could give the commander an estimate of the enemy's overall capabilities, limitations, and probable intentions for the employment of biological agents.

- Combat intelligence could give the commander an estimate of the enemy's battlefield readiness to employ biological agents.

- Technical and medical intelligence also have application. Technical intelligence could enable evaluation of the protective equipment of an enemy and determination of its availability to his forces. Medical intelligence might provide information concerning the status of enemy preventive medicine capabilities, medical treatment capabilities, and preparations being made in medical and related areas which might indicate imminent attack with biological agents. For example, the extent of an enemy's immunization program might be analyzed by methods, which include serum analysis and examination of captured immunization records to determine the antibody content in prisoners of war.

2. Sampling.

The purpose of sampling is to aid in agent identification by obtaining a large number of microorganisms relatively free from interfering material. Sampling will be done by individuals trained in sampling procedures, so that uniformity will exist in the samples. The data is forwarded to identification personnel. Sampling must not be done indiscriminately but performed only after an indication that an attack has occurred. The U.S. Army Standard A Sampling Kit is the M34 CBR Agent Sampling Kit.

Methods of collecting suspected material vary with the nature and source, that is, living or dead tissue, body secretions, water, and material from surfaces. Sampling varies with the method of agent release, such as aerosols from spray devices or bombs. If the agent is released as an aerosol, every effort should be made to obtain a sample as near the point of release as possible. The number, as well as the viability of the microorganisms in an aerosol, will decrease with the passage of time and distance from the point of release.

Samples of vegetation, water, and other material on which the agent has impacted may be of value in helping confirm the identity of the agent. The samples contain interfering contamination and yield a smaller number of microorganisms than were present in the original aerosol. Such samples should be taken as soon after release and as near the point of release as possible. Vegetation, water, and other solid and liquid samples are collected by placing contaminated portions of each in sterile containers. Samples from contaminated surfaces may be obtained by rubbing the surfaces with a sterile moistened cotton Swab and placing it in a sterile, capped container. Samples should be sent to the nearest designated laboratory for identification by the fastest method.

3. Identification.

The identification of microorganisms is a difficult and time-consuming process. The methods used are generally dependent upon obtaining living organisms by sampling. Laboratory procedures are used to establish or confirm the identity of a microorganism. The identification phase of detection is accomplished to determine which of the possible antipersonnel agents were used in an attack. Identification can aid in:

- Confirming that an attack has taken place.
- Determining the proper therapy to combat agent effects on exposed personnel.
- Estimating the expected number and type of casualties in the command.
- Determining the time-to-casualties, if the time of the attack is known.
- Evaluating an enemy's biological capability.

4. Epidemiology.

Epidemiology is the study of the aspects of disease and is used during epidemics or sudden outbreaks of disease. Epidemiology is the least desirable phase in determining that a biological attack has taken place at sometime in the past; however, the present time is the most positive. A long time may be pass before significant information is obtained. It is limited as a source of information upon which prompt defensive measures can be based. When a large number of cases of a disease suddenly appear within an area, an investigation is conducted to determine the cause. If all natural causes for the outbreak can be ruled out, an assumption can be made that a biological attack has occurred. Initial biological attacks would probably be detected by epidemiological findings of the Army or Air Force Medical Service.

PART C - DEFENSIVE MEASURES AGAINST BIOLOGICAL AGENTS

Defense against a biological attack must consist of preventive measures first, and then measures to combat agent effects on personnel, if an attack should occur. These measures are:

- Active defense measures.
- Passive defense measures.

1. Active Defense Measures.

Active defense measures to prevent attack are destroy the enemy's biological facilities and intercept the enemy's weapons systems.

a. Destroy the Enemy's Biological Facilities.

By locating and damaging or destroying the enemy's research and development facilities, laboratories, manufacturing plants, stock piles, and launching sites, their capability for attack can be reduced. This is an important active defense measure that will be utilized to its fullest extent, but will not be completely effective. Biological agents can be produced in relatively small installations that are easily hidden and dispersed targets.

b. Intercept the Enemy's Weapons Systems.

By destroying or disrupting the enemy's attacks, their operational effectiveness can be reduced. This measure will be implemented to the fullest extent, but experience has proven that some weapons systems will reach the target and effectively deliver their munitions.

2. Passive Defense Measures.

The purpose of passive defense is to reduce or minimize casualties resulting from a successful biological attack. The measures used are based on public health practices that have proved valuable in control of natural outbreaks of disease. These measures are not based on results from a biological attack, but they will aid in reducing the number of casualties and the severity of some of the diseases. The measures of passive defense are divided into three phases: Measures taken before, during, and after an attack.

a. Measures Taken Before an Attack.

The measures taken before the attack are designed to minimize the effect of the agent on personnel. These measures are: Personal Hygiene and Area Sanitation and Immunization.

(1) Personal Hygiene and Area Sanitation.

These measures are important in routine preventive medicine and are implemented in every unit. During normal situations, these measures tend to reduce the incidence of infectious disease and increase the general health of the individual and the unit. The infective dosage is dependent upon the physical condition of the exposed individual. Area sanitation plays an important part in defense against biological attack by preventing rodents and other vectors from transmitting disease to previously unexposed personnel.

(2) Immunization.

The use of immunization is valuable to the extent that disease symptoms are less severe or absent in immunized individuals. Immunity is the power or ability to resist or overcome infection or disease. An enemy might hesitate to use a particular agent against troops protected by immunization because they could not be sure of the results. The assumption must not be made that immunization is the only defense needed against biological agent employment. Effective immunization is not available for all the potential biological agents, and acquired immunity to some agents may be overcome if the dosage is high enough.

b. Measures Taken During Attack.

The measures taken by troops while under biological attack are similar to those taken while under chemical attack. The most important single item of protective equipment is the mask. A properly fitted protective mask in good operating condition will give adequate protection against aerosolized biological agents. The importance of proper fit and adjustment of the protective mask and hood cannot be overemphasized. Protective clothing is not necessary for protection against field concentrations of biological agents. Normal clothing, buttoned and arranged so that as much of the skin as possible is covered, will give good protection. If possible, any open wounds should be bandaged.

c. Measures Taken After Attack.

The defensive measures taken after an attack are designed to prevent casualties resulting from secondary contamination and exposure. The primary measure is decontamination of personnel, equipment, food, and water. Personnel and equipment must be decontaminated when the situation allows. Personnel should decontaminate themselves by taking a shower with hot, soapy water when it is available. In the absence of hot water or soap, physical removal of contamination can be achieved to some extent by rinsing in water. Washing with water removes about 90 percent of the microorganisms present on the skin. Soap and warm water removes about 99 percent of the microorganisms present on the skin. Cuts and other wounds should be treated as soon as possible with antiseptics. Food that has been stored in sealed containers, cartons, and cans can be made safe for consumption by decontaminating the outer container. Water poses a special problem for decontamination. Containerized water supplies such as canteens, Lister bags, or bladders can be considered uncontaminated if the outside surface is washed before opening. The only supply of adequately decontaminated water is from the Engineer Water Purification Unit. This piece of equipment is designed to remove even biological spores from contaminated water sources. All water supplies that were exposed during a biological attack should be discarded and replenished with water supplied by a water purification unit. In the event that water absolutely must be taken from a known or suspected contaminated source and a water purification unit is not available, the water should be boiled for as long as possible, at least 15 minutes, and water purification tablets added. The unit medic or surgeon should be notified of the situation as soon as possible so that therapeutic measures can be taken. Some therapeutic measures are:

(1) Therapy.

Once the agent used in a biological attack has been identified, a plan of action in treatment can be initiated. A plan might include the use of antimicrobial drugs for prophylaxis and/or therapy, supportive care, and immunization.

(2) Chemoprophylaxis.

The practice of using antimicrobial or antibiotic drugs, such as penicillin, tetracycline, or others, in an effort to prevent the initiation of an infection or to suppress certain infections during the incubation period, is called chemoprophylaxis. The use of quinine for malaria is the best example. It demands specific knowledge of the causative agent to know which antimicrobial drug to use, and how and when to administer it.

(3) Passive Immunization.

This technique is a transient immunity produced when blood serum or globulin of immune individuals or animals are given to the patient. The injection of serum containing antibodies leads to a maximal circulating concentration of the antibodies. Various procedures for passive immunization may include:

- Injection of serum from convalescent patients.
- Injection of serum from persons or animals hyperimmunized against the disease.

(4) Chemotherapy.

Some examples of chemotherapeutic agents are antibiotics, such as Penicillin, Streptomycin and Tetracycline; Sulfonamides, such as Sulfadiazine, Sulfamerazine, and Sulfathiazole; Arsenicals, such as Neoarsphenamine, Tryparsamide, and Mapharsen; and others such as Quinine, Atabrine, and Plasmachin. The primary example is the administration of chemotherapeutic agents after the appearance of clinical symptoms. A drawback is the fact that antimicrobial drugs are not effective in the treatment of all diseases, especially viral diseases. Chemotherapeutic agents retard the multiplication of invading pathogens. Chemotherapeutic agents may be classed as Bactericidal, such as Penicillin and Streptomycin, or Bacteriostatic, such as Sulfonamides and Tetracycline.

(5) Disinfectants and Antiseptics.

Many compounds are used to kill microorganisms or to inhibit their growth. Disinfectants are materials that kill pathogenic microorganisms. Antiseptics are substances that inhibit the growth and development of microorganisms, but do not necessarily kill them.

LESSON 2
PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. What is the ultimate objective of biological operations?

   A. To kill the enemy
   B. To reduce the enemy's ability to wage war
   C. To destroy the enemy's crops
   D. To create uncontrollable epidemics

2. What is the first step in preparing a sound biological defense?

   A. Improve biological agent detection techniques
   B. Conduct mass immunization programs
   C. Understand the nature of the threat
   D. Destroy the enemy's biological agent stock piles

3. Why are most biological attacks expected at night?

   A. Ultraviolet radiation (sunlight) is lethal to most biological agents.
   B. Most personnel will be in the least protection.
   C. The attack can be hidden by the darkness.
   D. The optimum humidity can best be achieved then.

4. What is the most effective wind speed (knots) for effective target coverage with a biological agent aerosol involving downwind travel?

   A. 2 to 4
   B. 4 to 8
   C. 8 to 18
   D. 19 to 25

5. Which is a detection phase of biological agents?

   A. Smell
   B. Sampling
   C. Taste
   D. Treatment

6. Biological agent identification can aid in which area?

   A. Complete immunization of personnel
   B. Strict sanitary procedures
   C. Determining the downwind hazard distance
   D. Evaluating an enemy's biological capability

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LESSON 2
PRACTICE EXERCISE
ANSWER KEY AND FEEDBACK

Item	**Correct Answer and Feedback**	
1.	B	To reduce the enemy's ability to wage war The ultimate ... war. Page 2-2, Part A, para 3
2.	C	Understand the nature of the threat The first ... threat. Page 2-3, Part A, para 1
3.	A	Ultraviolet radiation (sunlight) is lethal to most biological agents. Ultraviolet ... night. Page 2-3, Part A, para c
4.	C	8 to 18 Normally the ... knots. Page 2-4, Part A, para c
5.	B	Sampling Page 2-6, Part B, ·■ Sampling
6.	D	Evaluating an enemy's biological capability Identification can aid in: Page 2-8, Part B, para 3

LESSON 3
ASSESS WIND AND TEMPERATURE EFFECTS ON CHEMICAL AGENTS

Critical Tasks: 031-504-3001

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn about the effects of wind and temperature on chemical agents.

To properly predict the duration of effectiveness of chemical agents:

1. Describe the general characteristics of chemical agents.
2. Assess the effect of wind on chemical agents.
3. Assess the effect of temperature on chemical agents.

TERMINAL LEARNING OBJECTIVE

ACTION: Assess wind and temperature effects on chemical agents.

CONDITION: Given information about and illustrations of the general characteristics of chemical agents and the effect of wind and temperature on chemical agent cloud travel.

STANDARD: Demonstrate competency of the task, skills, and knowledge by responding to the multiple-choice test covering the general characteristics of chemical agents and the effects of wind and temperature on chemical agent cloud travel.

REFERENCE: FM 3-6

INTRODUCTION

Planning for the use of chemical agents by Threat Forces will be incorporated into the scheme of offensive and defensive maneuvers by US Army units. Chemical strikes may be employed in an anti-personnel role to neutralize US defensive operations or may be used to contaminate specific areas with persistent agents to act as an obstacle. However, chemical agents will be used by Threat Forces primarily to destroy our offensive capabilities.

The chemical warfare capabilities of the Threat Nations dictate that US Forces must be prepared to survive massive chemical attacks and to continue to function efficiently in a chemically contaminated environment.

PART A - CHARACTERISTICS OF CHEMICAL AGENTS

The ability of a man to function in a chemical environment is directly related to the degree of protection provided by protective equipment available and the level of acclimation achieved in wearing that equipment. This equipment consists of the protective mask, hood, gloves, overgarment, and footwear covets.

All chemical agents are affected by the environment. Weather conditions have a significant effect on the behavior of chemical agents when they are released. Chemical agents may be used to achieve surprise. There are certain times and conditions where they can be employed most effectively. The most favorable conditions usually occur at night, during early morning, at dusk, and when there is a heavy overcast with light, steady winds. Smooth terrain is usually favorable for the employment of chemical agents than rough terrain, and low places are generally more favorable than higher elevations, since the agents tend to linger and settle in the low places.

1. Chemical Agent Characteristics.

The persistency, duration of effectiveness, of a chemical agent is dependent on its physical properties, weather conditions, method of agent dissemination, and the type and condition of the terrain, material, and equipment on which the agent is deposited. The terms "persistent and nonpersistent agents" express the relative duration of effectiveness of chemical agents in the area of release. These terms do not refer to the duration of the effects of the agents on personnel.

a. Persistent Agents.

If a Threat chemical attack consists of liquid droplets from airburst artillery munitions, bomblets, bulk-filled missile warheads, or spray from aircraft, persistent agents probably have been used. These agents are used to contaminate equipment and terrain and to cause casualties by the skin absorption route. The agents may include persistent nerve agents, blister agents, or a combination.

b. Nonpersistent Agents.

Nonpersistent agents are probably being used if a Threat attack consists of vapors and aerosols from point-detonation or near-surface detonation, artillery munitions, bombs, or bomblets. Use of these agents is primarily intended to cause casualties by entry into the body through the respiratory system. The agents may include nonpersistent nerve, blister, blood, and choking agents, or a combination.

2. Types of Chemical Agents

a. Nerve Agents

These agents directly affect the nervous system of man and are highly toxic in both liquid and vapor form. Whether they are absorbed through the skin or inhaled, the effects on the body are similar. Symptoms of nerve agent exposure include a runny nose, tightness of the chest, difficult breathing, excessive sweating, drooling, nausea, vomiting, dimness of vision, pinpointing of the pupils of the eyes, convulsions, and death. The vapor is readily absorbed by the eyes and by the tissues in the nose and throat. The liquid readily penetrates the skin, eyes, and tissues of the body.

Most nerve agents act quickly when inhaled, with some symptoms developing within 1 to 2 minutes after inhalation. They act more slowly when penetration is by absorption through undamaged skin. When the eyes are exposed to a nerve agent vapor, the pupils will become pinpointed. However, pinpointing of the pupils may not occur for 10 minutes or more after exposure to a very low vapor concentration. When the only exposure to nerve agent is liquid contamination of the skin, the pupils may remain normal or be only slightly reduced in size. The casualties caused by nerve agents may range from mild disability to death, depending on the dose received and the adequacy and speed of first-aid treatment.

b. Blister Agents

Blister agents affect the eyes and lungs and blister the skin. Some types are painless, other sting, and others cause the formation of wheals. They may appear as colorless to dark brown, oily, liquid droplets, but normally are invisible in the vapor form. The characteristics and effects of blister agents are:

(1) In liquid or vapor form, these agents may burn or blister any part of the body they contact, either internal or external. The degree of damage depends on the type and concentration of the agent, weather, degree of activity , and exposure time.

(2) They are effective even in small quantities and produce delayed casualties. A drop of mustard agent the size of a pinhead can produce a blister one inch in diameter. Unprotected troops exposed

to a low vapor concentration of agent for a long period of time may eventually become casualties.

(3) Blister agents which come in direct contact with the eyes will produce marked effects such as redness, inflammation, and temporary blindness.

(4) Mustard agents are quickly absorbed through the skin. Reddening of the affected area may appear any time up to 12 hours, depending on the degree of contamination and weather conditions. Blisters may appear in a day or less following the reddening. Healing time varies from 6 days to 8 weeks in severe cases, particularly those involving moist skin areas, such as the armpits and crotch.

(5) Inhalation of blister agents will cause serious damage to tissues in the mouth, nose, throat, and lungs.

(6) Blister agents often have a more serious effect than is immediately apparent. Exposure to some of the mustard agents may go unnoticed because they usually do not cause any immediate pain and signs of injury may not appear for several hours. The vapor of other types of blister agents irritates the eyes and respiratory tract immediately, and the liquid stings the skin and causes pain within a few seconds after exposure.

c. Blood Agents

Blood agents are usually disseminated as vapors or gases and are taken into the body by breathing. They affect the circulatory and respiratory systems by preventing the use of the oxygen carried by the blood. They cause symptoms ranging from convulsions to coma. After inhaling a high concentration of blood agent, a soldier may become unconscious and die.

d. Choking Agents

Choking agents are usually disseminated as gases and are taken into the body by inhalation. They affect the respiratory system by damaging the lungs and, in extreme cases, cause them to fill with fluid. They produce the following symptoms: coughing; choking, tightness in the chest, nausea, headache, and watering of the eyes. Delayed effects, occurring 2 to 4 hours after exposure, usually follow a period during which the individual experiences no initial effects. These delayed effects include rapid and shallow breathing, painful cough, discomfort, fatigue, shock, and death.

PART B - THE EFFECT OF WIND ON CHEMICAL AGENT CLOUD TRAVEL

During the target analysis phase of planning chemical weapons employment, the effect of the current wind conditions, and the terrain in the target area must be given proper consideration. These two influences can mean the difference between a successful chemical operation and a disaster. Regardless of who fires the weapon delivering the agent, if the wind or terrain carries the agent or vapor hazard into friendly position, unprotected personnel will become casualties. For this reason, it is important to know how far and in what direction a chemical cloud will travel.

To determine the distance and direction of travel of a chemical cloud, you must be able to:

- Determine the wind direction,
- Determine the wind speed,
- Assess the dissipation effect of wind on a chemical cloud.

1. Determine the Direction the Cloud Will Travel

Army meteorological sections are organic to each division within the field army. This weather information may come from either artillery meteorological channels or from Air Force weather sections reporting to the staff weather officer. From this data, you will receive the direction from which the wind is blowing. To determine which direction the wind is blowing toward, note the given wind direction, and if it is 180° or more, subtract 180°. As an example, if the given wind direction is 240°, this is the direction from which the wind is blowing. To determine the direction the wind is blowing to, subtract 180° (240°-180°= 60°). Therefore, 60° is the direction the wind is blowing toward.

2. Determine the Speed the Cloud Will Travel

The staff weather officer will also be able to tell you at what speed the current surface winds are blowing. Normally, when you receive the wind speed, it will be given to you in nautical miles per hour (knots per hour). You must then convert the speed to kilometers. To convert knots per hour to kilometers per hour, multiply the knots by 1.85.

3. Determine the Dissipation Effect of Wind on a Chemical Agent Cloud

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 shells 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. In general, high wind speed increases the effectiveness of a nonpersistent surprise attack when munitions containing massive agent loads are used.

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

Once agents are detected, units can be warned to take appropriate protective measures to minimize the effects of chemical agents. Detection allows individuals to survive and units to accomplish the mission. Chemical agents can be delivered directly, on-target, on unit positions or upwind, off-target, to drift over the unit position.

Table 3-1 shows the arrival time of chemical agents for various wind speeds. A distance of 150 meters was chosen because that is the optimum distance that a chemical agent detector can be placed upwind and a chemical agent cloud cannot slip behind the alarm and hit the unit. When using the chart, commanders must realize that if the concentration of chemical agents is low, the alarm may not respond for several seconds. The average time to mask is 15 seconds. Warning times for different distances and wind speeds can be determined using the following formula:

- $$\text{Warning time (sec)} = \frac{\text{Distance (m)} \times 36}{\text{Wind speed (kmph)} \times 10}$$

- 36 is the factor to convert hours to seconds.
- 10 is the factor to convert kilometers to meters.

Table 3-1. Wind Speed Effects on Chemical Agent Arrival Time

Wind Speed (KMPH)	Time Before Agent Reaches Unit Location (Seconds)	Distance Between Unit and Detectors (Meters)
5	108	150
10	54	150
15	36	150
20	27	150
25	22	150

This method can be used only to warn against agents drifting into the unit location. On-target attacks circumvent detectors placed at this maximum distance.

PART C - THE EFFECT OF TEMPERATURE ON A CHEMICAL AGENT CLOUD AND AGENT PERSISTENCY

The stability of a chemical agent cloud is directly affected by the temperature of the air at the surface and the first few meters above the surface. For this reason, conditions within this air layer have been categorized into temperature gradients. 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 1/2 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. Temperature gradients can be estimated in the event meteorological data is not available.

1. 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% 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.

2. 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% 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.

3. 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 to 2 hours before sunset, or 1 to 2 hours after sunrise, when the middle and low clouds cover more than 30% 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.

Changes in surface temperatures, where land meets large bodies of water, affect the flow of air carrying a chemical agent cloud. As shown is Figure 3-1, air flow will be seaward at night and landward during the warmth of day. Temperatures can be extremely important in the persistency of chemical agents. In warm temperatures, the rate of evaporation will shorten the time that a liquid chemical agent is effective, while at cooler temperatures a chemical agent will remain for a much longer period of time. Some liquid chemical agents will freeze at low temperatures. When exposed to heat such as in a warm-up tent, these agents thaw and again become casualty producers.

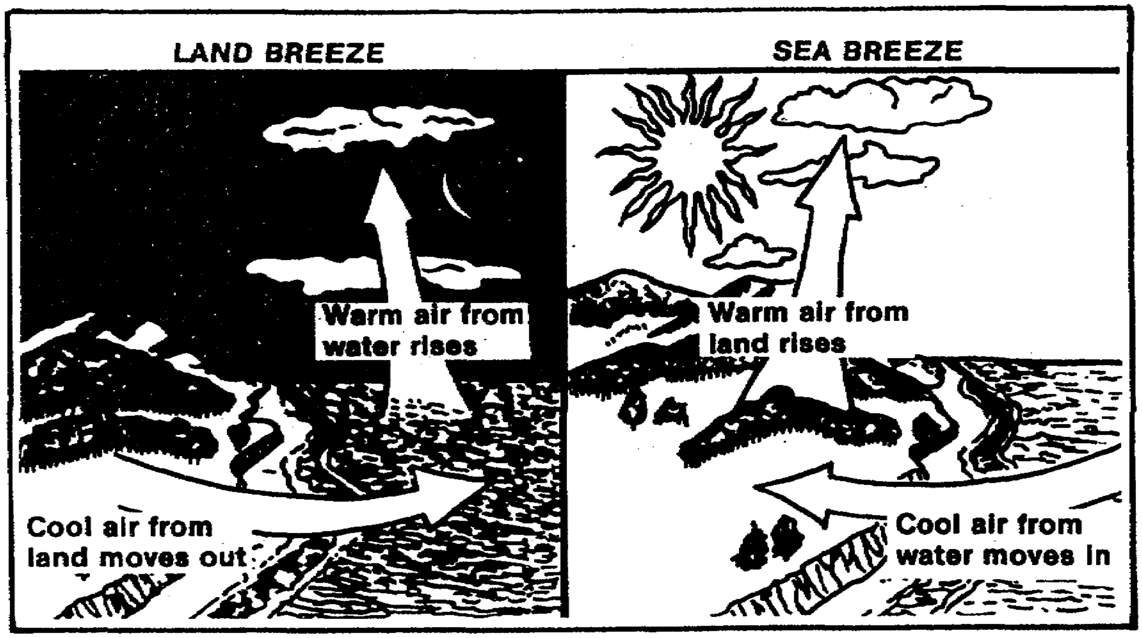

Figure 3-1. Air Current Over Land and Water

LESSON 3
PRACTICE EXERCISE

The following items will test your grasp of the material Covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check ;your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. What do the terms "persistent and nonpersistent" express?

   A. The effects of the agents on personnel and equipment
   B. The extent of decontamination required to remove the agents
   C. The incubation period of the agent
   D. The relative duration of the effectiveness of chemical agents in the area of release

2. How is wind speed converted from knots to kilometers per hour?

   A. Add 1.85
   B. Divide by 1.85
   C. Multiply by 1.85
   D. Subtract 1.85

3. Temperature gradients are determined by measuring the air temperature between 1/2 meter and how many meters above the ground?

   A. 2
   B. 4
   C. 6
   D. 8

4. Which temperature gradient is ideal for employment of chemical agents?

   A. Inversion
   B. Lapse
   C. Neutral
   D. Stable

5. What is the prevailing temperature gradient over large bodies of water?

   A. Inversion
   B. Lapse
   C. Neutral
   D. Variable

6. A neutral condition may exist when the wind speed is greater than how many knots per hour?

   A. 2
   B. 3
   C. 4
   D. 5

LESSON 3
PRACTICE EXERCISE
ANSWER KEY AND FEEDBACK

Item	Correct Answer and Feedback	
1.	D	The relative duration of the effectiveness of chemical agents in the area of release The terms release ... Page, 3-2, Part A, para 1
2.	C	Multiply by 1.85 To convert ... 1.85. Page 3-5, Part B, para 2
3.	B	4 For purposes ... ground. Page 3-7, Part C, Intro
4.	A	Inversion It is ... agents. Page 3-7, Part C, para 1
5.	A	Inversion Over large ... day. Page 3-8, Part C, para 1
6.	D	5 Independent ... knots. Page 3-8, Part C, para 3