Chapter 3
Chemical Agents

Avoidance of chemical agents requires a complete understanding of physical characteristics, employment, and weather and terrain conditions. Units can then estimate when and where specific type of chemical agents will be used, where the hazards are, and how best to avoid them.

Threat forces are equipped, structured, and trained to conduct chemical operations. We expect them to use chemical agents as part of their conventional fighting capability because so much of their training revolves around the use of such agents.

The basic threat principle is to use chemical agents on unprotected troops to create casualties. Against protected troops, the primary purpose is to make the use of equipment, terrain, and operations more difficult. The use of chemical weapons by the threat forces initially may require a decision at the same level as nuclear weapons. But they most likely will be used more freely once the initial use has been authorized. Threat forces consider chemical weapons as an extension of conventional warfare. If units understand the uses of chemical agents, they will be better able to avoid chemical hazards.

Types of Chemical Agents

Chemical agents may be classified persistent, nonpersistent and dusty. Threat forces classify chemical agents according to their effect on the body. They identify six major types—nerve, blood, blister, choking, psychochemical, and irritants.

Persistent

Threat forces are known to stockpile persistent and nonpersistent agents.

Persistent agents are used to impede the use of critical terrain, channelize the attacking force, or contaminate materiel. Persistent chemical agents are used to produce casualties (immediate or delayed). Immediate casualties occur when the soldier inhales the vapor. Delayed casualties occur and is absorbed through the skin demonstrating the need for protective equipment.

Persistent agents are used to—

- Contaminate rear area supply depots.
- Defend avenues of approach.
- Neutralize personnel defending a strong point.
- Protect flanks.
- Degrade unit efficiency,

To avoid persistent agents-

Avoid areas heavily splashed with liquid contamination which may be persistent for several days (depending on weather and type of agent). See FM 3-6 for more details.

- Cover personnel, equipment, and supplies whenever possible.
- Monitor for the chemical agent for 2 to 10 days (depending on weather and type of agent). See FM 3-6 for more details.
- Concentrate on finding clean areas and routes (recon units).
- Cross contaminated areas in MOPP 4.
- Mark contaminated areas.
- Avoid contact with unknown liquids.

Nonpersistent

Threat forces currently stockpile blood agents, choking agents, psychochemical agents and nerve agents such as Tabun (GA), Sarin (GB), and Soman (GD). Although G-series nerve agents (GA, GB, GD and GF) are classified as nonpersistent agents, some G agents may persist for hours to days. Refer to Table 1-2 in Chapter 1 of this Field Manual or FM 3-4 for persistency data. Nonpersistent agents should be expected along the forward line of troops (FLOT), and against units in contact with the attacking echelon. These agents are used to immobilize, injure, or hinder activities of the unit under attack. For example, threat may use a blood agent at a critical moment in battle to force troops into a higher MOPP level. Forcing troops into a higher MOPP level reduces morale and degrades performance. Another advantage is that the threat would not need to decontaminate the area before occupying it. Nonpersistent agents act through the respiratory system or through skin absorption.

Nonpersistent agents are used to—

- Create favorable fighting conditions.
- Produce casualties prior to an assault.
- Degrade and suppress troops by forcing them into a higher MOPP level.
- Allow occupation without decontamination.

To avoid nonpersistent agents-

- Avoid low areas and enclosed spaces where vapors lingers.
- Camouflage
- Maintain discipline

Dusty

Dusty agents, (toxic dust or dust-impregnated agents as they may be referred to) are not new. These agents have been subjected to extensive scientific research since the 1930's. These agents are primarily mustard (HD) and the nerve agent sarin (GB) impregnated onto a solid sorbent (usually on silica) and dispensed as aerosols. These agents generally have a lower vapor pressure and a dramatic increase in inhalation toxicity.

Vapors off gassing from the solid sorbent may be detected by the M256 Chemical Agent Detector Kit, Chemical Agent Monitor (CAM) or when mixed in water, by the M272 Water Test Kit.

Detection and Identification

Following OPSEC measures, the next most important step in chemical contamination avoidance is detecting and locating chemical agents. Once agents are detected units can be warned to take appropriate protective measures, and can plan operations to minimize the effects of chemical agents. Detection allows individuals to survive and units to accomplish their missions.

Chemical agents will be delivered either directly on unit positions (on-target attacks) or upwind to drift over the unit position (off-target attacks). Detection methods differ for each type of attack.

On-target attacks produce immediate casualties by contaminating troops and equipment. If the attack is intended to produce immediate casualties, a large amount of agent must be delivered in a very short time (within 30 seconds). The M8 series alarm does not detect all chemical agents; it takes several seconds to respond to those agents it does detect. Therefore, a large percentage of troops might be exposed to chemical agents before the alarm sounds. As an example the M8 Alarm will sound within 2-3 minutes when exposed to an nonpersistent nerve agent concentration of GB at 0.2 mg/m^3 and persistent nerve agent VX at 0.4 mg/m^3. The M8A1 alarm will sound within 1-2 minutes with an agent concentration of GB at 0.1 mg/m^3 and VX at 0.1 mg/m^3. This means that troops must recognize the delivery of the chemical agent, observe a color change in the detector paper, or recognize symptoms of chemical agent poisoning.

Off-target attacks are easier to protect against. Units use the M8 series alarm to alert the unit that a chemical agent is about to drift over their position. Detector paper also can alert units that they are moving into a contaminated area. Protective action can then be taken before troops are exposed to the agent. Table 3-1 shows the arrival time of chemical agents for various wind speeds. A distance of 150 meters was chosen for the table because it is the optimum distance that the detector can be placed upwind and a chemical agent cloud cannot slip behind the alarm and hit the unit.

Table 3-1. Wind speed effects on arrival time of chemical agents.

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

When using this chart, commanders must realize that if the concentration of chemical agents is low, the alarm may not respond for several seconds. Also the average time for individuals to mask (including reaction time) is about 15 seconds. Warning times for different distances and wind speeds can be determined using the following formula—

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

36 is the factor to convert hours to seconds

10 is the factor to convert kilometers to meters

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.

Automatic Chemical Agent Alarm

The automatic chemical agent alarm (ACAA) can be used in a stationary position. Keep the detector upwind at all times.

As soon as a unit arrives in an area it plans to occupy, it emplaces the alarms. The detectors are always placed upwind. Unless circumstances do not permit, they should be no more than 150 meters upwind from the farthest upwind position of the unit. This warns the soldiers upwind as well as the soldiers farther downwind. The detector units should never be placed more than 400 meters from the alarm unit. Otherwise the signal may not be strong enough to sound the alarm. The optimum spacing of 300 meters between detectors reduces the risk that a chemical agent cloud will drift between detectors without sounding the alarm. The number of alarms needed to protect a unit depends on the unit size. The larger the unit front, the more detectors are needed to warn the unit. In this case, front means the upwind direction. Front could be the left or right flank or the forward or rear edge of the unit. Table 3-2 gives an estimate of the number of detectors needed for fixed employment of the alarms.

Table 3-2. Detectors required for different size unit fronts.

Unit Front Size (meters)	Estimated Number of Detector Units
1-36	1
37-372	2
373-708	3
709-1044	4
1045-1380	5

Chemical alarms are usually employed at unit level. Exact positions for the alarms must be determined based on wind speed, wind direction, terrain, and tactical situation. The commander, with advice from the unit NBC NCO, will choose the actual positions. Figure 3-1 shows how a fixed emplacement might look. Note how the detectors are positioned and how these positions change when wind direction and unit position changes.

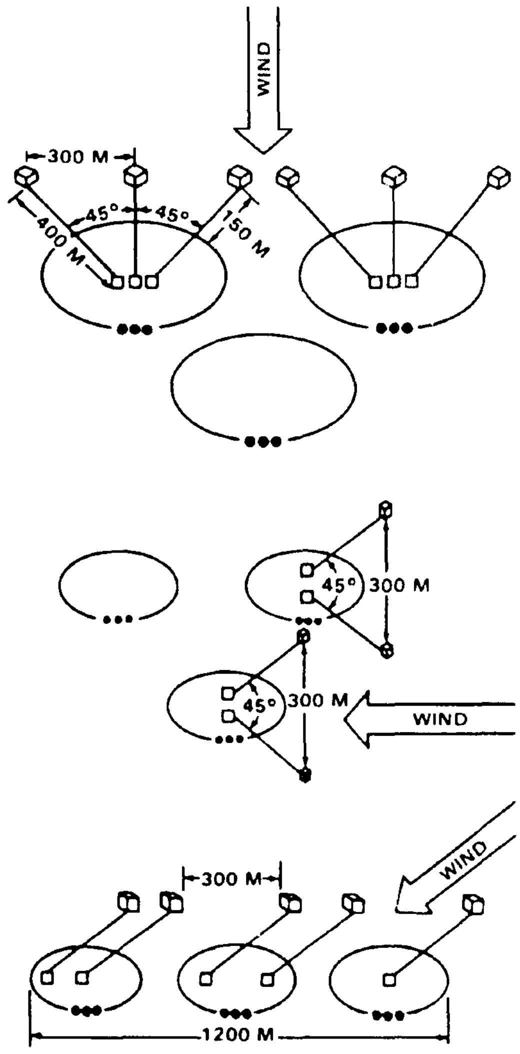


Figure 3-1. Fixed emplacement of ACAAs.

NOTE—When emplacement is completed for your element, you should show where the alarm's are by placing them on your range cards. For night operations a strip of engineer tape may be placed on the alarm so that they may be located.

When emplacing alarms, the wire connecting the alarm and detector must be protected from indirect fire. This can be done by burying the wire. The wire also should be checked periodically (at least once every four to six hours) to ensure it has not been broken or cut.

The M8 series alarm is designed to operate in a temperature range of -40°F to 120°F. During the war in the Persian Gulf deployed units experienced a high frequency of false alarms. This was due to a multitude of problems. However, the two principle causes were identified as the high temperatures the alarm was operating in and the dust concentration in the air. The high temperature problem was reduced by placing the alarm up off the ground on wood or boxes and placing the alarm in a shaded area either natural or manmade, such as under camouflage netting. High dust concentrations required replacing filter paddles in the alarm more frequently (1 every 1-2 hours of operation).

Since most units do not have many alarms, do not leave them behind. Ensure alarms are listed on vehicle load plans. The company chemical NCO, who controls placing and moving the alarm must ensure the unit personnel know when to retrieve the alarm. This is best done by making an alarm range card similar to a mine field range card.

The vehicular mode is only for the use of the vehicle's power supply. The backpack configuration is for small unit dismounted operations to facilitate transport. At no time should the M8 alarm be operated while moving. However, once vehicle brackets for newer vehicles become available (HUMMWV, M2, M1) the M8A1 alarm may be used on the move. M8A1 alarms may also be placed on helicopters while in flight but these alarms must operate on battery power.

Chemical Agent Monitor

CAM, Figure 3-2, is a vapor monitor and can only report conditions at the front of the nozzle assembly. It is a point monitor only and cannot give a realistic assessment of the vapor hazard over an area from one position. It is necessary to move the CAM around the area carrying out a complete reconnaissance if a proper assessment is to be made of the vapor hazard in the area. When conducting reconnaissance with the CAM in a windy area, (such as on board ship, ground surface winds at 8 kmph or higher) use a funnel, paper cone or **a can** with a hole punched in it the size of the CAM probe.

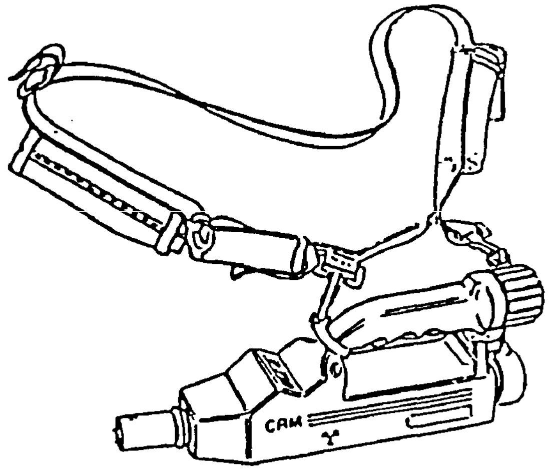


Figure3-2. Chemical Agent Monitor.

(Any assessment will probably be made in conjunction with other detection methods).

NOTE If there is a source of vibration in the area, WAIT may be displayed momentarily when searching for agent. This is especially true when the CAM is used on board aircraft while in flight.

There are a few vapors present in the atmosphere that can, in some circumstances, give a false response in CAM. The situations most likely to give a false response are in enclosed spaces or when sampling near strong vapor sources (dense smoke). Some of the types of vapors that have been found to give false readings are given below:

- Aromatic vapors. Included in this category are groups of materials such as perfumes and food flavorings. Some brands of after shave and perfume can give a response in G mode when CAM is held close to the skin, for example as in casualty handling procedures. Some sweets such as peppermints and cough lozenges and menthol cigarettes can cause a response in G mode if the breath is exhaled directly into the CAM inlet.
- Cleaning compounds. Some cleaning compounds and disinfectants contain additives which give them a pleasant smell. Some of these additives such as menthol and methyl saticylate (MS) can give false responses in the H mode. Ammonia gives a false response in the G-mode. Cleaning materials are, by nature, spread over large surface areas and, therefore, provide a considerable vapor source, particularly in enclosed spaces.
- Smoke and fumes. The exhaust from some rocket motors and the fumes from some munitions can give responses. Since monitoring with CAM in these situations is unrealistic, few problems should arise. Additional interferents are listed in Table 32-a.

If CAM is suspected of giving a false reading:

- Stay masked.

Table 3-2, Common Interferents for the CAM.

Interferent	G Bar Response	H Bar Response
M258AI decon kit		High
W80 DKIE		High
DS2	Low	
Insect repellent	Low-Very High	
Brake fluid	High-Very High	Very High
Cleaner, general purpose	High	
Buming kerosene		High
Breath mints	High	
Gasoline vapor	Low	Low
Burning grass	Low-High	Low
Burning gas	Low	
Green smoke	Low	Low-High

- Check for obvious vapor sources, and known interferents.
- Remove and discard the filtered nozzle standoff and place the nozzle protective cap assembly onto the front of CAM case and re-establish a clear air background.
- Remove nozzle protective cap assembly and add a new filter. If false response reoccurs, CAM may not be operable in the immediate area. Remove source of interferent (if possible) or replace nozzle protective cap assembly and remove CAM from area.

When investigating the contamination of a person, object, vehicle, aircraft or piece of equipment, it is essential to first establish what general vapor hazard exists around the suspected contaminated equipment. If a reading higher than the background level is obtained, then the equipment is contaminated. If the reading is the same as the background, then it may be contaminated or the CAM may merely be recording the background vapor hazard. Care must be taken when assessing the contamination of an object from the information indicated on the CAM display. CAM display bars and corresponding warning are depicted in Figure 3-3.

The CAM is used to search out clean areas, to search and locate contamination on personnel, equipment, ship's structures, buildings and terrain, structures, aircraft and land vehicles, buildings and terrain, and to monitor the effectiveness of decontamination. CAM can also be used for monitoring collective protection shelters and the chemical contamination of aircraft while in flight. The Chemical Agent Monitor responds to nerve and blister agent vapors down to the lowest concentrations that could affect personnel over a short period.

The CAM has two operating modes, selectable by means of the G H mode pushbutton switch. In the G mode, CAM monitors for G-series nerve agents as low as

0.03 mg/m^3; V-series nerve agent as low as 0.01 mg/m^3, both within 1 minute. In the H mode, CAM monitors for blister agents as low as 0.01 mg/m^3 within one minute. The selected mode is indicated on the display assembly by a G or H. An ON/OFF pushbutton switch applies 6 V DC battery power to the CAM. A nozzle protective cap assembly contains material to clean the air within the CAM; the cap assembly is located in the front of the CAM whenever the CAM is not being used to monitor for contamination. Additional information on the operation of the CAM may be obtained from TC 3-4 or appropriate TM.

1 bar	Masking not required
2-3 bars	30 minutes unmasking in 24 hours if operationally essential.
4-6 bars	Remain in protective posture and note changing display and amount of agent.
6-8 bars	Do not unmask.

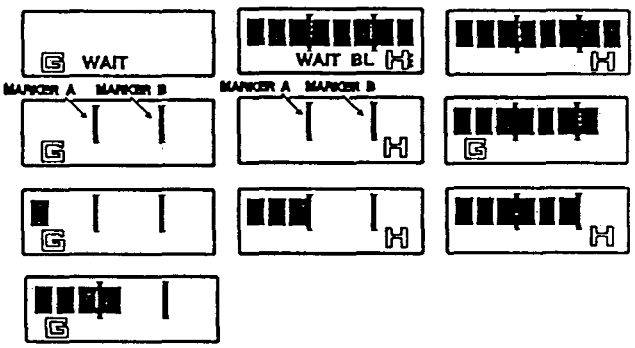


Figure 3-3. CAM Sensitivity Bars

Individual Chemical Agent Detector (ICAD)

The USMC issued ICAD (Figure 3-4) includes two electrochemical sensors, each of which is covered by a thin diffusion membrane. One sensor is sensitive to nerve agents (GA, GB, GD 0.5 mg/m^3m 120 seconds), blood agents (AC, 250 mg/m^3 in 120 seconds), and choking agents (CG 25.0 mg/m^3 in 15 seconds); the other sensor detects blister agents (H, L 10.0 mg/m^3 in x seconds). Chemical agents in the air diffuse through the membranes on the faces of the ICAD sensors, and are collected by the electrolyte behind the membranes. The chemical agent concentrations in the electrolyte are measured by multiple-ellectrode electrochemical sensor systems. When the concentration reaches a preset threshold level, an audio alarm sounds and a light-emitting diode (LED) comes on.

During normal operation, especially in dusty or dirty environments, the ICAD may require external cleaning. To remove external dust or dirt, remove the sensor module from the electronics/alarm module. Cover the connectors with your fingertips. With the connectors up, flush the sensor module with clean water, and then gently shake excess water from the unit. With the LED indicators and audio alarm up, flush the electronics/alarm module with clean water, and then gently shake excess water from the unit. Do not use soap or any cleaning solution on the ICAD. Do not scrub or wipe the sensor membranes.

The normal operating temperature range of the ICAD is 0 to 113 degrees F (-18 to 45 degrees C). The ICAD can be stored prior to activation at temperatures ranging from 40 to 150 degrees F (-40 to 65 degrees C).

Figure 3-4. Individual Chemical Agent Detector (ICAD).

CAUTION

Do not store or operate the ICAD at temperatures below or above the specified temperature ranges. The ICAD could be permanently damaged.

ABC-M8 Chemical Agent Detector Paper

ABC-M8 Chemical Agent Detector Paper detects liquid chemical agents. It& used whenever chemical agents are suspected. Every soldier carries a booklet of ABC-M8 Paper in the mask carrier. Each booklet contains 25 sheets of paper. This paper turns colors when the paper touches a chemical agent. V-type nerve agent turns the paper dark green, G-type nerve agent turns it yellow, and a blister agent turns it red.

Night operations cause problems when using ABC-M8 Paper. The paper must be read in white light. Since

ABC-M8 Paper is used to check suspected areas for contamination, it can be brought into a white light area for reading. During night recon operations, the monitor can take several marked samples, then bring them back to the vehicle for reading. The paper is used by blotting it on the suspected contaminated surface. Do not rub the ABC-M8 Paper against the surface because false positive (red) streaks are produced.

M9 Chemical Agent Detector Paper

Chemical Agent Detector Paper, M9 is the most widely used method of detecting liquid chemical agents. It is more sensitive and reacts more rapidly than ABC-M8 Paper. M9 Paper reacts to chemical agents by turning a red or reddish brown color. Place the M9 detector paper to opposite sides of the body. If you are right handed, place a strip of M9 paper around your right upper arm, left wrist, and right ankle. If you are left handed, place the M9 paper around your left upper arm, right wrist, and left ankle. It is also attached to large pieces of equipment (eg: conditioning systems, shelter or van entrances or vehicles). When attached to equipment it must be placed in an area free from dirt, grease, and oil. This is especially important since petroleum products and DS2 also cause the paper to change color.

M9 Paper is especially useful in detecting on-target attacks and keeping soldiers from entering contaminated areas. Whenever pink, red, reddish brown, or purple color appears on the paper, suspect the presence of chemical agents. As soon as M9 Paper indicates the presence of chemical agents, soldiers and units must take protective action to keep from becoming grossly contaminated. The results of the M9 paper should be confirmed with the M256 kit.

Night operations present some problems when using M9 Paper. Color changes will not show up when a flashlight with a red filter is used to read the paper. White light must be used. This could cause some serious OPSEC problems, especially for frontline troops. Commanders must realize that there is a risk if they do not establish procedures for checking M9 Paper for color changes. Soldiers can be rotated into a white light area or the M9 Paper can be collected periodically for reading.

M256 Series Chemical Agent Detector Kit

The M256 series Chemical Agent Detector Kit is capable of detecting both liquid and vapor concentrations of chemical agents. It detects chemical agents in the following concentrations-nerve (G series; 0.005 mg/m^3 VX; 0.02 mg/m^3 within 15 minutes), blister (H; 2 mg/m^3 12 mg/m^3 within 10 minutes), and blood agents (AC; 7 mg/m^3 within 10 minutes). The M256 Kit is issued at squad level, so every squad has the capability of detecting and classifying chemical agents. The M256 series contains ABC-MS Chemical Agent Detector Paper for liquids and samplers/detectors for vapors. An improved M256 Detector Kit will also be capable of detecting T2 mycotoxin.

M256 series samplers/detectors are used primarily to determine the type of chemical agents present. A unit may have noticed an attack or the alarm may have sounded. The M256 series is then used to check if there is a chemical agent present and to identify the agent.

The M256 series also causes OPSEC problems during hours of limited visibility. A white light is needed to read both the ABC-M8 Paper and the sampler/detector. The light must be shielded from enemy observation. This can be done by using a pancho or other suitable covering.

M272 Water Testing Kit. Chemical Agents

The M272 Water Testing Kit, Figure 3-5) Chemical Agents is a lightweight portable kit that will detect and identify harmful amounts of chemical warfare agents when present in raw and treated water. The kit will detect cyanide (AC) to 20 mg/liter, mustard (HD) to 2.0 mg/liter, lewisite (L) to 2.0 mg/liter and nerve agents (both G and V series) to 0.02 mg/liter. Water containing agents in less than these concentrations is permissible for short term (up to 7-day) use, in cold or warm regions with up to 5 quarts per person per day usage. These kits are usually found in chemical reconnaissance units, medical units and units with water purification or transportation missions.

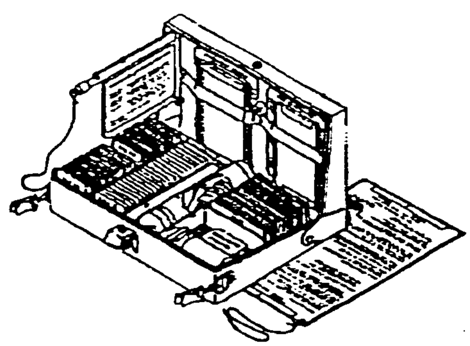


Figure 3-5. M272 Water testing kit, chemical agents.

FOX, XM93, NBC Reconnaissance System (NBCRS)

The FOX (Figure 3-6) is a fully integrated NBC reconnaissance system with the following characteristics and operational capabilities.

Six wheel, amphibious armored cargo and tactical transport vehicle powered by a V8 diesel engine (320 horse power). The maximum speed is 65 miles per hour with a cruising range of 500 miles. It weighs 18.7 tons combat loaded and 16.9 tons without the crew and ammunition. It is equipped with a 40mm smoke grenade launcher and an M240E1, 7.62mm machine gun. The FOX is also equipped with a collective protection system which keeps the crew's working area free from contamination.

The integrated NBC defense/detection system has four key components.

- Mobile Mass Spectrometer (MM1)-Consists of a detection membrane probe system with an air/ground probe, and a rugged microprocessor. The system can monitor and identify all known chemical agents.
- Radiac Equipment (ASGI-Consists of two probes installed in the exterior ports on each side of the vehicle connected to the radiation detection, identification, and computation instrument/recorder inside the vehicle.
- Vehicle Orientation System (VOS-25)—Operates through the principles of gyroscopic motion with a motion sensor attached to the vehicles' transmission. The unit (VOS-25) is integrated with the radiation (ASGI) and the chemical detection (MM1) and can accommodate depiction of chemical and radiological contamination on the map with the push of a button.
- NBC marking equipment—The vehicle has an NBC Marking Kit with an air-lock (glove port) through which the NBC contamination marking buoys are positioned.

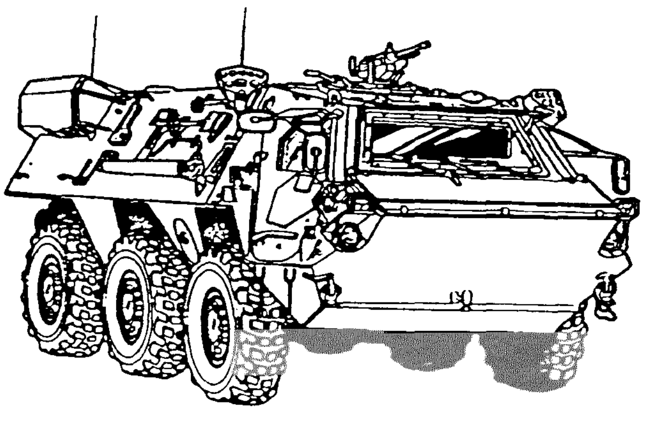


Figure 3-6. FOX, XM93, NBC reconnaissance system (NBCRS).

The FOX has nuclear, chemical and biological sampling equipment that consists of—

- A sample collecting device with transport container.
- Glove (rubber) protection for collecting samples

The equipment is fixed outside the vehicle and is operated manually using the glove and glove port device.

The FOX is also protected against electromagnetic pulse (EMP), transi-radiation effects on electronics (TREE), and electronic countermeasure (ECM).

The FOX system is assigned to the following units.

- Heavy Division (NBC recon platoon) has six (6) vehicles.
- Armored Cavalry Regiment (ACR) has six (6) vehicles.
- Motorized Brigade has six (6) vehicles.

NOTE—The FOX system will also be assigned to the NBC reconnaissance chemical companies assigned to the TAACOM/CORPS when these companies are placed in active duty status. The TAACOM/CORPS units are projected to receivw 36 systems each.

Employment concepts—

- Offense—During offensive operations (such as movement to contact), the FOX NBCRS should be positioned well forward just behind the leading combat elements to facilitate contamination avoidance, responsiveness to reports of NBC contaminations, and to provide freedom of maneuver.
- Defense— During defensive operations, the FOX NBCRS should be used to conduct NBC reconnaissance operations in the rear areas to ensure that the routes to and from the corps, brigade, and division support areas are free of NBC contamination. The FOX systems are also used to find clean fall back positions for the fighting forces during withdrawal and retrograde operations.

Remote Sensing Chemical Agent Alarm XM21 (RSCAAL)

This joint service system is a passive infrared spectroradiometer that uses an on-board microprocessor to detect and identify agent clouds. It operates by viewing a background scene (sky, terrain, buildings, etc.) and the airpath along its line of sight. When agent cloud enters the line of sight the new spectral information is compared to the stored background information and the specific infrared emission characteristics of a known agent. The detector scans along a 60-degree horizontal arc through seven 1.5 degree windows, the centers of which are 10 degrees apart. One scanning cycle (60-degree arc) takes less than 60 seconds. The detector has seven scan position lights that indicate which field of view (FOV) an agent cloud occupies. This allows the operator to determine an azimuth direction to the cloud and obtain an indication of horizontal movement. The XM21 is designed to operate within the temperature range of -25° to 120°F.

The XM21 can perform the basic missions of reconnaissance and point or area surveillance. Employment of the XM21 must be tailored to fit the tactical situation and the capabilities of the detector. Common missions for the detector are—scan a defensive front, vector battlefield assets, monitor barriers and obstacles, monitor avenues of approach, and search areas between and adjacent to enemy and friendly forces.

The selection of general sites requires a map reconnaissance of the area of operations. Personal reconnaissance may be carried out when the tactical situation permits. This technique is especially useful when the XM21 is used in the area surveillance mission where the M8A1 system is being replaced or augmented. When selecting specific positions for the system, the team leader conducts a full reconnaissance of the general site. Selection of the specific site must take into consideration the line of sight limitation of the XM21. When the situation permits, terrain profiles may be requested from the G2 to ensure line of sight to the target area.

- A properly emplaced XM21 will detect significant G-agent, HD, and Lewisite munitions events and resulting clouds at ranges out to 5km with a greater than 85 percent probability of detection. Other features include:
- Stand-off detection for G-agents, HD-mustard, and L-blister agent clouds. Concentration sensitivity levels are recorded as CT = concentration x time. For nerve agents this sensitivity level is recorded as 3 mg - min/m^3 and for blister this level is 150 mg - min/m^3.
- Operates under normal conditions without degradation at night.
- To set-up in the tripod mode by two trained personnel takes 10 minutes.

Limitations.

- Requires line of sight. Must be leveled and sighted to the terrain to maximize detection probability.
- Performance degraded by heavy rain, snow, dense foliage, and strong winds.
- System must be stationary to operate.
- A false alarm may occur when subjected to low angle direct sunlight on the optical window.
- Does not detect blood agents.
- Does not detect residual vapor hazard from evaporating liquid persistent agents under normal conditions.

Reporting

When chemical agents are detected and/or identified, the unit must report this information immediately to higher headquarters. Below company level, this is done with a SPOT report. The company NBC defense team then puts the report in an NBC 1 format and forwards it to battalion. Figure 3-7 is a sample NBC 1 Chemical Report.

If the unit uses the data from it's own Chemical Downwind Message to report attacks, this weather information must also be reported on the NBC 1 Chemical Report. This is accomplished by including line items Yankee (Y) and Zulu Alpha (ZA) on the NBC 1 Chemical Report. If the attack is unconfirmed or agent unknown, line item Zulu Bravo (ZB) will be included in the report at battalion level. Line ZB is the remarks line in the NBCWRS. Battalion chemical staff will include remarks indicating what measures have been taken to confirm the attack.

By the time the attack is confirmed, the NBC 1 Report would already be at division level. In the event that the report was based on a false alarm, an NBC 3 Chemical Report will still be issued but will include line item ZB stating the strike serial number and the words "cancelled - false alarm".

Standard Format	USMTF Format
NBC 1 Chemical	MSGID/NBC//
B LB200300	NBCEVENT/CHEMICAL//
D 200945Z	BRAVO/21RLB200300//
E 200950Z	DELTA/200945Z//
	ECHO/200950Z//
F LB200300 EST	FOXTROT/E/21RLB200300//
	GOLF/Artillery//
G Artillery	HOTELBC/Blister H/air//
H Blister H, Airburst	INDIA/5//
I (5 rounds)	

Figure 3-7. Sample NBC 1 Chemical Report.

Data Evaluation

Data evaluation consists of determining the attack location, confirming type of agent, means of delivery, type of attack, and assigning a strike serial number for each attack. Confirming the attack is critical, especially if it is the first reported chemical attack in the theater. Confirmation includes collecting samples of the suspected agent, obtaining pieces of shell or casing fragments, medical analysis of casualties (living or deceased), witness interviews and intelligence reports. Refer to Chapter 5 or FM 3-19 for detailed procedures on how to collect these samples. To confirm that a chemical attack has occurred, the M93 NBC reconnaissance vehicle should be dispatched to the area in question to take samples. In the event that this vehicle is not available, units should take additional samples using 2 or more sampler detector tickets from two different M256 detector kits or by using additional ABC-M8 detector paper strips. In the event that an M8A1 alarm goes off, this would normally indicate that a nerve agent is present. If liquid droplets are not present in the area, this may indicate the presence of a G-series nerve agent or a vapor cloud from off gasing VX contamination. To determine what type of nerve agent is present, the M93 NBC Reconnaissance vehicle should be dispatched to the area concerned. This vehicle is capable of determining what type of nerve agent is present. In the event that this vehicle is not available, units must rely on the ABC-M8 Paper to determine whether G or V series nerve agent is present. The M256 kit sampler/detectors will not make this differentiation. This test may not provide the necessary information required if no liquid droplets are available. If the ABC-M8 paper test proves to be insufficient or indicates that a G nerve agent is present, units should rely on available intelligence information to determine what type of agent fill is available to the enemy. Compare this information with the means of delivery for the chemical agent attack to determine the extent and duration of the hazard area. If units are still unable to determine what type of G series nerve is present, assume worst case, Type A Case b. The NBCC plots all NBC 1 Reports and consolidates data pertaining to each attack. From this data, the NBCC prepares the NBC 2 Report and assigns a strike serial number. A record of these numbers is kept in the strike serial log. Figure 3-8 is a sample NBC 2 Report. A suggested format for a log is shown in Figure 3-9.

Chemical Downwind Message

The Chemical Downwind Message (CDM) contains all the weather information needed to calculate a chemical downwind hazard. The CDM is useful because it provides the local wind speed, wind direction, stability category, and relative humidity in a short concise statement. It is prepared by corps and division NBCCS from information obtained through the US Air Force Air Weather Service (AWS), Staff Weather Officer, or the Fleet Weather Service.

The CDM is issued every six hours and is valid for three consecutive two-hour periods. It contains the following—

- Date-time group of the observation.
- Date-time group for basic data is the time the first forecast is effective. Adding two and four hours to this time gives the effective times for the other two forecasts.
- Area of validity is the area affected by the CDM. It could be a map sheet number or an area, such as division or corps.
- Air stability category describes the projected air stability. It will be one of seven numbers which correspond to stable, neutral, or unstable conditions.

Standard Format	USMTF Format
NBC 2 Chemical	MSGID/NBC2//
A C001 D 200945Z F LB200300 EST G Artillery H Nerve, Airburst Y 0130 Deg, 012 kmph ZA 412632	NBCEVENT/CHEMICAL// ALPHA/C001// DELTA/200945Z// FOXTROT/E/15RLB200300// GOLF/Artillery// HOTELBC/Nerve/air// YANKEEBC/0130DEG/012 Kmph ZULUA/4/12/6/3/2//

Figure 3-8. Sample NBC 2 Chemical Report.

Strike Serial Number (A)	Date/Time of ATK (ZULU) (D)	GZ Coordinates (ACT/EST) (F)	Kind of Attack (G)	Type of Agent (H)	Remarks
C001	200945Z	LB200300 EST	Arty	Nerve, Air.	

Figure 3-9. Suggested format for a chemical/biological strike serial log.

• Surface air temperature is the average temperature of the air in the forecast area.

• Surface wind speed and direction are the representative wind speed and direction during the forecast period.

• Relative humidity is the average humidity for the forecast period.

• Significant weather phenomena refers to any weather conditions that could affect either the distance the cloud travels or the duration of the agent in the hazard area

• Cloud cover in the area of validity.

Preparing the Chemical Downwind Message

Division NBCC is usually the lowest level that prepares a Chemical Downwind Message. Separate brigades also may be required to prepare a CDM when operating independently. Figure 3-10 is a sample CDM.

The first step in preparing the CDM is to acquire the weather data. The Air Weather Service (AWS) is the best source for this information. They provide weather forecasts for division or corps areas. Weather information can also be obtained from the artillery meteorological section. Although they cannot provide forecasts, they can provide current weather information.

The next step is to break it down into three consecutive two-hour increments. Line Whiskey Mike is used for the first two-hour increment, line X-ray Mike for the second, and line Yankee Mike for the final two-hour increment. Then the NBCC translates this data into codes and puts it in the proper format. Each forecast line contains 12 digits.

The first six digits represent the downwind direction and wind speed. The last six digits represent the air stability, temperature, humidity, significant weather phenomena, and cloud cover (see Figure 3-11). Weather data which is unavailable or for which no code exists is represented by a dash.

A valid CDM may not always be available from the corps or division NBCC or applicable to the unit area of operations. Units may estimate the air stability category by observing local meteorological conditions. A field expedient method of obtaining the necessary weather data may be used when all other sources are unavailable. In order to obtain local weather data, units may obtain a Belt Weather Kit (NSN—6660-01-024-2638) and barometer (NSN–660-00-551-3998) or use the equipment listed below. The weather information obtained in this manner is only for that particular area. for that period of time. It is by no means, a forecast from which a CDM maybe produced. However, it is a local method of verifying CDM weather data. If this method is used for local weather, include this data on the NBC 1 Chemical Report.

• M1 Ananometer (66000663-8090)
• Wet Bulb, Globe, Temp (C°) (6665-00-159-2218)
• Lensatic Compass

Step 1. Measure windspeed and direction with the lensatic compass and ananometer. Use the highest

Standard Format	USMTF Format
CDM	CDM
110500Z 110600Z I Corps WM 120010418742 XM 125019416742 YM 130005518642	MSGID/CDM// OBSTIME/110500Z// FCSTIME/110600ZMAR83// IIXAREA/I CORPS// FVALUE/WM/120/010/4/18/7/4/2// FVALUE/XM/125/019/4/16/7/4/2// FVALUE/YM/130/005/5/18/6/4/2//

Figure 3-10. Example of Chemical Downwind Message.

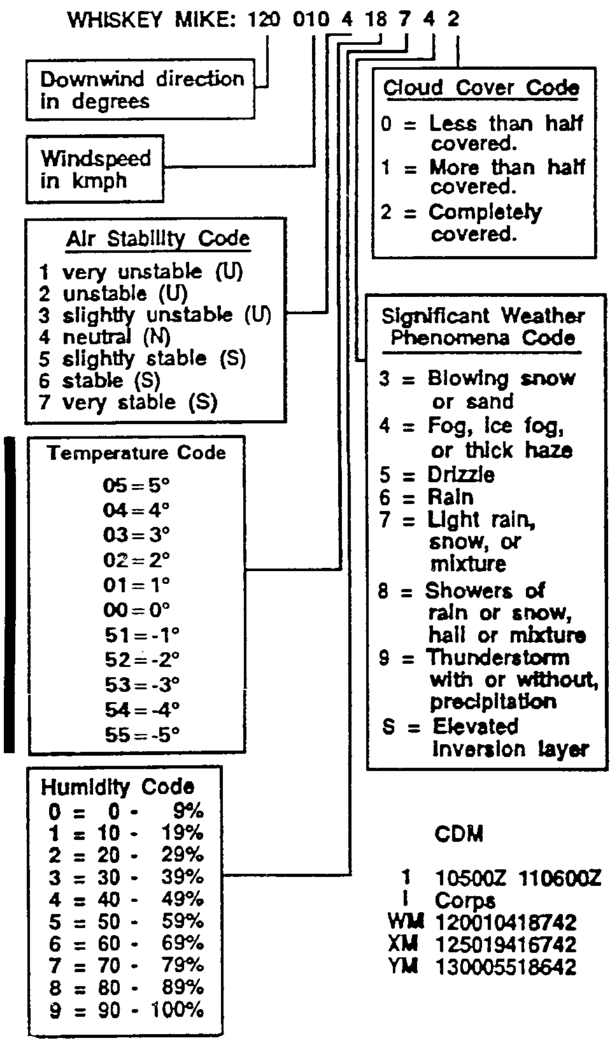


Figure 3-11. Coded weather information in a Chemical Downwind Message.

windspeed recorded. Take temperature and humidity readings using the wet bulb at one meter above the ground. Obtain readings every two hours if practical, but not greater than four hours.

Step 2. Determine the four transition periods of windspeed and direction during the day. Take average of the readings during each transition period.

The most difficult aspect is determining the sun by observation. Since most units do not have equipment to do this, make the best estimation possible.

Example—It is morning. The sun's angle is 45 degrees, and the sky is less than half covered. Find the time of day (morning) and angle of sun (45 degrees) on the chart at Table 3-3. Find the sky condition (less than half covered). Read across and down to the point where the lines converge. The air stability category is U.

Atmospheric Stability Charts

The stability of a chemical or biological agent cloud is directly effected by the temperature of the air at the surface of the earth and the first few meters above the surface.

Temperature Gradients

The air stability categories are dependent on the temperature gradient (difference of air temperature at two attitudes). The temperature gradient is determined by measuring the air temperature at two different altitudes.

Table 3-3. Air stability category basic chart.

Air Stability Category Basic Chart				
Time of Day* and Angle of Sun		Condition of Sky		
		Less Than Half-Covered	More than Half-Covered	Overcast
MORNING	< 4	S	S	N
	> 4° 32°	N	N	N
	> 32° 40°	U	N	N
	>40°	U	U	N
>EVENING	> 46°	U	U	N
	>35° 46°	U	N	N
	>12° 35°	N	N	N
	> 5° 12°	S	N	N
	< 5°	S	S	N

Compare the difference in air temperature to the normal or expected change in temperature. The normal change in temperature is 1 degree cooler for every 100 meters increase in altitude. The four possible gradient conditions are inversion, neutral. lapse, and elevated inversion.

Inversion Temperature Gradient (Stable-S).

If the air at the higher altitude is warmer than the normal temperature at the lower altitde, the air will not move vertically. This represents an inversion temperature gradient. This condition usually exists on a clear or partially clear night when 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 for enemy employment of chemical agents. Weak inversion conditions tend to prevail during the day over large bodies of water.

Neutral Temperature Gradient.

A neutral condition exists when air temperature shows very little or no change with air increase in altitude. This represents the neutral temperature gradient. This condition usually exist on heavily overcast days or nights at 1 or 2 hours before sunset or 1 to 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. A neutral temperature gradient is most favorable for enemy use of biological agents because the associated wind speeds result in larger area coverage.

Lapse Temperature Gradient (Unstable-U).

If the air at the higher altitude is cooler than the expected difference, then there will be vertical movement of air creating turbulence. This condition normally exists on a 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. This is the least favorable condition for the enemy to employ chemical or biological agents. Over large bodies of water, weak lapse conditions tend to prevail at night. When a lapse condition exists, area coverage without diffusion will be enhanced with a steady low wind speed of 3 to 7 knots.

Elevated Inversion (Stable).

Elevated inversion may occur when cooler air settles under warmer air. This condition will generally occur when a warm and cold frontal system converge or over large bodies of water. The significance of an elevated inversion layer is that the layer will act as a lid over the surface. This "lid" traps air particulants as well as chemical agents, in a concentrated form, at a given height above the ground, thus presenting an increased threat to aircrews. The Staff Weather Officer must report this condition, when it occurs to the NBCC and divisional aviation units.

Once you have obtained the air stability category from the basic chart, enter the adjustment chart with that category. Select the appropriate weather and terrain condition from Table 3-4. Read across to where they intersect and extract the final stability category. Use this stability category to determine the maximum downwind distance. For more information on field expedient behavior of chemical agents, see FM 3-6.

Simplified Hazard Prediction

The simplified hazard prediction tells subordinate units whether they are in a chemical downwind hazard area. Since Type A attacks present the greatest hazard, the simplified procedures are based on that type of attack. It is valid until an NBC 3 Report is received from higher headquarters.

Table 3-4. Air stability category adjustment chart.

Air Stability Category Basic Chart Adjustment Chart			
Weather and Terrain	Stability Category From Basic Chart		
All eight conditions given below must be checked. If more than one applies, choose the most stable category.	U	N	S
Dry to slightly moist surface.	U	N	S
Wet surface (after continuous rain or dew).	N	N	S
Frozen surface or partly covered with snow, frost, or hoarfrost.	N	S	S
Surface completely covered with snow.	S	S	S
Continuous rainfall.	N	N	N
Haze or mist (visibility 1 to 4 km).	N	N	S
Fog (visibility less than 1 km).	N	S	S
Downwind speed more than 18 km.	N	N	N

U = Unstable
N = Neutral
S = Stable

Units need to make a simplified prediction using a Chemical Downwind Message and a simplified template. The template can be made out of acetate, overlay paper, or plastic. Figure 3-12 shows a sample simplified predictor. The following steps show you how to use a simplified prediction.

Step 1. Get the wind speed from the CDM. If it is s 10 kilometers per hour, use the circular portion of the prediction. If it is > 10 kilometers per hour, follow the remaining steps.

Step 2. get the wind direction from the CDM. Mark that direction on the compass circle of the template.

Step 3. get the air stability code from the CDM; use this code (U, N, or S,) to determine the downwind distance.

Step 4. Place the template on the map with the attack center of the prediction (the cross mark) over the actual attack center. Rotate the predictor until the downwinds direction points toward GN.

Step 5. Draw the downwind line perpendicular to the downwind direction using distance obtained in step 3.

Means of delivery	Distance from center of attack area along downwind axis, when the air stability category is: U	N	S
Artillery, Bomblets, and Mortars	10 KM	30 KM	50 KM
Multiple rocket launchers, missiles, bombs, and unknown munitions	15 KM	30 KM	50 KM

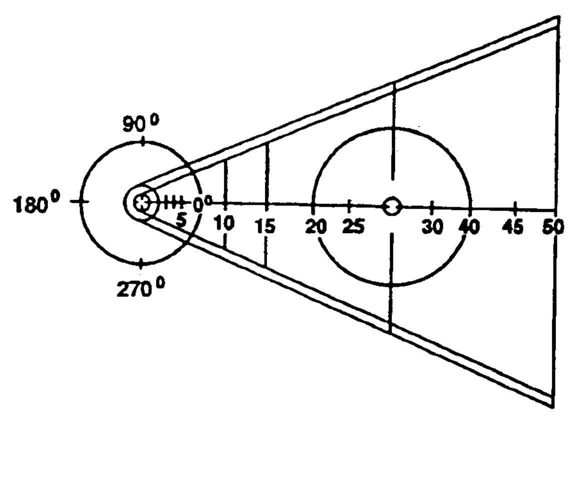


Figure 3-12. Area prediction, chemical downwind hazard.

Duration of Agent

For ground contamination, the temperature is one of the major factors for determiningg how long the agent presents a vapor hazard. Refer to tables 3-6 through 3-17, in Chapter 3, FM 3-4, NBC protection. These charts cover duration of agents at different temperatures, which will allow the commander to determine when to start MOPP opening/unmasking procedures.

NOTES

1. These charts are worse care using a 500 pound bomb.

2. In making hazard estimates, vapor is the determining factor within the attack area as well as in the downwind hazard area. However, the duration of hazard from contact with bare skin is difficult to predict. Duration can only be determined by the use of chemical agent detection devices.

3. When temperatures are consistently low, the duration of ground contamination maybe Linger than indicated in the table. The absence of vapor does not preclude the presence of contamination.

Chemical Downwind Hazard Prediction

The hazard from a chemical attack is not confined to the area directly attacked. The resulting vapor or aerosol travels with the wind and can cover a large area downwind of the attack area. To prevent casualties, you must quickly identify the possible hazard and warn units within the hazard area. This section provides instructions for defining the probable hazard area resulting from a chemical attack.

The prediction of the hazard areas is only an approximation. Terrain and weather, as well as delivery system variations, modify the hazard area. In addition, the methods used to predict the downwind hazard are safesided for troop safety. This assures that the hazard will be within the predicted area. This gives units in the area time to take appropriate precautions. These procedures are derived from STANAG 2103 and ATP-45 with change 1.

Type of Attack

For hazard prediction, all attacks are classified as either Type A, air-contaminating agents or Type B, ground contaminating agents.

The prediction of downwind chemical hazard areas depends on the wind speed, temperature, and humidity; and for ground-contaminating agents-the size of the attack area.

Air-Contaminating Agents-Type A

Type A agents are normally dispersed as an aerosol or vapor cloud with little or no ground contamination. A nonpersistent nerve agent employed upwind of the target. Air-contaminating agents are normally dispersed in ground-bursting munitions such as artillery shells and multiple rocket launchers. This type of attack is a Type A attack. Refer to flow chart on pages 3-13 thru 3-16.

Ground-Contaminating Agents-Type B

Type B agents are normally dispersed in liquid form to contaminate surfaces. Persistent nerve and mustard agents are examples of this type of attack. Refer to flow charts on pages 3-13 thru 3-16.

Ground-contaminating agents are normally dispersed by aircraft spray tanks, air-bursting artillery shells, rockets, missiles, and mines. Evidence of ground contamination on may include the observer's report of agent falling to the ground from air-bursting munitions, identification of agent with ABC-M8 paper, positive response of M9 Paper, or the identification of blister agent with the M256 series sampler, or reading on the CAM.

To predict a downwind hazard area, whether the attack was a Type A or Type B, you need the following information

- An NBC 1 or NBC 2 Chemical Report.
- Detailed meteorological information Chemical Downwind Message (CDM) or similar information.

This information is then used to determine the appropriate procedure to predicct the downwind hazard area. There are six cases that must be considered. Use the chart on the following page to determine which of the six procedures to use when constructing the downwind hazard prediction.

Plotting the Downwind Hazard-Type A

Two cases must be considered when plotting the downwind hazard area from a Type A attack.

Case a wind speeds of 10 kmph or less.

Case b wind speeds greater than 10 kmph.

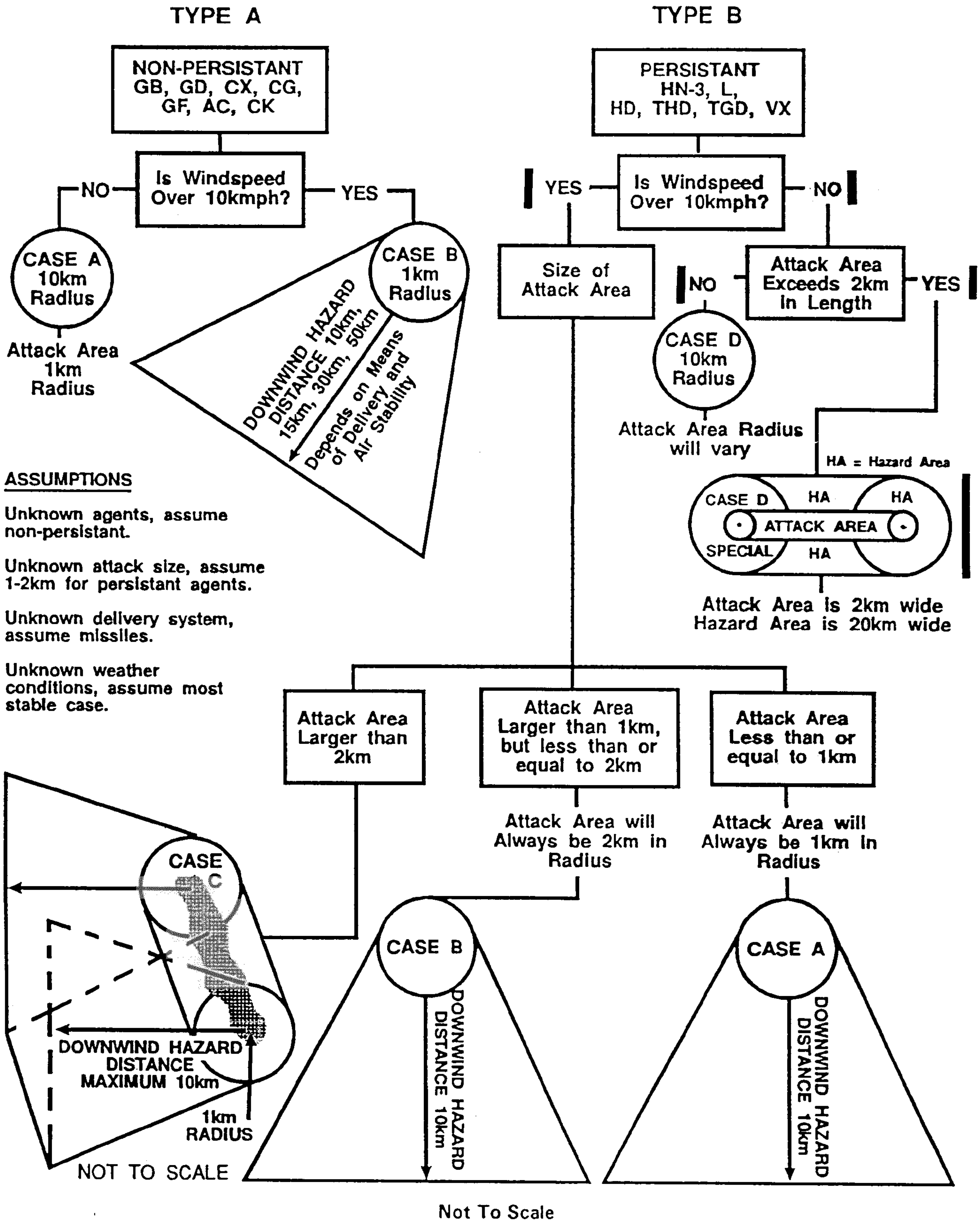
Type A, Case a (Figure 3-13, page 3-17) is for wind speeds of 10 kilometers per hour or less.

Step 1. Get the attack location from an NBC 1 or an NBC 2 chemical Report and plot the location on the map or template (preferably UTM scale 1:50,000).

Step 2. Draw a 1-kilometer-radius circle around the center of the attack location. The area within the circle represents the attack area.

Step 3. Draw a 10-kilometer-radius circle concentric with the 1-kilometer circle. The area within the circle represents the hazard area.

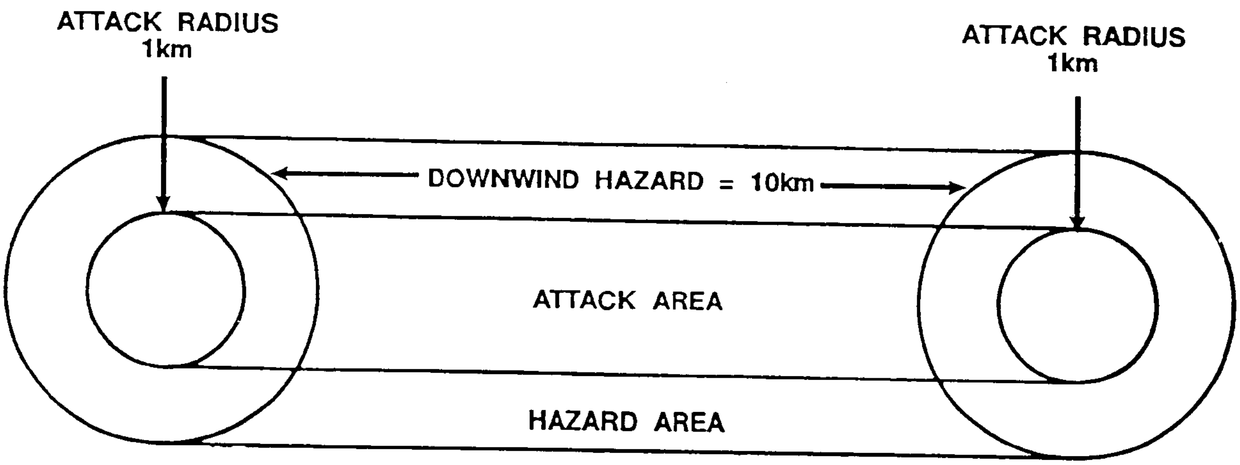
Step 4. Send an NBC 3 Chemical Report to


TYPE A
NON-PERSISTANT
GB, GD, CX, CG,
GF, AC, CK
Is Windspeed
Over 10kmph?
NO
YES
CASE A
10km
Radius
Attack Area
1km
Radius
CASE B
1km
Radius
DOWNWIND HAZARD
DISTANCE 10km,
15km, 30km, 50km
Depends on Means
of Delivery and
Air Stability
ASSUMPTIONS
Unknown agents, assume non-persistant.
Unknown attack size, assume 1-2km for persistant agents.
Unknown delivery system, assume missiles.
Unknown weather conditions, assume most stable case.
TYPE B
PERSISTANT
HN-3, L,
HD, THD, TGD, VX
Is Windspeed
Over 10kmph?
YES
NO
Size of
Attack Area
Attack Area
Exceeds 2km
in Length
NO
YES
CASE D
10km
Radius
Attack Area Radius
will vary
HA = Hazard Area
CASE D
SPECIAL
HA
HA
HA
ATTACK AREA
Attack Area is 2km wide
Hazard Area is 20km wide
Attack Area
Larger than
2km
Attack Area
Larger than 1km,
but less than or
equal to 2km
Attack Area
Less than or
equal to 1km
Attack Area will
Always be 2km in
Radius
Attack Area will
Always be 1km in
Radius
CASE
C
DOWNWIND HAZARD
DISTANCE
MAXIMUM 10km
1km
RADIUS
NOT TO SCALE
CASE B
DOWNWIND HAZARD
DISTANCE 10km
CASE A
DOWNWIND HAZARD
DISTANCE 10km
Not To Scale

Flow Chart

TYPE B
PERSISTANT

TYPE B CASE D
SPECIAL

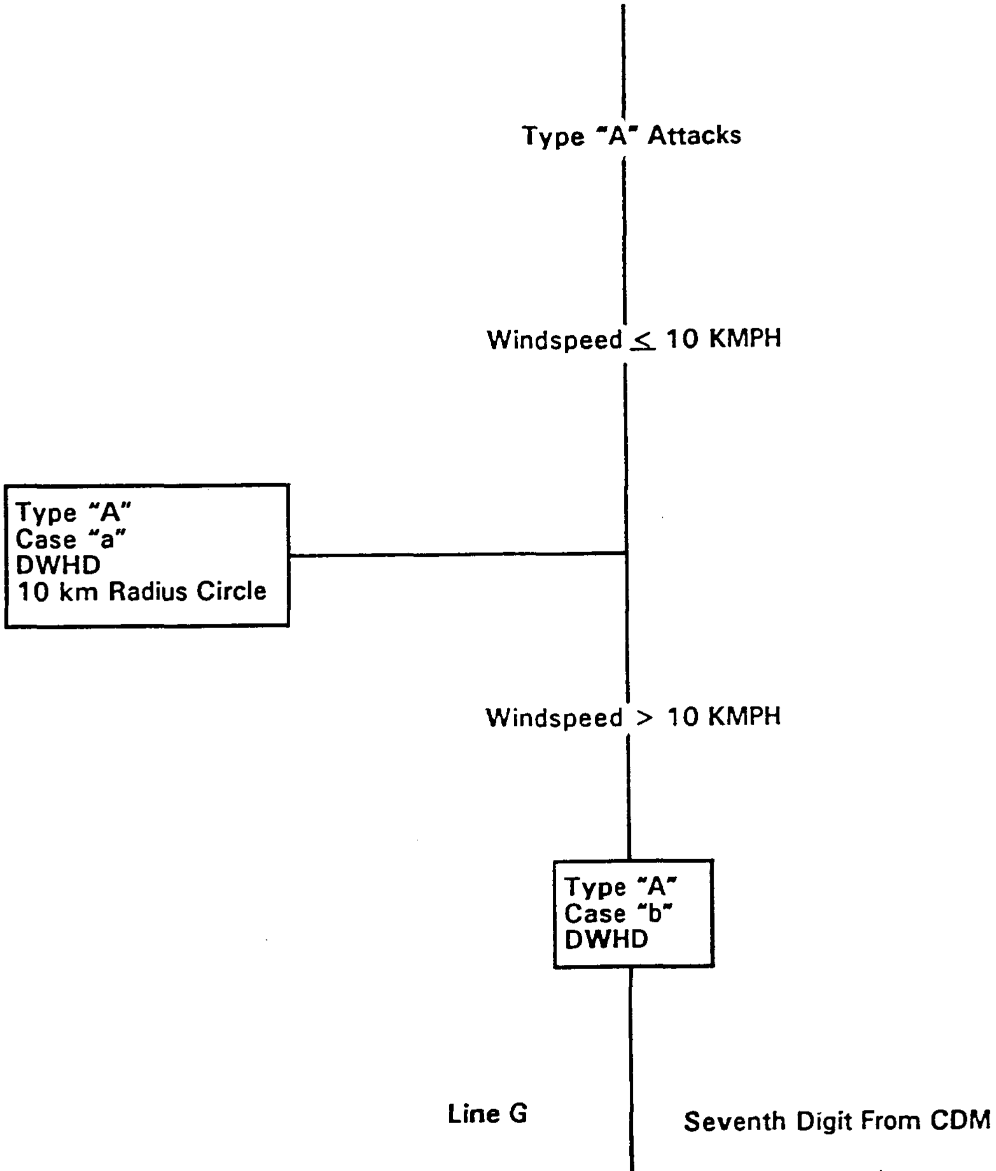


NOTE: When the windspeed is 10 kilometers per hour or less and you have a spray attack or large-scale artillery attack where the length of the attack area exceeds 2 km's, a 1 kilometer circle should be drawn around the start and end points. These circles should be connected on both the upwind and downwind sides to designate the attack area. Ten kilometer circles should be drawn around the start and end points and connected on the upwind and downwind sides to designate the hazard area (see plot above).

NOT TO SCALE

Flow Chart

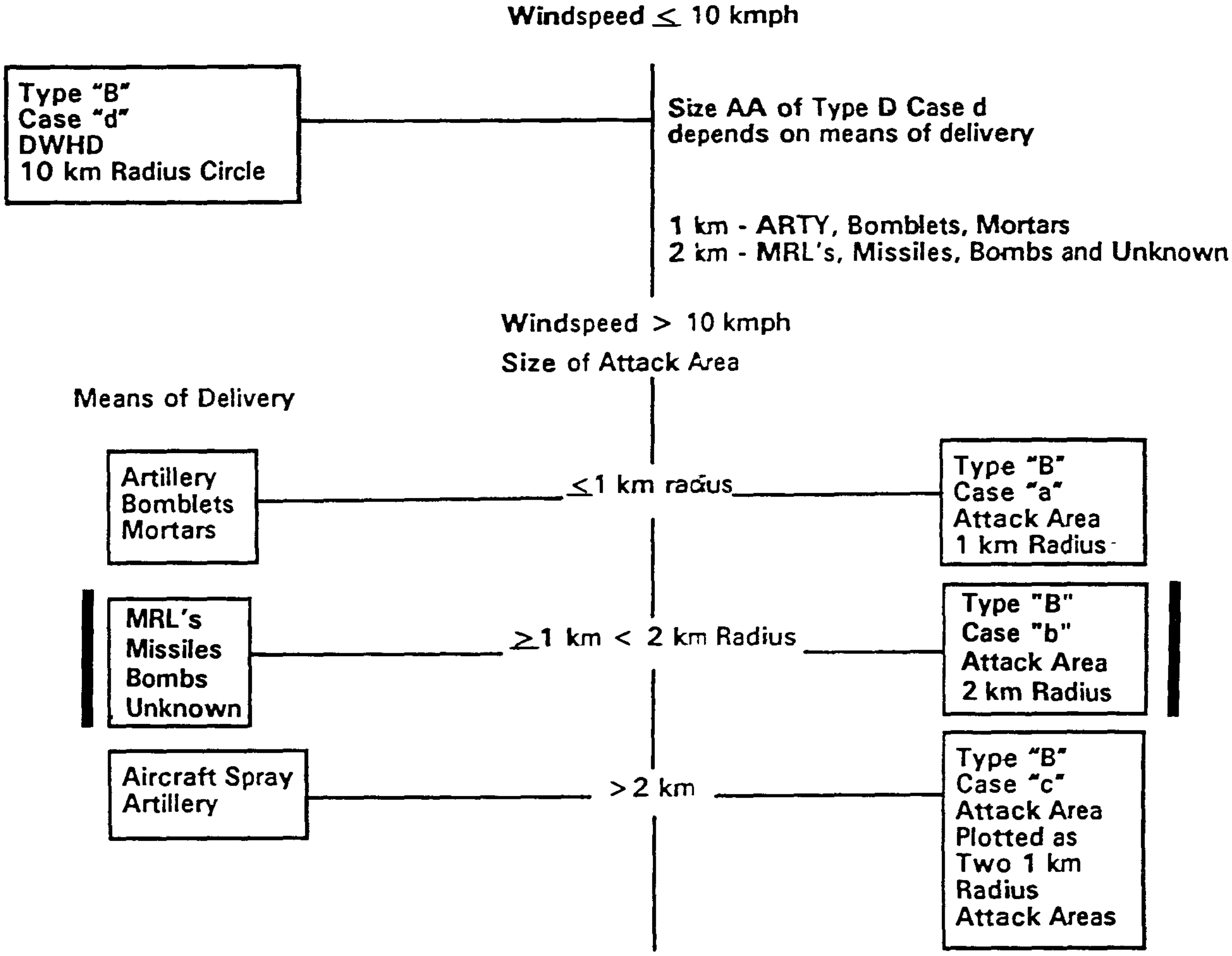
Chemical Hazard Prediction
Ground Burst Non-Persistent Agent



Means of Delivery	DWHD from Center of Attack Area		
	U	N	S
Artillery Bomblets Mortars	10 km	30 km	50 km
MRL'S Missiles, Bombs and Unknown	15 km	30 km	50 km

Flow Chart

Chemical Hazard Prediction
Air Burst Persistent Agent
Type "B" Attack



* All Type "B" Downwind Distance is 10 km
* Size of Attack Area Unknown, Use Type "B" Case "b"

Probable Time After Ground Contamination Which Personnel May Safely Remove Mask (Line Papa Bravo)		
Daily Mean Surface Air Temperature	Within Attack Area Number of Days	Within Hazard Area Number of Days
<0 - 10° C (32 -50° F)	3 - 10 Days	2 - 6 Days
11 - 20° C (51 -68° F)	2 - 4 Days	1 - 2 Days
21 - >30° C (69 - 86° F)	Up to 2 Days	Up to 1 Day

Flow Chart

units/installations in the hazard area (PA is 010).

Type A, Case b (Figure 3-14) is for wind speeds greater than 10 kilometers per hour.

Step 1. Get the attack location from an NBC 1 or an NBC 2 Chemical Report and plot the lcation on a map.

Step 2. Draw a GN line.

Step 3. Using the attack location as a center, draw a 1-kilometer-radius circle around the attack location.

Step 4. Obtain the downwind direction and speed from a valid CDM. Draw a line from the attack center representing the downwind direction-

Step 5. Find the appropriate air stability category and means of delivery in Table 3-5. Extract the maximum downwind distance of the hazard area. Plot the maximum downwind distance and draw a line perpendicular to the downwind direction.

Step 6. Extend the downwind direction line upwind 2 kilometers from the attack center. From this point, draw two lines that just touch the attack area circle and extend them until they intersect the maximum downwind distance line.

Step 7. Send an NBC 3 Chemical Report to units/installations in the hazard area.

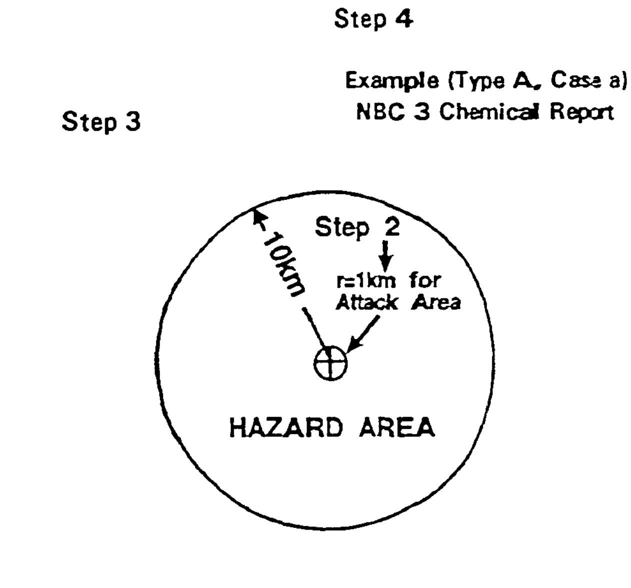


Figure 3-13. Plot for downwind hazard, Type A, Case a.

Plotting the Downwind Hazard-Type B

Four cases must be considered when plotting the downwind hazard area for a type B attack. One case (Case d) is for wind speeds of 10 kilometers or less. The other three cases are for wind speeds of greater than 10 kilometers per hour. In all cases, the maximum downwind distance is 10 kilometers. Therefore, the air

Table 3-5. Air Stability Category and Means of Delivery.

Means of Delivery	Distance from Center of Attack Area Along Downwind Axis, When the Air Stability Category is—		
	U	N	S
Artillery, Bomblets, and Mortars	10 km	30 km	50 km
Multiple Rocket Launchers, Missiles, Bombs, and Unknown Munitions	15 km	30 km	50 km

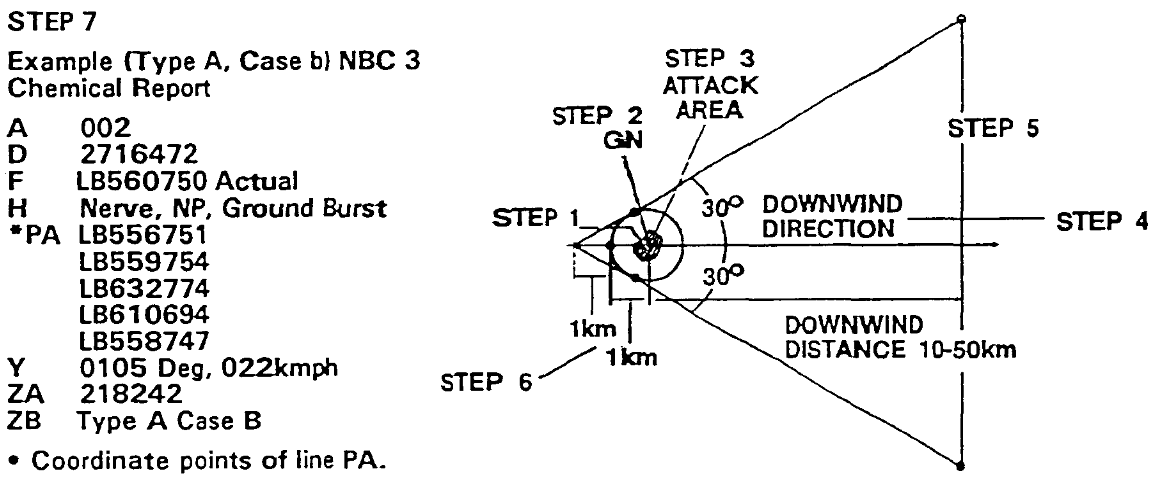


Figure 3-14. Plot for downwind hazard, Type A, Case b.

stability category does not need to be considered. The governing factor is the size of the contaminated area.

Three Type B cases have wind speeds greater than 10 kilometers per hour.

Case a (attack area ≤ 1 kilometer). Contamination is contained within a circular attack area of 1-kilometer radius. This most likely occurs after an artillery attack.

Case b (attack area > 1 kilometer 2 kilometers). Contamination is contained within a circular attack area; the radius is greater than 1 kilometer, but less than or equal to 2 kilometers. This most likely occurs after a missile attack with a high airburst, for example, over 1,000 meters high.

Case c (length of attack > 2 kilometers). Any dimension of the attack area exceeds 2 kilometers. This most likely occurs after a spray attack or an artillery attack of several regiments.

***NOTE** —If you know the attack is a ground attack but do not know the extent of it, assume it to be a Type B, Case b, attack.*

First, determine which case exists. Do this by plotting the actual attack location on a map, then determine which of the three cases it is.

Type B, Case a (Figure 3-15), occurs when the attack area is 1 kilometer or less. Plot the same as a Type A, Case b, attack; the single exception is that the maximum downwind distance is 10 kilometers.

Type B, Case b (Figure 3-16) occurs when the attack area is greater than 1 kilometer but less than or equal to 2 kilometers.

Table 3-6. Downwind hazard cases.

Type Attack*	Case	Attack Area**	Wind Speed	Downwind Hazard
Air (A)	a b	1 km 1 km	≤10 kmph > 10 kmph	10-km circle 10, 15, 30, or 50 km***
Ground (B)	a b c d	1 km 1 km 2 km 2 km distance same as case a, b, or c	> 10 kmph > 10 kmph > 10 kmph ≤10 kmph	10 km 10 km 10 km 10 km Circle

*Assume all attacks to be Type A attacks unless there is unmistakable evidence of ground contamination.

** if the size of the attack area is not known, assume the attack to be a Type B, Case b, attack.

*** Downwind hazard depends on the means of delivery and temperature gradient. (See table 3-5).

Step 1. Get the attack location from an NBC 1 or an NBC 2 Chemical Report and plot the location on a map.

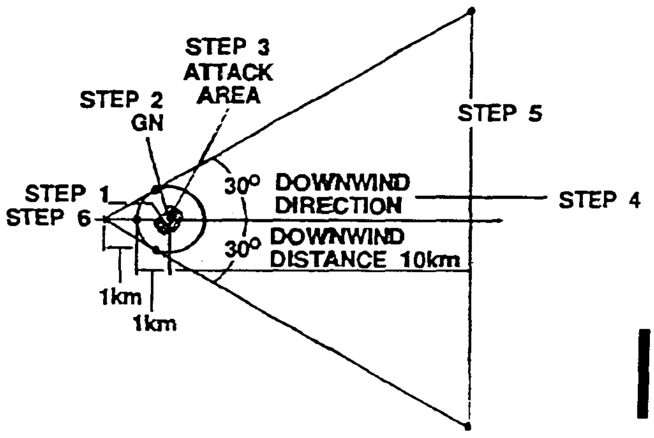
Step 2. Draw a GN line.

Step 3. Using the attack location as a center, draw a 2-kilometer-radius circle around the attack location.

Step 4. Obtain the downwind direction and speed from a valid CDM. Draw a line from the attack center representing the downwind direction. Extend this line 10 kilometers downwind. Draw a line perpendicular to the downwind direction.

Step 5. Extend the downwind direction line upwind 4 kilometers from the stick center. From this point draw two lines which just touch the attack area circle and extend them until they intersect the maximum downwind distance line.

Step 6. Send an NBC 3 Chemical Report to Units/installations in the hazard area.



STEP 7

Example (Type B Case a) NBC 3 Chemical Report

A 002
D 271472
F LB560750 Actual
H Nerve, NP, Ground Burst
PA LB556751
LB559754
LB632774
LB610694
LB558747
PB In attack area up to 2 days
In hazard area up to 1 day
Nerve, P, Airburst
Y 0105 Deg, 022 kmph
ZA 218242
ZB Type B Case A
• Coordinates points of line PA

Figure 3-15. Plot for downwind hazard, Type B Case a.

STEP 6

Example (Type B Case b) NBC 3 Chemical Report

A 002
D 271472
F LB560750 Actual
H Nerve, PER, Ground Burst
PA LB556751
LB559754
LB632774
LB106694
LB558747
Y 0105 Deg, 022 kmph
ZA 218242
ZB Type B Case b
• Coordinate Points For Lines PA

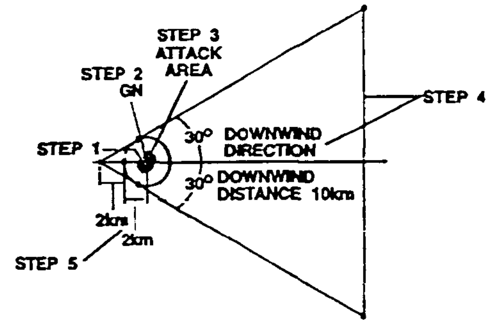


Figure 3-16. Plot for downwind hazard, Type B, Case b.

Type B, Case c (Figure 3-17) occurs when the attack area is greater than 2 kilometers.

Step 1. Plot the estimated attack area on the map and establish a point at each extreme end. Draw a GN line from one of the points.

Step 2. Draw a 1-kilometer-radius circle around each point.

Step 3. Draw a line tangent to both circles upwind of the attack area and a line tangent to both circles downwind of the attack area.

Step 4. Regard the two circles as being two separate attack areas and construct the two vapour hazard areas, as for a Type B, Case a.

Step 5. Draw a line from the point labelled "A" to the point labelled "B", as shown Figure 3-17.

Step 6. Prepare an NBC 3 chemical Report and send it to units/installtion within the hazard area.

Type B, Case d (Figure 3-18) is for wind speeds 10 kmph or less.

Step 1. Get the attack location from an NBC 1 or NBC 2 Chemical Report and plot the location on a map or template.

Step 2. Draw a 10-kilometer-radius circle around the attack area center.

Step 3. Draw the appropriate radius around the center of attack as per means of delivery.

Step 4. Send an NBC 3 Chemical Report to units/installations in the hazard area.

STEP 6

Example (Type B, Case c) NBC 3 Chemical Report

A 007
D 141550Z
F UC310060 to
UC370061 est
H Nerve, V, Spray
PA UC313068
UC303068
UC298059
UC305938
UC365939
UC481014
UC290040
PB Attack Area 2-4 Days
Hazard Area 1-2 Days
In attack area up to 2 days
In Hazard area up to 1 day
Y 0147 Degrees,
012 kmph
ZA 216662
ZB • Coordinate Poins For
Line PA

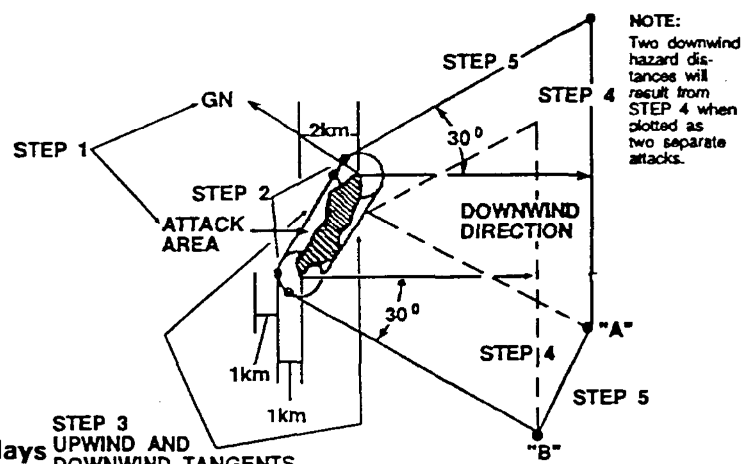


Figure 3-17. Plot for downwind hazard, Type B, Case c.

Type B, Case d (special) (Figure 3-19) is for winds speeds less than 10 kilometers per hour and you have a spray attack or large-scale artillery attack where the length of the attack area exceeds 2 kilometers.

Step 1. Get the attack location from the NBC 1 or NBC 2 Chemical Report and plot the location on the map or template.

Step 2. Draw a 1 kilometer radius circle around the start and end points.

Step 3. Connect both the upwind and downwind sides to designate the whole attack area.

Step 4. A ten kilometer circle should be drawn around both the start and end points of the attack.

Step 5. Connect both the upwind and downwind sides of the ten kilometer circles to designate the hazard area.

Step 6. Send an NBC 3 Chemical Report to Units/installations in the hazard area.

Adjusted Hazard Prediction

The methods previously discussed are based on constant environmental conditions. When the weather changes, the NBC 3 Report may no longer apply. An adjusted NBC 3 Report must be sent to unit/installations in the new hazard area, if possible. Also notify units who may no longer be in the hazard area.

Significant weather changes are:

- Representative downwind speed of 10 kmph or more, or if the windspeed increases from less than 10 kmph to more than 10 kmph or the reverse.
- Air stability category (applies to type A attacks only).
- Downwind direction by 30 degrees or more.

For **a charge in** wind speed determine the geographical center of the frontline of the traveling cloud at the time the new data becomes available. calculate this distance by multiplying the original wind speed times to twice the time in hours since the attack. The center of the cloud front is then considered to be the new center of attack area. Once the new center of attack is determined, the downwind hazard area is determined using the procedures outline for that type of attack.

Example (Type B, Case d) NBC 3 Chemical report

A 005
D 220730Z
F LB212295 est
H Nerve, V, Airburst
PA 010 km
PB In attack area up to 2 days
In hazard area up to 1 day
Y 0105 deg, 008 kmph
ZA 219452
ZB Radius of Attack Area 1 lm, Type B Case d
NOTE: Attack area radius depends on means of delivery

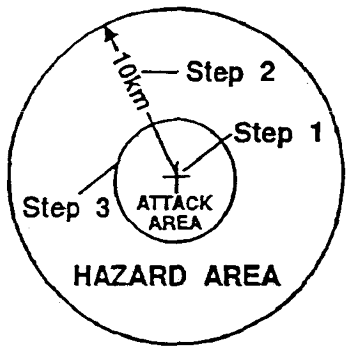
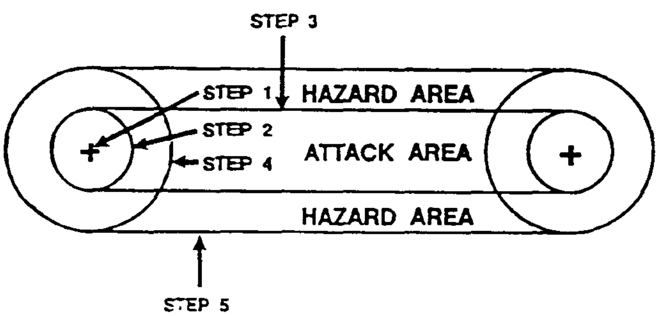


Figure 3-18. Plot for downwind hazard, Type B, Case d.

Example (Type B, Case d) (special).

A 005
D 220730Z
F LB212295 to LB242295 Actual
H Nerve, Persistent, Spray
PA 010 km
PB AA 2-4 days, HA 1-2 days
Y 0105 deg, 008 kmph
ZA 219452
ZB Type B, Case d (special)
NBC 3 Chemical



NOTE: Figure above is not to scale.

Figure 3-19 Plot for downwind hazard, Type B, Case d (special).

Recalculation Procedures for Wind Speed Changes

Step 1. If the increase in wind speed is 10 kmph, then the NBC 3 Chemical Report must be changed (line Yankee) to alert units to the earlier arrival time-

Step 2. If there is a change from > 10 kmph to < 10 kmph or vice-versa, the new attack area must be determined and the new prediction must be replotted.

For a Stability Category Change (Type A, Case b).

Step 1. Determine the distance the cloud will have reached (current windspeed X time after attack), and mark this on the downwind direction line.

Step 2. Using this point as the center, draw a circle with a radius of one half the width of fan (measured from the center pint). This is the new center of attack area.

Step 3. Determine the maximum downwind distance with the new stability category and subtract from it the distance the cloud has already traveled. Plot the remaining distance along the downwind direction line to establish the maximum downwind distance line. If the maximum downwind distance point lies within the radius of new attack area, extend it to the edge of the circle.

Step 4. Move twice the radius up the downwind direction line, establish a point, and draw the tangent lines from this point, just touching the edge of the attack area circle and extending to intersect with the maximum downwind distance line.

Step 5. Prepare a new NBC 3 Chemical Report.

For a Change in Direction of 30 Degrees (or more) Type A Attacks

Step 1. Plot a point on the downwind direction line that the cloud center would have reached (multiply current windspeed times the time) when the new wind direction occurred.

Step 2. Around this point, draw a circle with a radius of half the width of the fan (measured from center pint). This is the new attack area.

Step 3. From the center point, plot a line representing the new downwind direction.

Step 4. Subtract the distance the cloud has already traveled from the maximum downwind distance as determined from Table 3-5. Plot a point representing the new maximum downwind distance and draw a line perpendicular to the downwind direction.

Step 5. Move twice the radius up the downwind direction line. Establish a point, and draw tangent lines from this point, just touching the edge of the attack area circle and extending to intersect with the maximum downwind distance line.

Step 6. Prepare a new NBC 3 Chemical Report

For a Change in Direction of 30 degrees (or more) Type B Attacks.

Step 1. Using the original point of attack, reposition the fan along the new downwind direction line.

Step 2. Prepare a new NBC 3 Chemical Report.

Step 3. Units not located within the old or new fan but located within the arc created by the shift of the wind should also be warned.

Time of Arrival

The earliest an agent can be expected to arrive at a location is determined by dividing the distance from the attack center by 1.5 times the wind speed. For example, if you are 10 kilometers from the attack center and the wind speed is 5 kilometers per hour, the earliest the agent cloud would arrive at your location would be 1.33 hours.

10km ÷ (1.5 X 5 kmph) = 1.33 hr

Chemical Hazard Prediction at Sea

Chemical hazard prediction procedures at sea provides information on the location extent, and duration of the hazard area at sea as well as along coastal regions. It provides information necessary for commanders to warn units at sea and on the adjacent shore areas.

Definitions used in Naval Chemical hazard predictions are:

- Attack Area. The attack area is the area immediately affected by the delivered chemical agents at sea or on the shore line. If the location of the attack area is unknown, it is assumed to be located up-wind, at a distance equivalent to the units maximum range of reconnaissance. The size of the attack area is assumed to be contained within a 0.5 nautical mile (NM) radius circle.
- Hazard Area. The hazard area is the area in which unprotected personnel may be impaired in completing their mission by vapor spreading downwind from the attack area. The downwind hazard distance depends strongly on the defined hazard.
- Defined Levels of Hazard. In this procedure (three) different levels of hazard maybe taken into account.
  - LCt50,
  - ICt5, and
  - miosis

The following dosage limits (mg x min/m3) are used.

Agent	LCt50	ICt50	ICt5 Miosis
GB	70	35	5	3
GD	70	35	5	3

Only these agents are considered as a threat for naval forces. These chemical agents are the most damaging for ships at sea. Naval land forces follow the procedures and defensive actions outlined previously in this chapter.

When preparing a NBC 3 Chemical Report, indicate which hazard level the predicted hazard area is based upon in letter item ZB.

General Procedures

The horizontal extent of the downwind hazard area depends on—

- The type of chemical agent,
- The means of delivery (agent concentration in the attack area),
- the meteorological conditions, and
- the defined hazard (hazard level).

The vertical extent hazard extends at least up to 150 meters above the sea surface. Warn air crews flying low level.

Chemical attacks may basically be divided into-

- Air contaminating attacks (Type A attacks), (nonpersistent agents), and
- ground contaminating attacks (Type B attacks), (persistent agents).

Air contaminating Attacks (Type A attacks)—For prediction purposes, two types agents are recognized—

- Type A.1— Sarin (GB) and all other known nonpersistent agents, and
- Type A.2—Soman (GD) as an aerosol.

If the agent can not be identified, assume Type A. 1.

Ground contaminating Attacks (Type B attacks), (persistent agents):

After an attack with ground contaminating agents at sea, the hazard area will always be assumed to extend 10 nautical miles (NM) downwind, when the representative wind speed is more than 5 knots. At wind speeds of 5 knots or less, the hazard area is assumed to be contained within a circle with a radius of 10 nautical miles.

The following delivery means are recognized–

- Artillery (ART),
- multiple **rocket** launcher (MRL),
- missiles/rockets (RKT),
- bombs, massive (BOM),
- aircraft spray (AIRSPR).

In cases where the means of delivery is unknown, missiles are assumed.

Meteorological Data.

The meteorological data required for the downwind hazard area prediction procedure is provided in the form of a Naval Chemical Downwind Message (NAV CDM), which is transmitted 4 times daily by appropriate agencies and is valid for a 6 hour period, which is subdivided into three 2 hour periods.

Valuable MET information can be provided by the attacked unit itself. Therefore units at sea reporting a chemical attack should always attempt to include actual weather information under letter items, Y and ZA in NAV NBC 1 CHEMICAL or NAV NBC 2 CHEMICAL Reports. ZA may be encoded or in clear text.

Elevated Inversion Layers.

Certain meteorological conditions, known as elevated inversion layers, in the atmosphere act like a lid and trap the agents underneath.

This may lead to situations in which the chemical agent concentration aloft is very much higher than at the surface. The stability conditions detemined at the surface are neutral or even unstable in these cases, resulting in much shorter hazard distances.

Such situations are indicated in the NAV CDM by the letter "S" appearing in the coded significant weather phenomena. In this case, air crews must-be given an appropriate warning.

Prediction Procedures.

For sea areas, the prediction of chemical downwind hazard areas follows either the simplified, or detailed procedure.

The simplified procedure is intended for use on ships, whereas the detailed procedure is designed for use in NBC Centers at Naval Headquarters, where trained NBC personnel and suited facilities are available.

Naval Chemical Downwind Message (NAV CDM)

The NAV CDM is computed essential in the same manner as the land CDM. In most cases, the CDM information is obtained through land baaed NBC Centers.

In the event, however, that land CDM information is not available or differs significantly from the weather conditions at sea, Figure 3-20 is used to determine the stability category. The numbers one through seven depicted on "the graph refer to the seven stability categories used in the land CDM.

Once the stability category is determined, enter Table 3-7 or 3-8 (page 3-24), depending on which agent was used, to determine the downwind hazard distance.

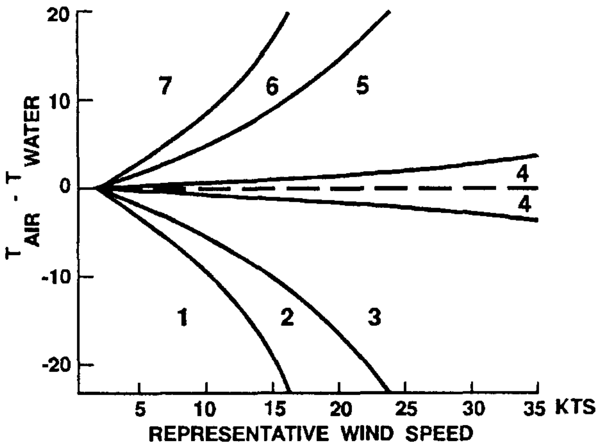


Figure 3-20. Determination of Air Stability Category (SEA)

Naval Chemical Downwind Hazard Prediction Simplified Procedure

If a valid NAV CDM is not available, Figure 3-20 may be used to determine the air stability category, which is the basis for the determination of the maximum downwind hazard distance.

This distance is determined from Tables 3-7 and 3-8 (page 3-24). When using the simplified procedure, use the downwind hazard distances related to miosis.

The representative downwind direction and downwind speed must be determined onboard the affected ship.

Determination of the Hazard Area

The hazard area is determined as follows:

Step 1. The center of the attack area (NBC 1 Chemical or NBC 2 Chemical letter item F) is plotted on the chart. A circle, the radius of which is 0.5 NM is drawn around the center. This circle represents the attack area (Figure 3-21).

Step 2. A template for a simplified chemical hazard area prediction is place on the chart in such a way that the center point of the template circle coincides with the center of the attack area and so that the value on the protractor, corresponding to the downwind direction given in the NAV CDM is oriented towards the north on the chart. A sample template is at Figure 3-22.

Step 3. This position of the template is marked on the chart by using holes punched in the template along the downwind axis. The template is then moved back along the downwind axis until the radial lines become tangents to the circle (30 degrees standard). Use the holes punched out along the radial lines to mark the position and connect to circle, forming tangents.

Step 4. The maximum downwind hazard distance is marked on the downwind axis. Through this point a line is drawn perpendicular to the downwind axis, to intersect the tangents (Figure 3-23).

When, in the NAV CDM, light or variable winds are reported (wind speeds of 5 kts or less or variable wind direction (999), the hazard area is represented by a circle concentric to the attack area, with a radius equal to 15 NM.

Naval Detailed Chemical Downwind Hazard Prediction

The detailed procedure for prediction of chemical downwind hazard areas is designed for use at naval headquarters, and leads to a more accurate prediction than does the simplified procedure. The detailed procedure is based upon the information compiled in the "Chemical Prediction Data Sheet" (CPDS) and NAV NBC 1 or NAV NBC 2 Chemical Report. The CPDS < Figure 3-3 must be filled in immediately on receipt of a new and updated CDM, and check on the receipt of a NAV NBC 1 or NAV NBC 2 Chemical containing meteorological information in letter items Y and ZA.

The delineation of the hazard area resulting from an attack with chemical agent requires information on the chemcial agent and means of delivery.

Location of the attack area as reported in NAV NBC 1 or NAV NBC 2 Chemical Report

Representative downwind direction of the agent cloud (taken from CPDS).

Maximum downwind hazard distance(s) related to the appropriate hazard level(s) (LCt50) and/or ICt and/or

Table 3-7. Downwind Hazard Distance (Nautical Miles) "Sea"

Agent: SARIN
Weapon: ARTILLERY
Eff. Payload: 650 kg

STABILITY	1	2	3	4	5	6	7	DOSE
Wind (KTS) 5 - 9	< 1 4 4	< 1 4 6	< 1 6 8	< 1 8 10	< 1 8 12	2 10 12	2 8 12	LCt50 ICt5 MOISIS
10 - 14	< 1 2 4	< 1 4 6	< 1 6 8	< 1 6 10	< 1 8 12	2 10 14		LCt50 ICt5 MOISIS
15 - 19		< 1 2 4	< 1 4 6	< 1 6 8	< 1 6 10			LCt50 ICt5 MOISIS
20 - 24			< 1 4 4	< 1 4 6	< 1 6 8			LCt50 ICt5 MOISIS
25 - 29			< 1 2 4	< 1 4 6	< 1 4 8			LCt50 ICt5 MOISIS
30 - 34			< 1 2 4	< 1 4 4	< 1 4 6			LCt50 ICt5 MOISIS

Agent: SOMAN
Weapon: ROCKET/MISSILE
Eff. Payload: 250 kg

STABILITY	1	2	3	4	5	6	7	DOSE
Wind (KTS) 5 - 9	< 1 2 2	< 1 2 4	< 1 2 4	< 1 4 4	< 1 4 6	< 1 4 6	< 1 4 6	LCt50 ICt5 MOISIS
10 - 14	< 1 2 2	< 1 2 2	< 1 2 4	< 1 2 4	< 1 4 6	< 1 4 8		LCt50 ICt5 MOISIS
15 - 19		< 1 2 2	< 1 2 2	< 1 2 4	< 1 2 4			LCt50 ICt5 MOISIS
20 - 24			< 1 2 2	< 1 2 2	< 1 2 4			LCt50 ICt5 MOISIS
25 - 29			< 1 2 2	< 1 2 2	< 1 2 4			LCt50 ICt5 MOISIS
30 - 34			< 1 2 2	< 1 2 2	< 1 2 2			LCt50 ICt5 MOISIS

NOTES: (1) For "artillery 650 kg": One minute of fire at maximum rate from a regimental artillery group consisting of two battalions of 122 howitzers and one battalion of 152 howitzers (18 guns/battalion).

(2) For "rocket/missile 250 kg": One FROG or SCUD missile.

Table 3-8. Downwind Hazard Distance (Nautical Miles) "Sea"

Agent: SARIN
Weapon: BOMBS
Eff. Payload: 600 kg

STABILITY	1	2	3	4	5	6	7	DOSE
Wind (KTS) 5 - 9	< 1 4 4	< 1 4 6	< 1 6 8	< 1 6 10	< 1 8 12	2 8 12	2 8 10	LCt50 ICt5 MIOSIS
10 - 14	< 1 2 4	< 1 4 6	< 1 4 8	< 1 6 10	< 1 8 12	2 10 12		LCt50 ICt5 MIOSIS
15 - 19		< 1 2 4	< 1 4 6	< 1 4 8	< 1 6 10			LCt50 ICt5 MIOSIS
20 - 24			< 1 2 4	< 1 4 6	< 1 6 8			LCt50 ICt5 MIOSIS
25 - 29			< 1 2 4	< 1 4 6	< 1 4 6			LCt50 ICt5 MIOSIS
30 - 34			< 1 2 4	< 1 2 4	< 1 4 6			LCt50 ICt5 MIOSIS

Agent: SARIN
Weapon: MULTIPLE ROCKET LAUNCHER
Eff. Payload: 3500 kg

STABILITY	1	2	3	4	5	6	7	DOSE
Wind (KTS) 5 - 9	2 12 16	2 16 22	2 20 30	4 26 36	4 28 38	4 26 34	4 20 26	LCt50 ICt5 MIOSIS
10 - 14	2 12 16	2 14 20	2 20 28	2 26 38	4 30 44	4 32 42		LCt50 ICt5 MIOSIS
15 - 19		2 10 16	2 16 22	2 20 30	2 26 38			LCt50 ICt5 MIOSIS
20 - 24			2 12 18	2 18 26	2 22 34			LCt50 ICt5 MIOSIS
25 - 29			2 10 16	2 14 22	2 20 30			LCt50 ICt5 MIOSIS
30 - 34			2 10 14	2 12 20	2 18 28			LCt50 ICt5 MIOSIS

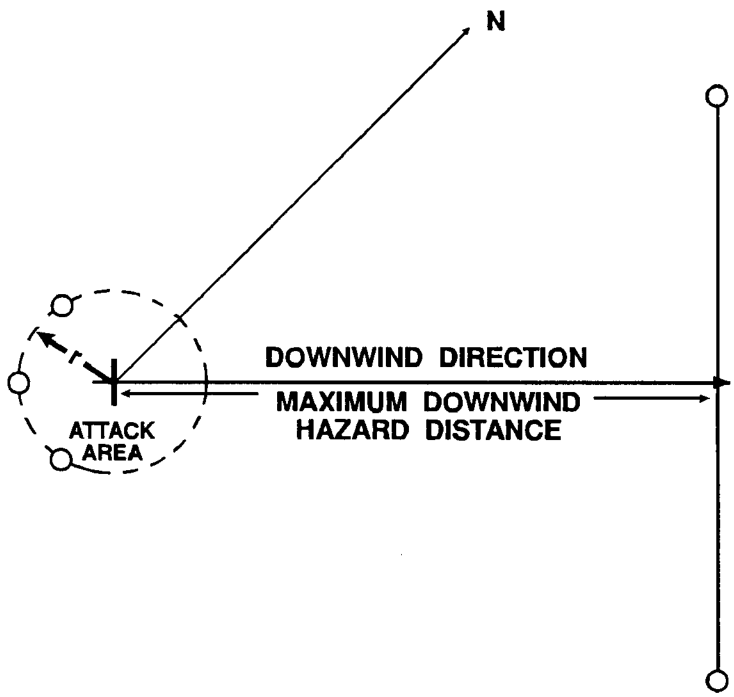
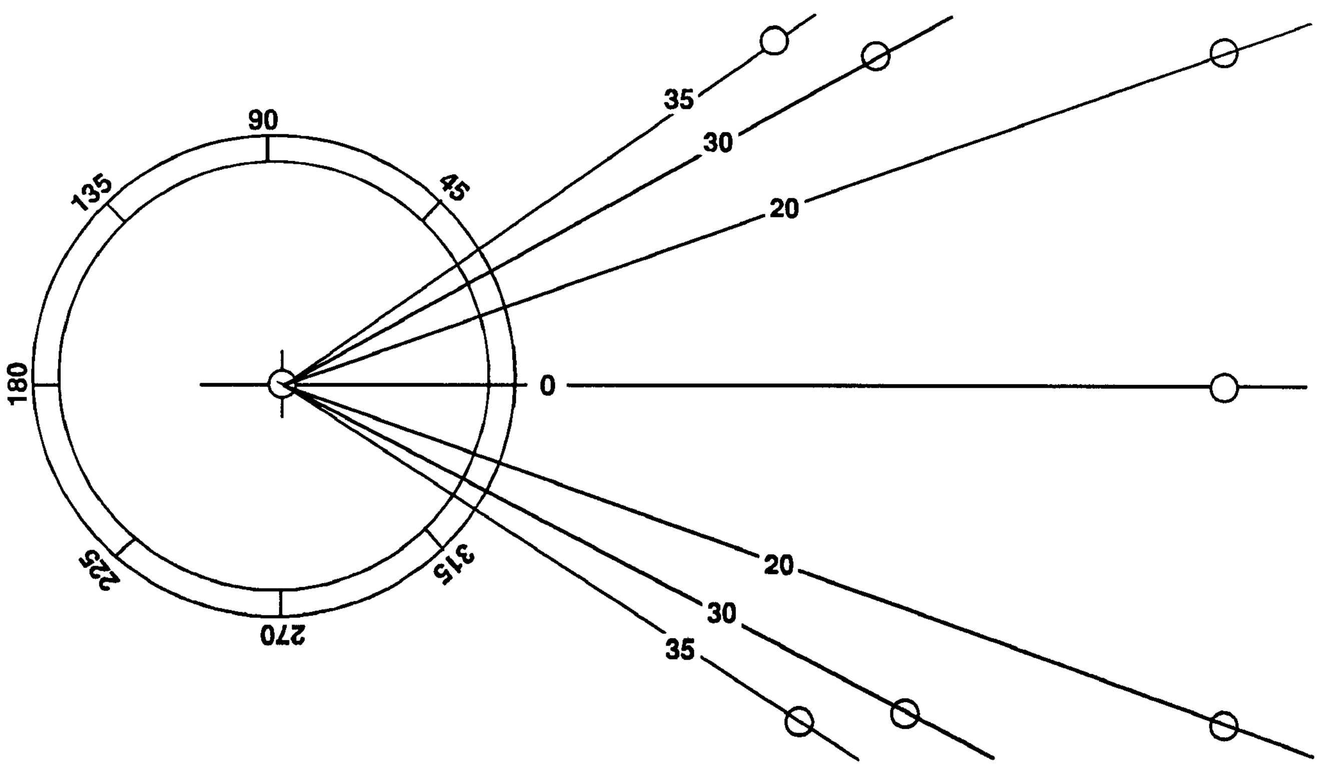
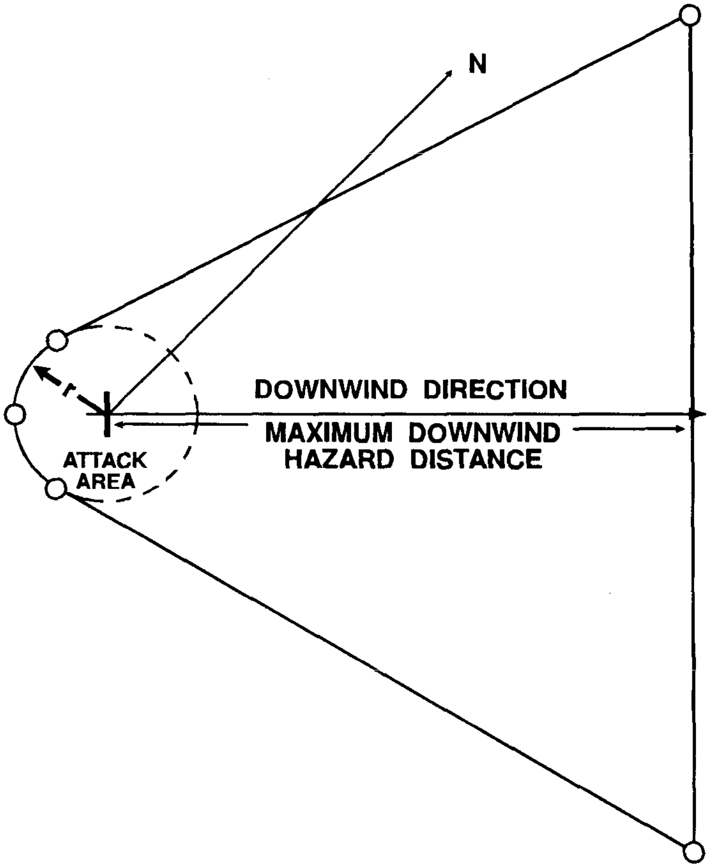


Figure 3-21, Step 1, Chemical Downwind Hazard Area.



Note—0 represents areas to puncture holes as described in step 3.

Figure 3-22. Chemical Ship's Template.



NAV NBC 2 Chemical

A. 001
D. 110333Z
E. 110340Z
F. 5459.In
0516.4E
Estimated
G. Bombs
H. Nerve, P, Airburst
Y. 0050 006
ZA. 214—0
ZB. Type of Agent Confirmed
by Attacked Unit

Figure 3-23. Completed Simplified Chemical Downwind Hazard Area with NAV NBC 2 Chemical Report.

miosis) (taken from CPDS).

Half-sector angle of the hazard area:

- 35 degrees for wind speeds higher than 5 knots, but less than 10 knots
- 20 degrees for wind speeds of 10 knots and more.

For wind speeds equal to 5 knots or less, the hazard area will be circular with radius equal to the downwind hazard distance for 5 knots wind speed. However, the radius should not exceed 15 nautical miles.

Determination of the Downwind Hazard Area.

Step 1. To plot the chemical downwind hazard area on a sea chart or on general operations plot, the above information is used in the following way (see Figure 3-22).

ZCZC 054
fxd182 edzl
110525Z
NAV CDM

110500 11 Aug
0600GMT
JQ 12
W: 999005
11470-
X: 040010
31566-
Y: 070012
41666-

Chemical Prediction Data Sheet Agent: SARIN Hazard Level: ICt5 Delivery Means: Artillery				
1	NBC-Center: AMZ BSN			
2	Area of validity: JQ 12			
3	Originator of NAV CDM: F1Kdo/GEOPHYS B1SL N			
4	Date: 11 Aug 19XX	Period		
5	Time of Validity: 0600Z - 1200Z	W	X	Y
6	Downwind Direction (Degrees)	999	040	070
7	Representative Downwind Speed 10 m (KTS)	5	10	12
8	1.5 Times the Wind Speed (KTS)	7.5	15	18
9	.5 Times the Wind Speed (KTS)	2.5	5	6
10	Stability Category	1	3	4
11	Temperature (Centigrade)	14	15	16
12	Humidity	7	6	6
13	Significant Weather Phenomena	-	Rain	Rain
14	Cloud Coverage	-	-	-

Figure 3-24. Chemical prediction date sheet sample.

Step 2. Plot the location of the attack area. If the exact location (center of the attack) is known, draw a circle around this point with a radius of 0.5 nautical miles. If only a dissemination area is reported determine the center point of this area and draw a circle around this point, using a radius of 0.5 nautical miles. If the size of the attack area is known to be larger, the radius must be adjusted accordingly.

Step 3. From the center of the attack area circle draw a line, representing the downwind direction.

Step 4. Draw two lines which, being tangents to the circle, form an angle equal to the half sector angle on either side of the representative downwind direction (downwind axis).

Step 5. Label the point on the downwind direction line (downwind axis, thus marking the extent of the downwind hazard distance(s) for the relevant level(s) of hazard LCt50 and/or ICt5 and/or miosis) and draw a line through this (these) point(s), perpendicular to the downwind axis and intersecting the two tangents. The downwind hazard area(s) is (are) contained within (these) line(s), the tangents and the upwind arc of the attack area circle.

When low wind speeds or variable wind directions are reported in the NAV CDM, (wind speed 5 knots or less or variable wind direction (999)), draw a circle

A. 006
D. 110558Z
F. 5447.3N 0643.8E
Actual
G. MRL
H. SARIN Surface Burst
PA. 015
Y. 0999 005
ZA. 1144—0
ZB. DHD MIOSIS 16 NM
DHD ICt5 12 NM
DHD ICt50 2 NM

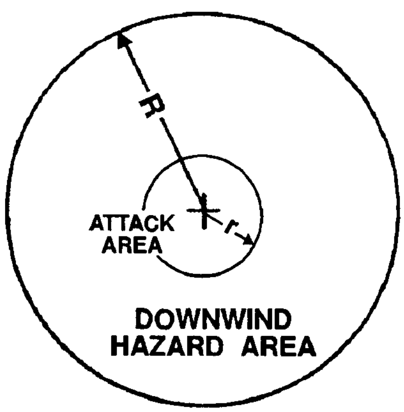


Figure 3-25. Downwind Hazard Area, Type "A" Attack, Wind Speed 5 kts or Less or Variable.

concentric to the attack area circle, using the relevant downwind hazard distance as the radius. However, the radius should not exceed 15 nautical miles (see Figure 3-25.

When wind speeds are 10 knots or more, the chemical plot and subsequent NBC 3 Chemical Report would look like that shown in Figure 3-26.

If the meteorological conditions change within the period of duration of the hazard, the predicted hazard area must be adjusted only if—The stability category changes from one category to another, and/or the wind speed changes by more than 5 knots or from 5 knots or less to more than 5 knots and vice versa, or the wind direction changes by more than 20 degrees.

The hazard area is then determined as follows:

Calculate the downwind distance which the agent cloud may have travelled at the time the change in the meteorological conditions occurred, by using the representative downwind wind speed. Consider this point to be the center point of a "new" attack area, and draw a circle around it with a radius equal to half the width of the hazard area at that point. From there on, repeat the steps described earlier for determination of the downwind hazard area. The distance which the agent cloud may already have travelled must be subtracted from the maximum downwind hazard distance under the new weather conditions (Figure 3-27).

When a cloud from a chemical agent crosses the coastline from sea to land or vice versa, consider the point where the downwind direction line (downwind direction line or downwind axis) intersects the coastline to be the center point of a "new" attack area. Follow the procedure described above, using the appropriate tables for sea and land to determine the downwind hazard distances. When frequent changes occur, use land procedures when working manually.

In the case of air contaminating attacks, the beginning and the end of the hazard at a certain location may be determined from—the representative downwind speed, the distance of the location from the edge of the attack area, and the beginning and the end of the attack.

The following two formulas are used:

$t_B = (d_\mu \times 60) / (1.5 \times V_Z)$ or
$t_B = (d_\mu \times 40) / V_Z$ and

$t_E = (D_\mu \times 60) / (0.5 \times V_Z)$ or
$t_E = (d_\mu \times 120) / V_Z = 3 \times t_B$

t_B = time in minutes from the beginning of the attack to the beginning of the hazard.

d_μ = distance between the location and the downwind edge of the dissemination area (in NM).

V_Z = wind speed in kts. If necessary, the wind speed must be determined as the mean wind speed over several periods of validity of the NAV CDM.

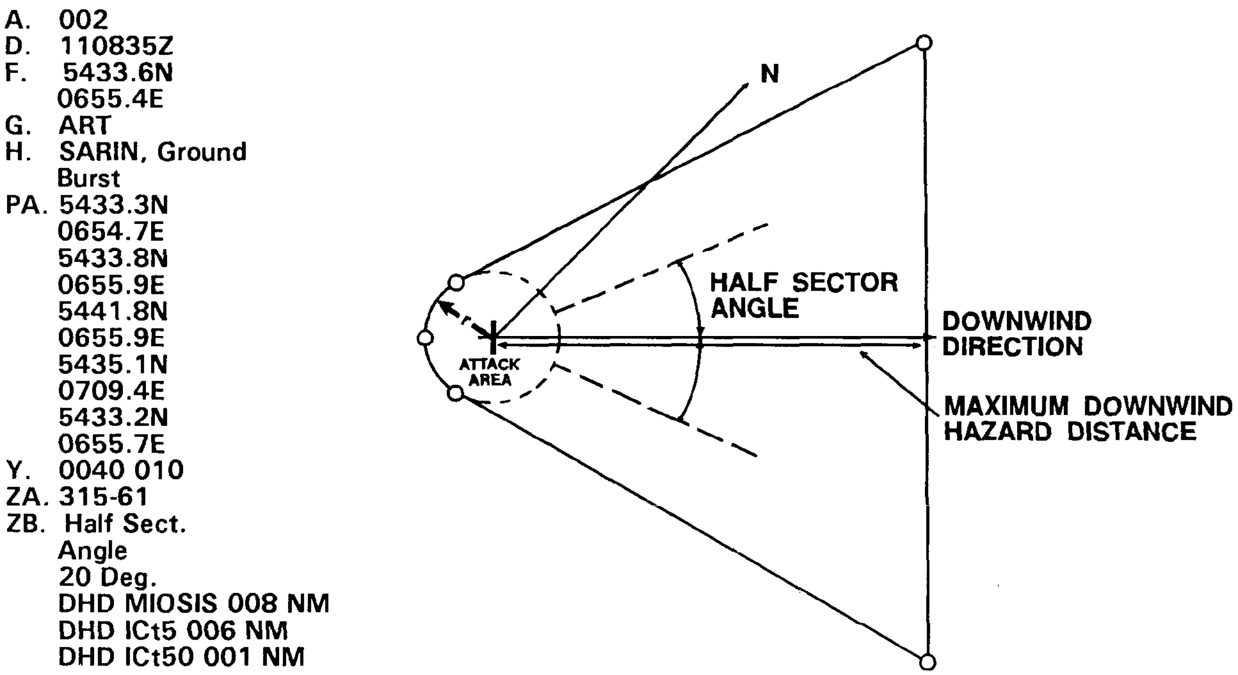


Figure 3-26. Downwind Hazard Area, Type "A" Attack, Wind Speed 10 kts or more.

t_E = time in minutes from the end of the attack to the end of the hazard.

Example:

Given–alp = 5 NM, V_Z = 10 kts.

Using the formulas, t_B and t_E are calculated as follows—

t_B = (5 NM x 40) / 10 kts = 20 minutes, and

t_E = (5 NM X 120) / 10 kts = 60 miuntes

So, the beginning of the hazard is expected at this location 20 minutes after the beginning of the attack and is expected to end 60 minutes after the end of the attack.

The expected maximum duration of the hazard maybe obtained by using the maximum downwind hazard distance as d^, and calculating t_E from the formulas.

The NBC agency (NBC Collection Center/NBC Sub-Collection Center) must continuously check the NAV NBC 3 Chemical Report issued, in order to ensure that any new information (meteorological or NBC) is considered.

If necessary, a corrected NAV NBC 3 Chemical Report must be transmitted.

Avoidance Procedures

Once chemical agent hazard areas are plotted, units may elect to by-pass suspected contamination or operate within these areas. If the unit elects or is required to operate within a contaminated environment, refer to FM 3-4 for performance degradation factors. Appendix A to this field manual provides a checklist for CB operations for platoon through Brigade Task Forces. This checklist may serve as a guide for unit operations in a contaminated environment.

Vehicle Operations

If agents have been used, soil particles become contaminated. When a track vehicle moves across the surface and it's movement causes these soil particles to be suspended in the air, liquid droplets of chemical agent are also suspended in the air. The suspension of the chemical agent, therefore, becomes an increased threat **to** follow on vehicles.

Table 3-9. Calculated Maximum Distance of Agent Travel

Agent Travel [1] (meters) by Vehicle Type				
Vehicle Speed (mph)	M1 (A1)	M60	M2/M3	M113
6	1	1	1	1
12	4	4	3	3
18	7	7	6	6
24	13	12	10	11
30	19	18	16	16
35	26	25	21	22
40	34	32	27	28
45	43	40	34	35
50	52	49	42	43

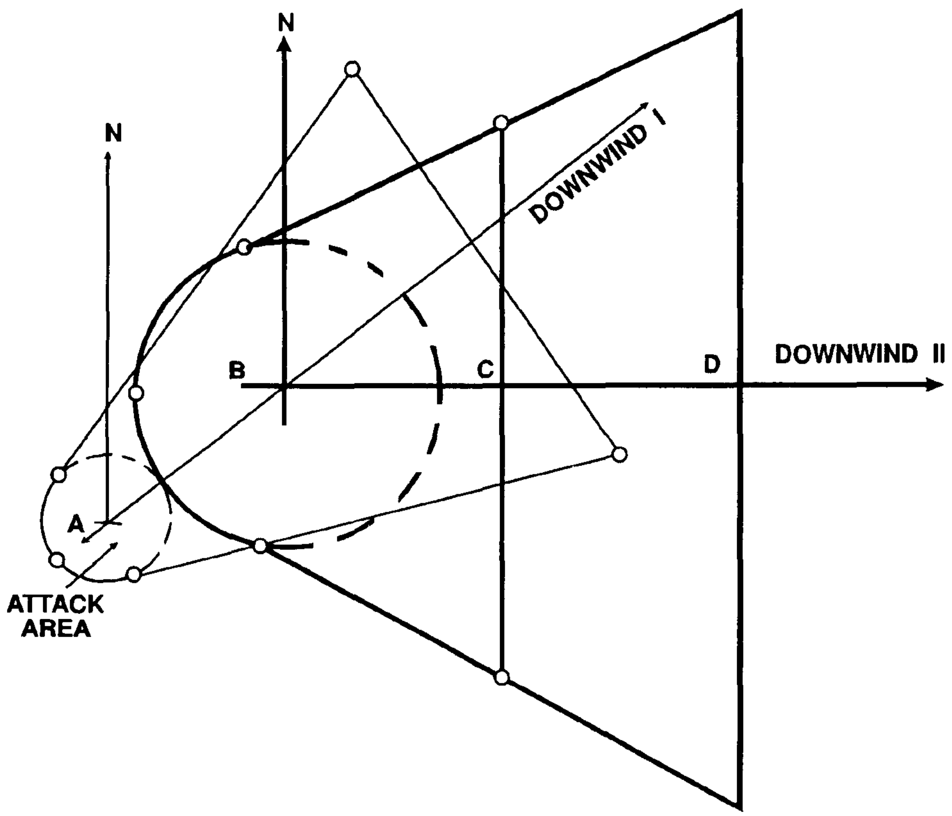


Figure 3-27. Recalculation of Downwind Hazard Area, Type "A" Attack, After Change in Downwind Direction at Point B.

One of the basic tenants of crossing contaminated terrain is to keep the contamination level as low as possible. Based on recent studies the distance that chemical agents may travel when suspended in the air by vehicle movement is depicted in Table 3-9.

The data presented in Table 3-9 represents the distance in meters that chemical agent contaminated soil particles may travel, regardless of wind effects. When track vehicles move across contaminated terrain, it is possible that minute droplets of chemical agent, as small as 25 micrometers (urn), may become suspended in air and carried by the natural or vehicle induced air currents. These droplets may rise as high as 10 meters above the surface and extend downwind as far as 3 km. To reduce agent contamination trail vehicles should remain "button up" even if no vapor contamination is detected while transversing terrain.

Units in the traveling formation may also encounter cross-contamination to some degree if a lateral interval sufficient to avoid dust from the side of the track vehicle is not maintained. In the absence of cross winds a 50 meter spacing laterally is sufficient to avoid cross-contamination.

Helicopter Operations

Helicopters flying over contaminated terrain may also suspend chemical agents in the air increasing the risk to aircraft following close or directly behind the lead aircraft. Recent test results indicate that to avoid cross-contamination from the lead aircraft pilots should double the normal trailing distance between aircraft. Further, according to these studies aircraft flying at an airspeed of 50 knots or more and at an altitude of 84 feet or higher (or an H/D of 2.0), above contaminated terrain may not receive an incapacitating vapor dosage of chemical agent inside the aircraft as long as all doors, windows and vents are closed.

In the event that this altitude or airspeed cannot be achieved or maintained monitor the interior of the aircraft with the M8A1 Chemical Agent Alarm or the Chemical Agent Monitor (CAM).

If the aircraft becomes contaminated, flying with the doors and windows open for approximately 15-20 minutes at approximately 90 knots, will reduce the contamination level by 95%. This may reduce the contamination level to such an extent that unmasking procedures may be initiated using the M256A1 Chemical Agent Detector Kit.