Chapter 3

Chemical Vulnerability Assessment and Force Protection

This chapter addresses vulnerability assessment and force protection at the tactical level, brigade through corps, and its integration into the staff estimate process. The assessment provides units with an estimate of the probable impact of enemy chemical attacks on their force. Using this estimate, commanders can help reduce the risks associated with enemy chemical weapons use and maximize force effectiveness under NBC conditions.

The vulnerability assessment is a primary means through which the chemical officer participates in the battlefield assessment process. In the assessment, the chemical officer develops information for integration into the various staff estimates. From the S2, the chemical officer/NCO obtains the following information (but is not limited to)—

- Time periods of interest.
- Weather and terrain data.
- Threat chemical delivery capabilities.
- Threat chemical weapons efficiency information.
- Threat courses of action and intent.
- Named areas of interest (NAIs) and target areas of interest (TAIs).
- Summary of enemy activity, including any NBC attacks.

From the fire support officer (FSO), the chemical officer obtains information on casualty percentages from friendly and threat conventional munitions. Examples of information may include—

- Casualty percentages based on target sizes.
- Casuahy percentages based on weapon system.

These are just some of the things that the chemical officer might require from the other staff elements to be able to provide the commander with a chemical vulnerability assessment.

The commander's information needs from the chemical vulnerability assessment include, as a minimum—

- Any reports or threat NBC attacks.
- Higher headquarters NBC defense guidance (minimum MOPP, automatic masking, MOPP gear availability).
- Impact of degradation on mission performance.
- Anticipated chemical casualties and how long persistent agents will remain as a hazard.

Any other pertinent information will just enhance the assessment for the commander.

Coordinating staff officers, with the chemical officer's assistance, use this information to assess the viability of friendly COAs and to decide upon appropriate risk reduction actions. The chemical officer uses the assessment to support the decision-making process in areas such as the development of the concept of chemical defense (for example, MOPP guidance) or chemical unit mission priorities. The simplified data provided by the assessment is also useful in providing the commander information on the enemy chemical capability.

Completion of this assessment requires use of tables and graphs contained in this manual. These items were designed to accomplish two purposes: first, to provide commanders and staffs with an estimate of the likely effects of enemy chemical strikes and second, to provide leaders with a simple, rapid process to support vulnerability assessment on a fast-moving battlefield. Because of rapidly changing situations, units may modify and/or supplement estimates to increase their use under local conditions and to incorporate experience gained through combat. The emphasis on simplicity should remain constant.

At battalion level and below, leaders use MOPP analysis (see Chapter 2 discussion) to conduct their vulnerability assessment. Leaders determine the appropriate protective posture for their soldiers based on the threat and the mission.

This chapter is divided into two parts: assessment procedures and integration of the results into operational plans to achieve appropriate levels of force protection. These procedures apply to brigade-level and higher units. At these levels, there is more information available and time to evaluate and incorporate applicable information into OPLANs. This assessment process results in better synchronization of the battlefield operating systems (BOS) such as fire support, intelligence, command and control, mobility, and survivability. The assessment of chemical vulnerability supports synchronization through improved preparedness for various contingencies such as chemical attacks, improved unit mobility through a more pragmatic approach to MOPP guidance, and improved tactical decision aids to support the commander's information needs.

The end product of the assessment process is information addressing the likely effects of enemy chemical attacks within an AO during specified time periods. This assessment can be conducted prior to or after enemy initiation of chemical warfare. Depending on the commander's concept and the needs of the staff, the assessment can be highly detailed or very brief such as a few lines of information. The assessment process addresses casualty effects estimates, times and locations vulnerable to chemical downwind hazards, chemical barriers, and persistency.

Conduct the assessment in two parts. First, make an estimate of the threat's capability to employ chemical munitions in our force's AO within a specific time period. Second, use this information to generate simplified effects information. The remainder of this second section provides detailed how-to information on how to conduct this analysis. See Figure 3-1 for an overview of the assessment process.

Estimate Delivery Capability

Determine time periods of interest. Time periods of interest are determined based on the commander's concept of the operation and the factors of METT-T. The time period of interest is determined by the chemical officer after coordination with the G2/G3 sections. They will normally conform to phases or the expected duration of an operation, however, it may often be desirable to use other criteria. For example, a light infantry unit may want to use the expected time lag between an anticipated enemy chemical attack and the needed arrival of their protective gear as the time period of interest. A time period could also be based on factors relating to enemy tactics: for example, the expected time of arrival of a second-echelon force. Further, significant weather changes could also influence the selection of time periods.

The time period of interest can range from 6 to 48 hours. The vulnerability assessment process is generally conducted in support of the planning process, and not in support of current operations. A brigade planning window usually focuses on a 12- to 48-hour period and as a rule, time periods of 24 hours or greater are generally used where possible based on the IPB. Time periods of less then six hours are usually not used. For short-term actions, shorter time periods could be used to estimate the effects of initial enemy preparation fires or to estimate the effect of a single chemical attack.

Associate weather data with each time. Associate each time period with a temperature, wind speed, and stability category. All required information can be obtained from the chemical downwind message (CDM). The CDM is generated every six hours and originates from corps and division NBCCs based on information obtained through the US Air Force Weather Service (AWS), SWO, or Fleet Weather Service.

Temperature will impact primarily on agent persistency. For each time period, temperature should be expressed as one of the following: 55°C, 50°C, 40°C, 30°C, 20°C, 10°C, 0°C, -10°C, -20°C, or -30°C. Determine temperature by taking the average of the temperatures from each CDM line applicable to the time period of interest. Use this average temperature for all calculations except for one condition. When estimating persistency for agents expected to last beyond the time period of interest, use the average daily temperature of the day in which the attack occurred.

Wind speed will impact on casualty production, persistency, and downwind agent travel. It should be expressed as one of the following: 3, 6, 9, 12, 15, or 18 kmph. As a rule of thumb, for any wind speed above 18 kmph, use 18 kmph. Calculate wind speed in the same manner you used above for temperature. In some situations it may be necessary to modify this number for casualty estimate purposes. For example, if a 24-hour period contains six hours of expected high wind speeds (very unstable conditions), you will probably elect to disregard those figures and

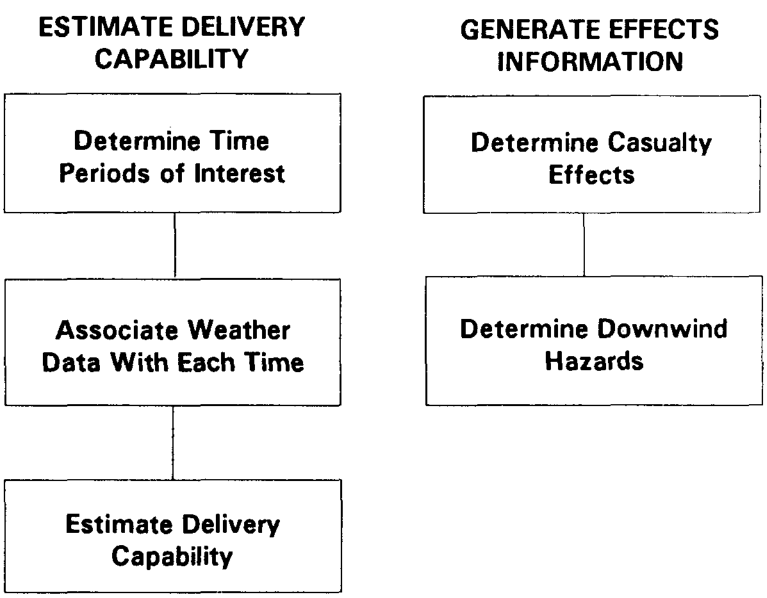

Figure 3-1. Overview of assessment process.

develop a separate (lower) average for casualty estimation. The chemical officer/NCO estimate that an enemy would not employ chemicals for casualty effects during that six-hour period of high winds. Base your decision on whether or not to do this on the magnitude and duration of the wind change and the expected enemy COA.

Stability categories also affect casualty production and downwind agent travel. However, their impact is minor compared to temperature and wind speed.

Expressed as stable (inversion), neutral, or unstable (lapse), determine the stability category in the same way as temperature and wind speed.

Other environmental factors exist that could impact on the assessment. For example, terrain and vegetation could affect the estimate. However, these factors have been incorporated in the persistency estimate process.

Estimate delivery capability. Estimate the number of chemical munitions likely to be employed in your AO for each time period. Coordinate with the S2/G2 to produce this estimate.

The chemical officer will provide the S2/G2 with the time periods of interest. The S2/G2 can, upon request, produce information concerning the threat's capability to deliver chemical munitions in your AO. The estimate should indicate the number of delivery units (by type) and the number of rounds by agent types if available. The S2/G2 also provides estimates on when, where, and what type of agent the enemy will use in your unit's AO. If the situation or event template does not yield needed information, assume that the enemy can optimize his agent mix. For example, to determine the threat's capability to create contamination barriers, we assume they will fire all persistent agents. Likewise, to predict casualty effects, assume that the enemy will fire agents that have the greatest casualty-producing effects.

When the primary threat is covert or unconventional, express enemy delivery capability in terms of agent weight or as agent weight times some expected delivery means: for example, 20—5KG HD field-expedient land mines.

If threat estimates indicate limited agent supply, it will be difficult to estimate how much of that supply will be used each day. As an option for this situation, conduct the assessment for a single enemy attack based on the threat's maximum employment capability during the selected time period.

The S2/G2 will consider a number of factors in making his estimate:

- The number of employment assets within range of your unit.
- Other AOS the enemy force must service. Do not assume that every delivery system within range will be firing into your AO.
- The locations of enemy chemical munitions.
- Threat forces' capability to deliver chemical munitions to the firing units.
- Impact of threat attach on civilians.

The S2/G2 estimate should provide a range of numbers based on estimated threat COA for each time period. For example, the estimate should provide the enemy's maximum capability and its likely delivery capability. Alternatively, different estimates can be provided that would support various enemy COA. Estimates should not be based on friendly COA unless they would significantly impact on enemy delivery capability. It is not necessary to assess every possible situation and enemy option. To do so would result in inefficient use of available time. The goal is to provide estimates to the commander and staff, which can be later refined. Continuously assess the situation and look for events and options with the potential of changing the outcome of the battle.

Generate Effects Information

At this point you have a set of time period/munition delivery estimate combinations. For each of these combinations you can now develop a set of effects information: casualty estimates, contamination barriers, persistence, and times and locations of downwind agent effects. Effects information will provide the following estimates:

- Casualty effects (ten 100-meter by 200-meter targets can be attacked so that troops masking within 15 seconds will suffer 10 percent casualties).
- Contamination barriers (four 200-meter by 400-meter areas can be contaminated to a level sufficient to prevent crossing).
- Persistence (a particular contaminated area can be crossed in mask and summer uniform in four hours; it may be occupied in summer uniform, possibly without mask, in nine hours).
- Downwind agent effects. Subdivide each time period of interest into phases that correspond to specific chemical downwind hazard effects estimates likely to occur during that phase. These procedures do not address the effects of specific attacks. These procedures assist units in determining (based on their AO and weather information) periods of high or low risk from chemical attack. To determine the effect of a specific attack, refer to FM 3-3.

The procedures are brief, unclassified, and generic with respect to both agent type and delivery system. They were designed for use by multiple theaters and levels of command and for applicability across the entire operational continuum.

Determine casualty effects. Tables 3-1, 3-2, and 3-3 provide casualty estimates as a function of temperature and agent delivered expressed in kilograms per hectare (kg/ha). They are valid for wind speeds less than 20 kmph. Other factors such as air stability category, humidity, variations in wind speeds under 20 kmph, and delivery errors were found to have a minimal effect on casualty estimates for a given time period of hours as opposed to a specific instance in time. Figure 3-2 outlines the procedures for determining casualty estimates.

Step 1. Determine the target size of interest.

a. Based on IPB, select a target(s) that an enemy would target and then determine target size. For example, determine the area occupied by a maneuver company in a defensive position. Use intelligence data concerning enemy targeting methods and priorities at this point. For example, if it is known that our infantry companies are treated as a 400 x 600 meter target by the enemy, then that is the target size that should be used.

b. Calculate the number of hectares in the target size of interest. For example:

Given: 1 hectare (ha) = 10,000 meters square

Target size = 400 meters x 600 meters = 240,000 meters square

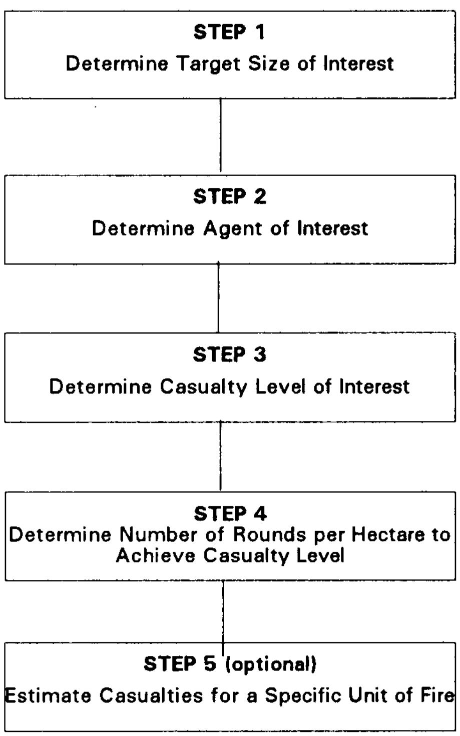

Figure 3-2. Steps in determining casualty estimates.

Determine the number of hectares in the target area.

$$\text{Number of hectares in the target area} = \frac{240{,}000\text{m}^2}{10{,}000\text{m}^2} \quad 24$$

Number of hectares in the target area = 24ha

Step 2. Determine agent of interest. The nerve agent table (Table 3-1) is based on a 15 liter per minute breathing rate (rest or light work) and a 15-second masking time. For TGD or VX, the persistent agent table (Table 3-2) is based on MOPP level zero. At higher MOPP levels (for example, MOPP levels 1 to 4), TGD and VX are not effective casualty producers because of the skin protection provided by the overgarment. The blister agent table (Table 3-3) applies to all blister agents. Table 3-3 is based on either MOPP level zero or 1.

Unless it is known which agents the threat will fire, assume that the most effective casualty-producing agent in the threat stockpile will be used. For example, if an enemy can use GB, TGD, or VX, assume the threat will use GB. If the threat has both GB and HD, assume they will use GB.

Step 3. Determine casualty level of interest. Estimate threat courses of action and intent. Coordinate with the S2/G2 to estimate whether the threat attacks would intend to destroy, suppress, or harass our forces. Casualty level of interest estimates using percentages such as 25 percent or 30 percent (suppression) provide an example of this step's application.

Note: Soviet categories of target damage include-

- Destruction. A destroyed target has completely lost its combat effectiveness. A point target is considered destroyed when there is a 90 percent probability that it has suffered serious casualties or damage. An area target is considered destroyed when it is highly probable (90 percent) that no less than 50 percent of the target's subelements (including personnel) or no less than 50 percent of the target area have suffered serious casualties or damage.
- Suppression. A suppressed target has suffered sufficient damage or casualties to lose its combat effectiveness temporarily or to restrict its ability to maneuver or effect command and control. An area target is considered to be suppressed when it is highly probable (90 percent) that no less than 25 to 30 percent of the target's subelements or 25 to 30 percent of the target's area or personnel have suffered serious damage or casualties.
- Harassment. Harassment fire is conducted sporadically to prevent troop movement in the open and to lower the morale of the enemy.

Table 3-1. GB nerve agent casualties.						
Munitions in Rounds per Hectare			Temperature °F			
BM-21/ha	152mm/ha	122mm/ha	10	32	50	68
1	2	4	10%	16%	24%	33%
2	4	7	14%	22%	30%	40%
3	6	10	19%	27%	37%	47%
4	8	14	25%	34%	43%	54%
4	10	17	31%	40%	50%	60%
			Casualty Percentage			

Table 3-2. TGD or VX nerve agent casualties.							
Munitions in Rounds				Temperature °F			
Msl/1000ha	Msl/150ha	Bombs/1000ha	Bombs/150ha	10	32	50	68
6	1	26	4	5%	14%	20%	21%
9	2	40	6	8%	18%	25%	25%
12	2	54	8	12%	24%	31%	31%
15	2	68	10	16%	28%	36%	36%
18	3	80	12	19%	32%	40%	41%
21	3	94	14	21%	35%	42%	43%
24	3	106	16	23%	37%	44%	45%
				Casualty Percentage			

Table 3-3. THD blister agent casualties.			
Munitions in Rounds		Protective Posture	
152 mm/ha	122 mm/ha	MOPP zero	MOPP 1
4	7	17%	13%
7	14	24%	18%
11	20	34%	23%
14	27	43%	28%
18	33	51%	32%
21	40	57%	36%
		Casualty Percentage	

Step 4. Determine the number of rounds required to achieve the desired casualty level.

a. Assume MOPP zero for all calculations unless otherwise indicated.

b. Refer, at this point, to Tables 3-1, 3-2, or 3-3. Locate the appropriate temperature and read down until you reach a casualty figure higher then the determined casualty level of interest. Read to the left to find the number of rounds per hectare required to produce that casualty level.

c. Multiply the number of rounds per hectare by the number of hectares in the target. For example:

Given: Casualty level wanted is 30%.

Target size = 24 ha

Present temperature is 50°F

From Table 3-1, extract the following information:

Casualty level = 37%

Weapon system = 152mm

Agent = GB

Rounds per hectare = 6 rds

Rounds required per ha x total number hectares in the target is equal to total number of rounds required: for example, 6rds/ha x 24ha = 144rds.

To achieve greater than 30 percent casualties on the target, the enemy would have to fire 144 rounds of 152-mm artillery.

Note: THD is effective at temperatures down to -30°C (-20°F).

Step 5 (optional). Estimate casualties produced by a specific unit of fire.

a. If intelligence analysis indicates the enemy will engage a specific target with a specific number of rounds, calculations can be performed to estimate the expected casualties on the target. For example:

Required: Determine casualty percentage based on a specific unit of fire for persistent nerve agents.

Given: Target area = 24ha

Agent = GB

Temperature = 50°F

Weapon = 152-mm artillery

Intelligence estimates the enemy will fire 240 rounds at a friendly target. Determine the number of rounds per hectare for the desired casualty effect.

(1) $\frac{\text{No. of rds}}{\text{target area}} = \frac{240\text{rds}}{24\text{ha}} = 10\text{rds/ha}$

(2) Using Table 3-2, find 10rds/ha and read right to find the casualty percentage based on the 50°F temperature.

Casualty percentage = 50%

b. To determine blister agent casualties, use the same procedures as described before and Table 3-3. However, when reading right to determine casualty percentage, use MOPP zero or 1 rather than temperature.

The above procedures depict an estimated enemy capability to attack a target and/or estimate of casualties if the attack occurred. To estimate the duration of hazards resulting from an enemy attack, see the section on MOPP open/unmasking guidance.

Determine downwind hazards. The purpose of this section on vulnerability assessment is to identify times and locations of vulnerability or relative safety from downwind hazards during a designated time period. Use the CDM as your basic tool during this process. Also use the IPB weather and terrain analysis to determine such things as prevailing winds and type of terrain. This assessment does not focus on specific chemical attacks but identifies potential times and locations of high or low risks from chemical attacks. Hazard prediction for specific chemical attacks is contained in FM 3-3.

Two primary hazards result from downwind agent travel, casualties, and degradation. Downwind agent travel can affect large portions of the force due to the triggering of alarm systems. Activation of alarm systems will cause units to mask. Degradation effects are also enhanced by large area coverage of chemical agent concentrations.

Casualties resulting from downwind hazards should be very few, assuming units make proper use of alarm and warning systems. For the vulnerability assessment, use the CDM to determine whether your unit would fall into one of the following three conditions (see FM 3-6 for stability categories):

High casualty risk. This occurs at wind speeds of 10 kmph or less during stability categories of 5 to 7 (Table 3-4). Agent clouds will produce very narrow, 1 to 4 kilometers wide at 30 kilometers distance, and very long, beyond 20 kilometers, hazard clouds. Dosages over 100 times the lethal levels are possible in the hazard area. Because the cloud is narrow and hugs the ground, it may bypass alarms deployed for area defense. Units located close to the attack mask once they are warned since the potential dosages are too high to be completely mitigated by unit alarm systems. Units further away can be warned only and stand a good chance of being unaffected.

Table 3-4. Atmospheric stability categories.

Stability Category	Atmospheric Description
1	Very Unstable
2	Unstable
3	Slightly Unstable
4	Neutral
5	Slightly Stable
6	Stable
7	Extremely Stable

High degradation risk. This occurs during stability categories of 4 or less and wind speeds less than 10 kmph. Agent clouds will produce wide hazard areas, 2 to 7 kilometers wide at 6 kilometers distance, with lethal effects rarely extending as far as 10 kilometers. The casualty risk to warned, unmasked personnel is low. However, due to the large cloud width it is possible for every unit in the downwind hazard area to be forced to mask for several hours. Alarms may be triggered at distances of 20 to 30 kilometers away.

Low casualty risk. This occurs at wind speeds of 10 kmph or greater at stability category 4 or less. The casualty risk is very low outside the area of immediate effects (see FM 3-3 for downwind hazard prediction). A significant number of units will be forced to mask; however, this effect will be short lived and will not extend as far as in the previous category (2 to 7 kilometers).

The example on the next page shows how all the information obtained can be incorporated into the assessment. Other information can be included and will be discussed later in the chapter. This is only an example and can be modified to best suit the using command.

Standard MOPP Gear and Field-Expedient Items

Standard MOPP gear is used as the primary protection means against liquid droplets. However, field-expedient items such as ponchos and rain jackets also can provide initially (for a period of only minutes) adequate protection against the initial casualty effects of the liquid droplet component of a chemical agent attack. If the following two conditions are met, then casualties resulting from the chemical attack will be less than an equivalent conventional attack:

- Soldiers are at MOPP1 or wearing a field-expedient covering that covers all exposed skin except the face, hands, and feet. This field-expedient covering must be disposed of within 20 minutes.
- Units take protective action against chemical agent vapor by immediately masking.

While effective in protecting against initial liquid

CHEMICAL VULNERABILITY ASSESSMENT		
1) 240600Z to 252400Z	July 90-------70°F	3kmph--neutral(4).
2) 240600Z to 260600Z	July 90-------70°F	6kmph--neutral(4).
ENEMY CAPABILITY		
	COA 1	COA 2
	3000rds of 122mm GB/HD 1500rds of 152mm GB/HD 36 bombs 60KG HD	5000 rds of 122mm GB/HD 2500 rds of 152mm GB/HD 54 bombs 60KG HD
Casualties:		
Inf Co. 400x600m area 30% casualties number of munitions required per hectare	17rds/ha-122mm(168rds 15rds/ha-152mm(96rds) 3-bombs/ha 60KG	29rds/ha-122mm(168rds) 26rds/ha-152mm(96rds) 4-bombs/ha 60KG
Barriers:		
HD 200x400m 2 hrs duration	16-122mm(180rds) 16-152mm(92rds) 9-bombs 60KG	27-122mm(180rds) 27-152mm(92rds) 13-bombs 60KG
Downwind hazard:		
240600Z to 240900Z 241000Z to 241300Z 241400Z to 242000Z 242100Z to 250400Z 250500Z to 252100Z 252200Z to 260600Z	high degradation risk low casualty risk high degradation risk high casualty risk high degradation risk low casualty risk	
NOTE: 241000Z to 241700Z--Units at heavy work rates ineffective after 2 hours in MOPP3 or 4. 251100Z to 251600Z--Units at moderate work rates ineffective after hours in MOPP3 or 4		

effects, field-expedient items are inadequate if an enemy force engages in sustained chemical warfare. Field-expedient items do not allow units to fight dirty or operate in a contaminated environment for extended periods of time. Soldiers will suffer higher sublethal agent dosages if they remain in field-expedient gear too long. Field-expedient overgarments cause significant degradation to our soldiers (for example, heat stress). Operating for long periods while in field-expedient items also greatly increases the risk of the soldier becoming a chemical casualty.

Field-expedient protective gear provides short-term protection. If the threat assessment indicates low risk of chemical agent use, field-expedient protection gear readily available provides a limited backup for the overgarment. Field-expedient items must be quickly replaced by overgarments when the threat assessment indicates the enemy has the capability to employ chemical weapons. The use of field-expedient items is an option during the period between enemy first use and delivery of standard MOPP equipment to subordinate units. However, if a unit is attacked with chemicals, the delay in the receipt of MOPP gear would result in unacceptable casualties to unit personnel. Field-expedient gear could also be used during periods of sporadic small scale chemical attacks or when standard MOPP equipment has been expended.

Use of NBC Reconnaissance Assets

Battalion and higher units use NBC recon and chemical agent alarms as a part of the IPB process and for unit operations.

The chemical officer assists the S2/G2 in developing NAIs that relate to enemy chemical attacks. Based on threat doctrine, likely chemical targets can be identified that support various threat COA.

For example, a brigade identifies potential avenues of approach. For each of these avenues of approach, likely threat countermeasures are identified. Threat doctrine calls for potentially restricting the use of lateral routes with chemical barriers to preclude our timely movement of forces. Also, the detection of chemical barriers along one of our avenues of approach can indicate that the threat could be trying to channelize our forces.

Identification of NAIs along routes for potential chemical attacks helps determine enemy intentions and speeds our response to threat chemical attacks. If a chemical attack was reported in such an NAI, our force could send recon assets to determine the extent of the contamination and identify bypasses if necessary. Decontamination, engineer, or smoke assets can be dispatched to assist in reducing and concealing the obstacle. Finally, the commander can be alerted that his counterattacking force may be delayed in reaching its attack position, possibly requiring him to begin his movement earlier than desired.

Monitor NAIs with a combination of chemical alarms and units (chemical units) in the area. Units in these areas should report the occurrence of chemical attacks or of large scale artillery barrages that impact in their vicinity. Position chemical alarms at key points along the route to cover areas not occupied by units. If an area cannot be continuously monitored, dispatch NBC reconnaissance assets to the area once the threat reaches an NAI that indicates they are committing to a certain avenue of approach.

Consideration is given to area defense against downwind vapor hazards. For example, threat chemical attacks may occur upwind of your unit. By remaining aware of unit situations and weather data, you can determine whether your unit is at a low or high risk (see FM 3-3, CDMs).

To devise a plan, conduct a map reconnaissance to determine likely wind patterns based on the terrain and wind direction. Locate troop concentrations upwind where an enemy can deliver chemical munitions. Select a line between these two locations. Verify the wind directions in this area by a survey of units in the area. Finally, position some means of detection along this line.

Casualty Estimation

The S1/G1 assesses the probability and impact of chemical-related casualties. This assessment addresses whether a net increase in casualties will result from enemy chemical use.

Liquid chemical attacks, artillery or bomb, on our units (see figure 3-3) will create an uneven spread of contamination. Some portions of the targeted area will not receive any contamination. Applying the NBC defense principles of contamination avoidance, protection, and decontamination for our units provides several benefits. Using contamination avoidance techniques and procedures to disperse, harden, or camouflage friendly positions decreases vulnerability. Use of active measures such as NBC reconnaissance and NBC warning and reporting provides detection and identification to determine the presence of clean or contaminated areas. Units maximize use of NBC protection for key facilities and personnel, prioritize use of NBC collective Protection capabilities. Units cover selected high priority stocks and establish priorities for decontamination efforts.

If units are wearing protective gear and masks according to doctrine, then no net increase in casualties should result due to threat indirect fire. However, increased casualties will result from the following:

- Units in MOPP3 or MOPP4 are less effective in force-on-force battles. This effect is most pronounced if the enemy operates in an undegraded posture. Increased direct fire casualties will probably also result from this degradation.
- Soldiers operating in contaminated areas will make errors, thereby increasing their risk of becoming casualties.
- Increased heat stress casualties can occur. If units in MOPP3 or MOPP4 are worked past the endurance limits (described in Chapter 2), heat casualties are likely. With proper precautions, heat stress should be kept to a minimum.
- Psychological casualties are likely to increase because of encapsulation.

Soldiers may show symptoms associated with chemical agents, such as a runny nose and eye irritation, and believe it is a result of chemical agents.

The effects of the above factors are difficult to predict without the benefit of combat experience.

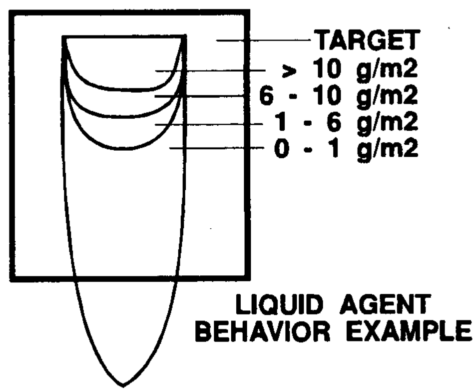

Figure 3-3. Percent target coverage.

Chemical Overgarment Risk Assessment

Leaders conduct MOPP analysis to determine what protection level (e.g., MOPP 0, MOPP1, etc) should be used. Decisions are made based on an analysis of mission, threat, and the risk a commander is willing to accept. For example, some commanders in Southwest Asia during Operation Desert Shield made an initial decision that their units should go to MOPP1 and don their initial set of contingency overgarments. Subsequently, they had to decide when to replace these materials, or vehicle parts. Chemical contamination may be detected initially when using chemical detectors. Remember, going to MOPP open or unmasking is a command decision.

MOPP Open Procedure

MOPP open is used to reduce heat stress and prolong soldier endurance when in MOPP3 or MOPP4. MOPP open is used if the vapor on skin has decreased to the ICT5 risk level, but the inhalation and/or liquid-on-skin risk remains above ICTS. The worst case MOPP open times are given in Tables 3-6, 3-9, 3-11, 3-12, 3-14, and 3-16. Local weather conditions may permit going to MOPP open sooner.

Procedure With CAM

Designated personnel must survey the suspected contaminated area with the CAM. Since the CAM is designed as a point detector, multiple readings must be taken in and around the unit area. Select areas for sampling that were most heavily contaminated during the attack or low-lying areas where agent vapor may linger. If CAM readings are three bars or less, go to MOPP open. If personnel show any signs of chemical agent poisoning, they should go to MOPP4. If meteorological conditions change, use the CAM to recheck the unit area as described above. See Table 3-5 for allowable MOPP open times based on CAM readings.

Procedure Without CAM

Designated personnel must check the area for vapor hazard using the M256-series chemical agent detector kit. If M256 testing indicates a positive reading for blister or nerve agent, going to MOPP open may exceed the ICT5 risk level. MOPP open should not be used due to the vapor-on-skin ICT5 risk unless mission accomplishment is jeopardized. If the M256 results provide a negative reading, initiate action to go to MOPP open and unmasking procedures. If unit personnel show any symptoms of chemical agent poisoning, go to MOPP closed.

Using Worst Case MOPP Open/Unmasking Time Tables

The information in the tables provides planning estimates for unmasking and MOPP open times for chemical agents GA/GF, HD, VX and TGD. The worst case unmasking times are given in Tables 3-7, 3-10, 3-13, 3-15 and 3-17. Tables 3-8 and 3-11 are a combination of MOPP open/unmasking times. Figure 3-5 depicts a MOPP open/unmasking decision flow chart for commanders to use with the MOPP analysis process. The times in the tables assume constant weather conditions. If the weather condition changes, use the following procedures to update time estimates:

- Read the worst case time from the current weather conditions directly from the appropriate table. Keep track of how long the current conditions last until the next weather update.
- When weather conditions change, determine the percentage of the original worst case time remaining (remaining time divided by original time).
- Determine the new worst case time for the new weather conditions.
- Multiply percent of original worst case time remaining by the new worst case time. The results are the updated worst case time.

Example

a. The contamination is HD on sand with initial weather conditions of 90, unstable temperature gradient, and 0-10 kmph wind speed. From Table 3-10 (Sand) the worst case unmasking time is 53 hours.

b. Two hours later the weather changes to a higher wind speed, 11-24 kmph. Percent worst case unmasking time remaining is (53-2)/53 = 0.96.

c. From table 3-10, the worst case unmasking time for the new weather conditions is 25 hours.

d. The updated worst case unmasking time is 25 x 0.96 = 24 hours.

e. After another six hours, the weather changes to 100^{0}F, neutral temperature gradient, and 0-10 kmph wind speed. Percent worst case unmasking time remaining is (24-6)/24 = 0.75.

f. From Table 3-10, the worst case unmasking time for the new weather conditions is now 48 hours.

g. The updated worst case unmasking time is 48 x 0.75 = 36 hours.

h. Repeat the above procedures whenever the weather changes until the hazard is gone or the unit moves away from the contamination hazard.

Formula Procedure

a. Variables.

P = Percent of worst case time remaining
O = Original worst case time from table
N = New worst case time from table
T = Time between original estimate and weather change
U = Updated worst case time

b. Procedure.

(1) Read O directly from table.
(2) Weather change:
P=(O-T)/O ←
U=PxN
Weather changes again:
Set 0 = U
Set T = time since last weather change
Repeat as required ——

group of individuals. Symptoms associated with the ID for a blister agent would include redness, pain and swelling, but no blisters. Symptoms associated with an ID for a nerve agent would include pinpointing of the eye pupils (miosis), dimness of vision, loss of night vision, excessive sweating, runny nose, nausea; headache, tightness in the chest, and shortness of breath.

NOTE: The ID indicated above provides an estimate of the risk of incapacitation to a group of warned/protected individuals from a liquid agent in a targeted area.

CPOG Risk Assessment.

Extending the wear of the CPOG beyond 14 days is an option for the commander, but insufficient information is available from testing to provide an estimated risk of injury or incapacitation associated with extending CPOG wear beyond 14 days. The heavy impregnation of charcoal in the lining of the CPOG serves to continue to provide protection for the soldier against exposure to liquid chemical agents. The chemical protection provided by the CPOG is superior to that provided by any other type of field expedient protection such as wet weather gear.

In summary, the BDO and CPOG are both well designed effective garments, but the preferred chemical overgarment for use is the BDO. The BDO's improved design and capabilities enhance the protection offered to the soldier.

DAYS OF WEAR	RISK OF INJURY
<30	Negligible
>30	30 (approx 5%)
>45	45 (approx 10%)
>60	60 (1 5%)

Figure 3-4 BDO Risk Assessment.

MOPP Open/Unmasking Guidance

The information in this section is intended to assist the commander, staff, and chemical staff officer/NCO in NBC defense planning efforts concerning MOPP open/unmasking times for agents GA/GF, GD, GB, and HD at high temperatures. Specifically, it provides chemical officers and NCOs a means of estimating the allowable MOPP open times based on CAM readings and the worst case length of time a unit may have to remain in MOPP closed and/or masked. The term MOPP open, as mentioned in Chapter 2, means opening (at MOPP 3/4) the overgarment jacket and rolling the protective mask hood for ventilation to decrease soldier heat stress. The term MOPP closed involves the use of till protection at MOPP4. Additionally, the tables serve as a tool for commanders and staffs to use in conjunction with MOPP open or unmasking procedures. Furthermore, the information in the tables may be used to support commanders' decisions on weighing the risk of chemical casualties against degradation due to time in MOPP. These charts should be used in conjunction with the MOPP analysis process and the commander's judgment on how well his soldiers can tolerate degradation in MOPP4. Following are examples:

Table 3-5. Allowable MOPP open times.

	(HOURS)			
	CAM BARS			
AGENT	1	2 - 4	5 - 7	8
G	IND	167	17	MOPP4
H	IND	7.5	1.5	MOPP4

Notes:
1. IND—Indefinite, negligible vapor-on-skin hazard.
2. Allowable MOPP open time means the length of time the MOPP suit can be left opened with the given CAM reading and still not exceed 5 percent incidence of incapacitation due to vapor on skin.
3. Remember that the CAM will only tell whether a G-series nerve agent or H-series blister agent is present. It does not identify the specific type of agent, such as GA, GF, or HD.

If the tables indicate an agent will take too long to weather, based on the commander's estimate of his unit's ability to fight degraded, he may consider moving to a clean area and/or request decontamination. If contamination is encountered, he may use the tables to support his decisions on whether to go through or bypass the contaminated area.

The worst case times in the charts are based on the highest contamination levels from a threat use of chemical weapons and bare skin exposure toxicity data. An attacked unit area will most likely have lower levels of contamination, and most soldiers will be wearing some clothing beneath their BDOS. The worst case times given in this section are upper time limits. Periodic monitoring will provide feedback on when the hazard in a particular area has weathered enough to allow MOPP open and/or unmasking. The estimates in these tables are based on the time required for a given agent to weather to an acceptable risk level that is no more than 5 percent incident of mild incapacitation due to vapor on skin and/or inhalation if soldiers open MOPP and/or unmask at the stated time. This risk level is abbreviated as ICT5.

Safety

Based on the MOPP status currently in effect, the MOPP level may have to be upgraded if soldiers undertake tasks that may disturb such things as soil, materials, or vehicle parts. Chemical contamination may be detected initially when using chemical detectors. Remember, going to MOPP open or unmasking is a command decision.

MOPP Open Procedure

MOPP open is used to reduce heat stress and prolong soldier endurance when in MOPP3 or MOPP4. MOPP open is used if the vapor on skin has decreased to the ICT5 risk level, but the inhalation and/or liquid-on-skin risk remains above ICT5. The estimated wait time before executing MOPP open procedures are given in hours at the ICT5 risk level on Tables 3-6 through 3-17. Local weather conditions may permit going to MOPP open sooner.

Procedure With CAM

Designated personnel must survey the suspected contaminated area with the CAM.. Since the CAM is designed as a point detector, multiple readings must be taken in and around the unit area. Select areas for sampling that were most heavily contaminated during the attack or low-lying areas where agent vapor may linger. If CAM readings are three bars or less, go to MOPP open. If personnel show any signs of chemical agent poisoning, they should go to MOPP4. If meteorological conditions change, use the CAM to recheck the unit area as described above. See Table 3-5 for allowable MOPP open times based on CAM readings.

Procedure Without CAM

Designated personnel must check the area for vapor hazard using the M256-series chemical agent detector kit. If M256 testing indicates a positive reading for blister or nerve agent, going to MOPP open may exceed the ICTS risk level. MOPP open should not be used due to the vapor-on-skin ICT5 risk unless mission accomplishment is jeopardized. If the M256 results provide a negative reading, initiate action to go to MOPP open And unmasking procedures. If unit personnel show any symptoms of chemical agent poisoning, go to MOPP closed.

Using Worst Case MOPP Open/Unmasking Time Tables

The information in the tables provides planning estimates for unmasking and MOPP open times for chemical agents GA/GF, HD, GB, VX and GD. The worst case unmasking times are given in Tables 3-7, 3-10, 3-13, 3-15 and 3-17. Tables 3-8 and 3-11 are a combination of MOPP open/unmasking times. Figure 3-5 depicts a MOPP open/unmasking decision flow chart for commanders to use with the MOPP analysis process. The times in the tables assume constant weather conditions. If the weather condition changes, use the following procedures to update time estimates:

- Read the worst case time from the current weather conditions directly from the appropriate table. Keep track of how long the current conditions last until the next weather update.
- When weather conditions change, determine the percentage of the original worst case time remaining (remaining time divided by original time).
- Determine the new worst case time for the new weather conditions.
- Multiply percent of original worst case time remaining by the new worst case time. The results are the updated worst case time.

Example

a. The contamination is HD on sand with initial weather conditions of 90, unstable temperature gradient, and 0-10 kmph wind speed. From Table 3-10 (Sand) the worst case unmasking time is 53 hours.

b. Two hours later the weather changes to a higher wind speed, 11-24 kmph. Percent worst case unmasking time remaining is (53-2)/53 = 0.96.

c. From table 3-10, the worst case unmasking time for the *new* weather conditions is 25 hours.

d. The updated worst case unmasking time is 25 x 0.96 = 24 hours.

e. After another six hours, the weather changes to 100°F, neutral temperature gradient, and 0-10 kmph wind speed. Percent worst case unmasking time remaining is (24-6)/24 = 0.75.

f. From Table 3-10, the worst case unmasking time for the new weather conditions is now 48 hours.

g. The updated worst case unmasking time is 48 x 0.75 = 36 hours.

h. Repeat the above procedures whenever the weather changes until the hazard is gone or the unit moves away from the contamination hazard.

Formula Procedure

a. Variables.

P = Percent of worst case time remaining
O = Original worst case time from table
N = New worst case time from table
T = Time between original estimate and weather change
U = Updated worst case time

b. Procedure.

(1) Read 0 directly from table.

(2) Weather change:

P (O - T)/O ←
U P x N
Weather changes again:
Set 0=U
Set T = time since last weather change
Repeat as required

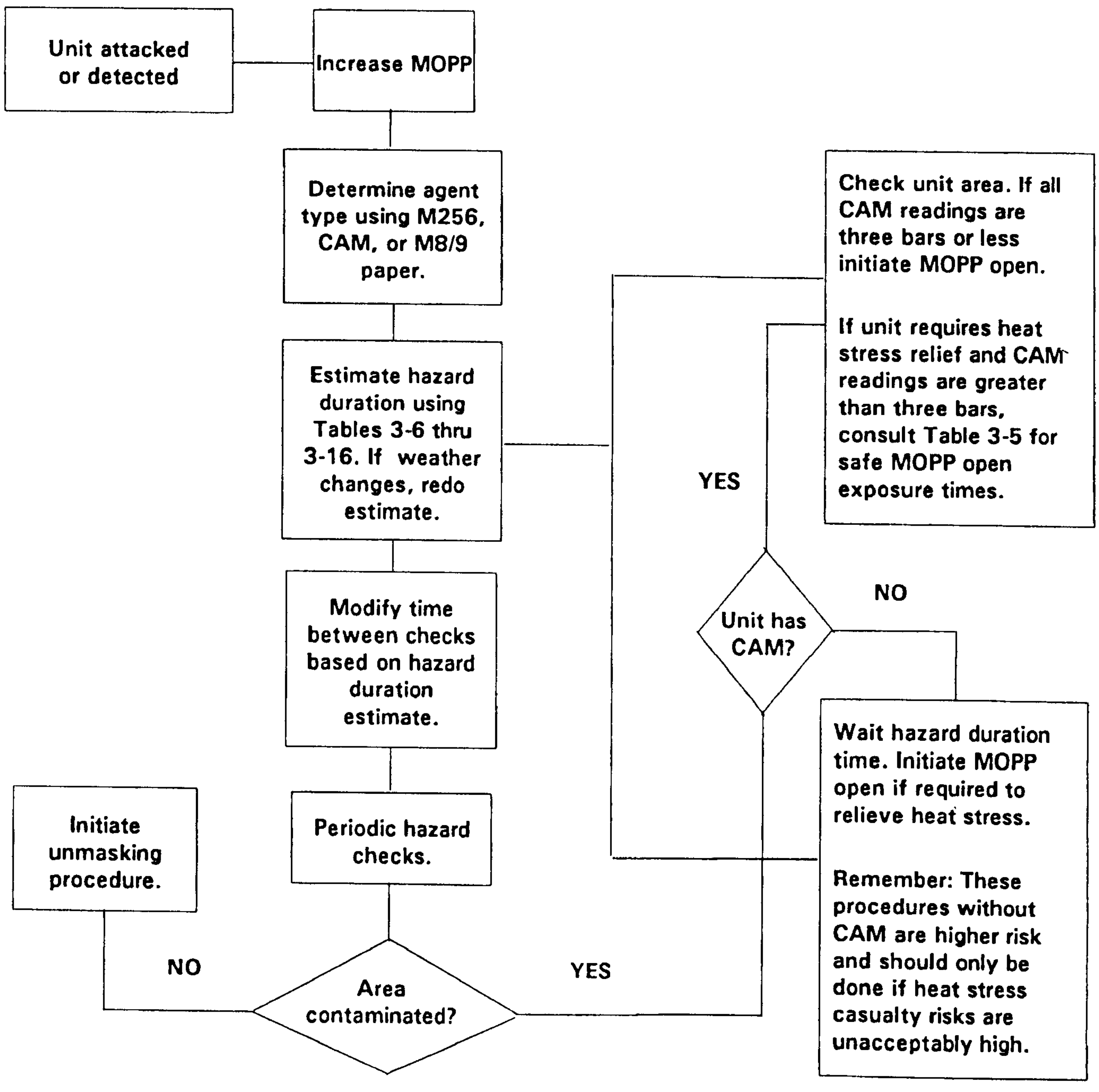

Figure 3-5. Unmasking/open MOPP action/decision flow chart

Table 3-6. Estimated wait times before executing MOPP open procedures (ICT5 Risk Level).

AGENT: GA/GF
TERRAIN: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	60+	53	33	20	13	10	8	5
	NEUTRAL	60+	60+	45	28	18	13	8	5
	STABLE	60+	60+	58	38	23	15	10	8
11-24	UNSTABLE	13	8	5	3	3	2	2	2
	NEUTRAL	20	13	8	5	5	3	2	2
	STABLE	20	13	8	5	5	3	2	2
> =25	NEUTRAL	2	2	2	2	2	2	2	2

Notes:
1. Worst case MOPP open time—information in the table indicates the time for GA/GF to weather below 5 percent incidence of incapacitation due to vapor-on-skin effects. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap MOPP clothing; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. To get times for grass terrain, multiply numbers in the chart by 0.4. DO NOT INTERPOLATE!
4. See FM 3-6 for definition of stability categories.

Table 3-7. Estimated wait times before executing unmasking procedures (ICT5 Risk Level).

AGENT: GA/GF
TERRAIN: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	60+	60+	60+	55	35	25	15	13
	NEUTRAL	60+	60+	60+	60+	45	30	20	13
	STABLE	60+	60+	60+	60+	55	35	23	15
11-24	UNSTABLE	60+	60+	60+	38	23	15	10	8
	NEUTRAL	60+	60+	60+	43	28	18	13	10
	STABLE	60+	60+	60+	45	30	20	13	10
> =25	NEUTRAL	60+	60+	35	23	15	10	8	5

Notes:
1. Worst case unmasking time—information in the table indicates the time for GA/GF to weather below 5 percent incidence of incapacitation due to inhalation. DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. To get times for grass terrain, multiply numbers in the chart by 0.4. DO NOT INTERPOLATE!
3. See FM 3-6 for definition of stability categories.

Table 3-8. Estimated wait time before executing MOPP open/unmasking procedures (ICT5 Levels).

AGENT: GA/GF
SURFACE: CARC
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	1.25	0.75	0.50	0.25	0.25	0.25	0.25	0.25
	NEUTRAL	1.50	1.0	0.50	0.50	0.25	0.25	0.25	0.25
	STABLE	1.50	1.0	0.50	0.50	0.25	0.25	0.25	0.25
11-24	UNSTABLE	0.75	0.50	0.25	0.25	0.25	0.25	0.25	0.25
	NEUTRAL	0.75	0.50	0.25	0.25	0.25	0.25	0.25	0.25
	STABLE	1.0	0.50	0.50	0.25	0.25	0.25	0.25	0.25
> =25	NEUTRAL	0.50	0.50	0.25	0.25	0.25	0.25	0.25	0.25

Notes:
1. Worst case MOPP open/unmasking time—information in the table indicates the time for GA/GF to weather below 5 percent incidence of incapacitation due to vapor on skin and inhalation. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES! DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap suit; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
4. If soldiers are working on vehicles, avoid skin contact with the vehicles.
5. See FM 3-6 for definition of stability categories.
6. For planning, ensure the following steps are taken:
a. Remove as much earth and debris as possible from the CARC painted surface and conduct operator spraydown.
b. Above times are estimated weathering times for CARC painted surfaces; confirm contamination-free status by using detection devices before MOPP reduction.
c. If possible, move uncontaminated equipment from the contaminated area.
d. Anything not painted with CARC (such as concrete, plastics, and weapons) must be individually checked for contamination.

Table 3-9. Estimated wait times before executing MOPP open procedures (ICT5 Risk Level).

AGENT: HD
TERRAIN: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	60+	60+	60+	60+	48	32	23	15
	NEUTRAL	60+	60+	60+	60+	60+	43	28	20
	STABLE	60+	60+	60+	60+	60+	58	38	25
11-24	UNSTABLE	60+	60+	43	28	18	13	8	5
	NEUTRAL	60+	60+	60+	38	25	18	10	8
	STABLE	60+	60+	60+	40	28	18	13	8
> =25	NEUTRAL	33	20	13	8	5	5	3	3

Notes:
1. Worst case MOPP open time—information in the table indicates the time for HD to weather below 5 percent incidence of incapacitation due to vapor-on-skin effects. To get times for grass terrain, multiply the numbers in the chart by 0.4. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap MOPP clothing; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
4. See FM 3-6 for definition of stability categories.

Table 3-10. Estimated wait times before executing unmasking procedures (ICT5 Risk Level).

AGENT: HD
TERRAIN: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	60+	60+	60+	60+	53	35	23	18
	NEUTRAL	60+	60+	60+	60+	60+	48	33	23
	STABLE	60+	60+	60+	60+	60+	60+	45	28
11-24	UNSTABLE	60+	60+	58	38	25	15	10	8
	NEUTRAL	60+	60+	60+	50	33	23	15	10
	STABLE	60+	60+	60+	53	35	23	15	10
>=25	NEUTRAL	53	33	20	13	8	5	5	3

Notes:
1. Worst case unmasking time—information in this table indicates the time for HD to weather below 5 percent incidence of incapacitation due to inhalation. To get times for grass terrain, multiply numbers in the chart by 0.4. DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
3. See FM 3-6 for definition of stability categories.

Table 3-11. Estimated wait time before executing MOPP open/unmasking procedures (ICT5 Levels).

AGENT: HD
TERRAIN: CARC
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	11	7	5	3	2	2	1	1
	NEUTRAL	12	8	5	4	2	2	1	1
	STABLE	13	8	5	4	2	2	1	1
11-24	UNSTABLE	7	5	3	2	2	1	1	1
	NEUTRAL	8	5	3	2	2	1	1	1
	STABLE	8	5	3	2	2	1	1	1
>=25	NEUTRAL	5	3	2	1	1	1	1	1

Notes:
1. Worst case MOPP open/unmasking time—information in this table indicates the time for HD to weather below 5 percent incidence of incapacitation due to vapor on skin and inhalation. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES! DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap suit; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
4. If soldiers are working on vehicles, avoid skin contact with the vehicle.
5. See FM 3-6 for definition of stability categories.
6. For planning, ensure the following steps are taken:
a. Remove as much earth and debris as possible from the CARC painted surface and conduct operator spraydown.
b. Above times are estimated weathering times for CARC painted surfaces; confirm contamination-free status by using detection devices before MOPP reduction.
c. If possible, move equipment from contaminated area.

Table 3-12. Estimated wait time before executing MOPP open/unmasking procedures (ICT5 Levels).

AGENT: VX
SURFACE: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	60+	55	50	45	36	26	17	8
	NEUTRAL	60+	60+	60+	60+	49	38	26	15
	STABLE	60+	60+	60+	45	51	41	32	23
11-24	UNSTABLE	60+	55	50	45	35	25	15	5
	NEUTRAL	60+	60+	60+	60+	48	35	23	10
	STABLE	60+	60+	60+	60+	49	38	26	15
>=25	NEUTRAL	60+	60+	60+	60+	47	34	21	8

Notes:
1. Worst case MOPP open/unmasking time—information in the table indicates the time for VX to weather below 5 percent incidence of incapacitation due to vapor on skin and inhalation. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES! DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap suit; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. To get times for grass terrain, multiply numbers in the chart by 0.4. DO NOT INTERPOLATE!
4. See FM 3-6 for definition of stability categories.

Table 3-13. Estimated wait time before executing MOPP open/unmasking procedures (ICT5 Levels).

AGENT: VX
SURFACE: CARC
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	8.25	5.25	3.5	2.25	1.5	1	0.75	0.5
	NEUTRAL	8	5	3.25	2	1.25	1	0.75	0.5
	STABLE	9.25	6	3.75	2.5	1.5	1	0.75	0.5
11-24	UNSTABLE	5	3	2	1.25	0.75	0.5	0.25	0.25
	NEUTRAL	5	3.25	2	1.25	0.75	0.5	0.5	0.25
	STABLE	5.75	3.5	2.25	1.5	1	0.75	0.5	0.25
>=25	NEUTRAL	3.25	2	1.25	0.75	0.5	0.5	0.25	0.25

Notes:
1. Worst case MOPP open/unmasking time—information in the table indicates the time for VX to weather below 5 percent incidence of incapacitation due to vapor on skin and inhalation. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES! DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap suit; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
4. If soldiers are working on vehicles, avoid skin contact with the vehicles.
5. See FM 3-6 for definition of stability categories.
6. For planning, ensure the following steps are taken:
a. Remove as much earth and debris as possible from the CARC painted surface and conduct operator spraydown.
b. Above times are estimated weathering times for CARC painted surfaces; confirm contamination-free status by using detection devices before MOPP reduction.
c. If possible, move uncontaminated equipment from the contaminated area.
d. Anything not painted with CARC (such as concrete, plastics, and weapons) must be individually checked for contamination.

Table 3-14. Estimated wait times before executing MOPP open procedures (ICT5 Risk Level).

AGENT: TGD
TERRAIN: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	8	6	4	3	3	3	3	3
	NEUTRAL	8	7	6	5	4	4	3	3
	STABLE	25	22	18	15	13	10	8	5
11-24	UNSTABLE	3	3	3	3	3	3	3	3
	NEUTRAL	5	4	3	3	3	3	3	3
	STABLE	5	4	3	3	3	3	3	3
>=25	NEUTRAL	3	3	3	3	3	3	3	3

Notes:
1. Worst case MOPP open time—information in the table indicates the time for TGD to weather below 5 percent incidence of incapacitation due to vapor-on-skin effects. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap MOPP clothing; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. To get times for grass terrain, multiply numbers in the chart by 0.4. DO NOT INTERPOLATE!
4. See FM 3-6 for definition of stability categories.

Table 3-15. Estimated wait times before executing unmasking procedures (ICT5 Risk Level).

AGENT: TGD
TERRAIN: SAND
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	60	46	32	18	14	10	6	3
	NEUTRAL	60+	53	47	40	33	25	18	10
	STABLE	60+	60+	60+	60	48	36	24	13
11-24	UNSTABLE	25	18	12	5	4	4	3	3
	NEUTRAL	60	45	30	15	12	9	6	3
	STABLE	60	45	30	15	12	9	6	3
>=25	NEUTRAL	18	12	7	3	3	3	3	3

Notes:
1. Worst case unmasking time—information in the table indicates the time for TGD to weather below 5 percent incidence of incapacitation due to inhalation. DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. To get times for grass terrain, multiply numbers in the chart by 0.4. DO NOT INTERPOLATE!
3. See FM 3-6 for definition of stability categories.

Table 3-16. Estimated wait times before executing MOPP open procedures (ICT5 Risk Level).

AGENT: TGD
TERRAIN: CARC
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	1.75	1	0.75	0.5	0.25	0.25	0.25	0.25
	NEUTRAL	1.75	1	0.75	0.5	0.25	0.25	0.25	0.25
	STABLE	2	1.25	0.75	0.5	0.25	0.25	0.25	0.25
11-24	UNSTABLE	1	0.75	0.5	0.25	0.25	0.25	0.25	0.25
	NEUTRAL	1	0.75	0.5	0.25	0.25	0.25	0.25	0.25
	STABLE	1.25	0.75	0.5	0.25	0.25	0.25	0.25	0.25
>=25	NEUTRAL	0.75	0.5	0.25	0.25	0.25	0.25	0.25	0.25

Notes:
1. Worst case MOPP open—information in this table indicates the time for TGD to weather below 5 percent incidence of incapacitation due to vapor on skin. DO NOT OPEN MOPP WITHOUT FOLLOWING MOPP OPEN PROCEDURES!
2. Opening the MOPP suit—unzip and/or unsnap suit; do not remove.
3. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
4. If soldiers are working on vehicles, avoid skin contact with the vehicle.
5. See FM 3-6 for definition of stability categories.
6. For planning, ensure the following steps are taken:
a. Remove as much earth and debris as possible from the CARC painted surface and conduct operator spraydown.
b. Above times are estimated weathering times for CARC painted surfaces; confirm contamination-free status by using detection devices before MOPP reduction.
c. If possible, move equipment from contaminated area.
d. Anything not painted with CARC (such as concrete, plastic, and weapons) must be individually checked for contamination.

Table 3-17. Estimated wait times before executing unmasking procedures (ICT5 Risk Level).

AGENT: TGD
TERRAIN: CARC
The numbers in the chart represent hours.

WIND SPEED KMPH	STABILITY	TEMPERATURE (F)							
		50	60	70	80	90	100	110	120
0-10	UNSTABLE	3.25	2	1.25	0.75	0.5	0.25	0.25	0.25
	NEUTRAL	3.25	2	1.25	0.75	0.5	0.25	0.25	0.25
	STABLE	3.5	2.25	1.5	1	0.5	0.5	0.25	0.25
11-24	UNSTABLE	2	1.25	0.75	0.5	0.25	0.25	0.25	0.25
	NEUTRAL	2	1.25	0.75	0.5	0.25	0.25	0.25	0.25
	STABLE	2.25	1.25	1	0.5	0.25	0.25	0.25	0.25
>=25	NEUTRAL	1.25	0.75	0.5	0.25	0.25	0.25	0.25	0.25

Notes:
1. Worst case unmasking time—information in this table indicates the time for TGD to weather below 5 percent incidence of incapacitation due to inhalation. DO NOT UNMASK WITHOUT FOLLOWING UNMASKING PROCEDURES!
2. When the actual temperature is between two listed temperatures, enter the table with the lower temperature. DO NOT INTERPOLATE!
3. If soldiers are working on vehicles, avoid skin contact with the vehicle.
4. See FM 3-6 for definition of stability categories.
5. For planning, ensure the following steps are taken:
a. Remove as much earth and debris as possible from the CARC painted surface and conduct operator spraydown.
b. Above times are estimated weathering times for CARC painted surfaces; confirm contamination-free status by using detection devices before MOPP reduction.
c. If possible, move equipment from contaminated area.
d. Anything not painted with CARC (such as concrete, plastic, and weapons) must be individually checked for contamination.