Chapter 2

MOPP Analysis

This chapter addresses the methodology for determining appropriate levels of protection from chemical hazards. Units do this by modifying their protective postures, using chemical agent detectors and alarms, determining automatic masking criteria, and making informed decisions at the right time.

On the battlefield, units will have incomplete intelligence concerning enemy NBC chemical capabilities. However, units use intelligence preparation of the battlefield (IPB) to estimate how many enemy fire support systems are in range, where and what they are, and how they could support probable enemy courses of action (COA). Further, your assessment of the enemy's intent and capabilities is a necessary part of the MOPP analysis and directly affects your recommendations.

However, at higher levels of command, for example, brigade or higher, more data are available to better determine threat capabilities and intent. Estimates provided by these headquarters enable subordinate units to determine appropriate postures.

Subordinate units must be given the flexibility to modify MOPP guidance received from higher headquarters based on local conditions. Units may be granted the flexibility to raise or lower their protective posture from that recommended by higher headquarters by using the techniques described in this chapter. This may be done down to platoon level and by any element that finds itself isolated. If higher headquarters specifically denies this flexibility, then protective postures may only be raised, not lowered, by these units.

This chapter will discuss the use of IPB as it relates to NBC operations, standard MOPP postures, automatic masking, MOPP flexibility, the sources and management of performance problems in MOPP, troop preparation, MOPP analysis procedures, and other procedures regarding the wear of the BDO and other individual protective equipment. Advice on use of MOPP guidance, techniques for use of alarms, and unmasking procedures are included, as well as filter replacement criteria.

Assessing Threat Information

Chemical officers' and NCOs' (battalion/brigade) responsibilities include using MOPP analysis to provide their commander with the best possible NBC estimate. In coordination with the S2 and S3, chemical staff personnel (battalion/brigde) address NBC during all phases of the battle. This is done by using assessment information from higher headquarters (see discussion in Chapter 3) and summarizing that information for their unit's needs.

The IPB process includes evaluation of the threat-the organization, composition, tactical doctrine, weapons, equipment, and their supporting battlefield functional systems of the enemy. It includes evaluating areas of operation and times of interest set by the commander. Terrain and weather analysis are also included in the process. The final step in the process is threat integration. This includes integrating the above mentioned items and enemy doctrine to determine how the enemy will fight. Threat integration is accomplished through development of the doctrine, situation, event, and decision support templates used by the S2 in briefing the commander.

The chemical officer uses the doctrine template in his estimate to address the when, where, why, and how the enemy will employ any NBC hazards in an AO. This provides the commander the information on threat NBC employment required for developing his concept of the operation. Threat chemical barrier production can also be depicted on this template. NBC reconnaissance will be conducted to confirm or deny whether any chemical barriers are present. Procedures to estimate the duration of the hazard are covered in Chapter 3.

Next, the chemical officer applies the situation template to his units' actual AO to provide a detailed assessment of all possible threat NBC actions that have either already happened or are anticipated based on how the battle is taking shape. The situation template helps explain how future events on the battlefield can affect the units' operations.

The events template lays out possible events that could happen as the battle progresses. The chemical officer examines each forecasted event to assess all possible threat NBC interdictions that could impact on his units' mission within-the AO. For example, the chemical officer's/NCO's assessment includes estimating the percentage of friendly chemical casualties that could occur if the enemy employed agents at that particular time. The procedure for estimating chemical casualties is discussed in Chapter 3.

Based on the situation, the events template predicts possible enemy COA at certain times and places on the battlefield. Based on these COA, a decision support template is created.

The decision support template provides the commander with his own COA to counter the threat. These COA are based on certain actions happening on the battlefield, or at a certain time or phase during the battle. The commander may use decision points on the battlefield to initiate certain COA. Based on the NBC threat, these decision points can result in the commander ordering a higher MOPP level based on an increased NBC threat at a particular time or phase of the battle. He may request NBC reconnaissance of critical terrain that templating indicates could be contaminated with persistent agents. These are just a few examples of possible input the chemical officer could provide to the S2's IPB estimate.

Using the IPB process, the chemical officer/NCO provides the commander and staff updates on the NBC situation. The chemical officer provides the following based on the time periods of interest set by the commander:

- Detailed information on enemy NBC capability based on the type of weapon systems that the enemy has available at that period of interest.
- How the enemy would employ chemicals.
- Areas of likely employment based on threat employment doctrine.
- Detailed analysis of terrain and weather in the unit's AO during each period of interest.
- MOPP guidance for each period of interest.
- Templates of predicted fallout data that are updated as conditions change.
- Alternative actions the commander can initiate prior to the time period in question so as to minimize degradation of affected units.
- Continuous monitoring of S2 message and radio traffic for any NBC-related information that could be important to the unit's mission.

Prior planning based on information provided by the chemical officer will help the commander make sound decisions. Regular updates need to be provided to the commander because of rapid changes in the situation.

It is corps and higher-level commanders' responsibility to direct minimum MOPP levels appropriate to the threat. They are aware of the intelligence that might indicate the probable use of NBC weapons. These commanders have the initial responsibility for upgrading unit protective posture. Ordering MOPP2 through MOPP4 is the responsibility of the division and lower commanders. The final responsibility, however, is that of the company commander or platoon leader who is on the spot. At this level there is a better appreciation for what the unit can and cannot do. These leaders increase or decrease their unit's protective posture based on an analysis of the situation and guidance from higher command. Final responsibility at this level retains flexibility of the system. The lower echelon unit's leader should not decrease the protective posture below the minimum level established by the next higher headquarters without prior approval.

Based on the threat assessment, units may be directed to deploy with only their protective masks. During Operation Just Cause in Panama in 1989 and Operation Urgent Fury in Grenada in 1983, several US units, based on intelligence information, determined that the protective mask would meet their NBC defense needs. This represents an example of the flexibility that is inherent in the MOPP system. During Operation Desert Shield/Storm, most US units deployed to Saudi Arabia at MOPP zero and had their MOPP gear readily available. Again, this represents, based on intelligence information and the threat, the flexibility that is inherent in the MOPP system.

Standard Mission-Oriented Protective Postures

All leaders need to be familiar with standard MOPP levels. Knowing these levels will aid the commander or small unit leader in making rapid and educated decisions regarding the level of MOPP to be worn by his soldiers. Standardized MOPP levels allow commanders to increase or decrease levels of protection through the use of readily understood prowords. Commanders determine which protective posture their subordinate units will assume (Figure 2-1), and then direct their units to assume that MOPP level.

The commander's or leader's directive also can include, based on the threat, the percentage of soldiers that will mask: for example, MOPP1, 50 percent masked. The system is flexible, and subordinate leaders can modify their units' MOPP level to meet mission needs according to the procedures described on pages (38 through 43). The following standardized protective postures assume that soldiers are also carrying their individual decontamination kit (M258A1 or M291), M8/M9 detector paper, NAAK, and their protective mask, unless the threat assessment indicates a zero percent probability of NBC use.

MOPP Ready

Soldiers carry their protective masks with their LCE. The soldier's MOPP gear is labeled and stored no further back than the BSA and is ready to be brought forward to

the soldier when needed. Pushing it forward should not exceed two hours. Units in MOPP Ready are highly vulnerable to persistent agent attacks and will automatically upgrade to MOPP Zero when they determine, or are notified, that chemical weapons have been used or that the threat for use of chemical weapons has risen. When a unit is at MOPP Ready soldiers will have field-expedient items identified for use. See page 3-6 for further discussion on field expedient items.

MOPP Zero

Soldiers carry their protective masks with their LCE. The standard BDO and other IPE making up the soldier's MOPP gear are readily available. To be considered readily available, equipment must be either carried by each soldier or stored within arms reach of the soldier; for example, within the work area, vehicle, or fighting position. Units in MOPP Zero are highly vulnerable to persistent agent attacks and will automatically upgrade to MOPP1 when they determine, or are notified, that persistent chemical weapons have been used or that the threat for use of chemical weapons has risen.

MOPP1

When directed to MOPP1, soldiers immediately don the BDO. In hot weather, the overgarment jacket can be unbuttoned, and the BDO can be worn directly over underwear. M9 or M8 chemical detection paper is attached to the overgarment. MOPP1 provides a great deal of protection against persistent agent. This level is automatically assumed when chemical weapons have been employed in an area of operations or when directed by higher commands.

MOPP2

Soldiers put on their chemical protective footwear covers (CPFCs), GVOS, or a field expedient item (for example, vapor-barrier boots) and the protective helmet cover is worn. As with MOPP1, the overgarment jacket may be left unbuttoned, but trousers remain closed.

MOPP3

Soldiers wear the protective mask and hood. Again, flexibility is built into the system to allow soldiers relief at MOPP3. Particularly in hot weather, soldiers can open the overgarment jacket and roll the protective mask hood for ventilation, but trousers remain closed.

MOPP4

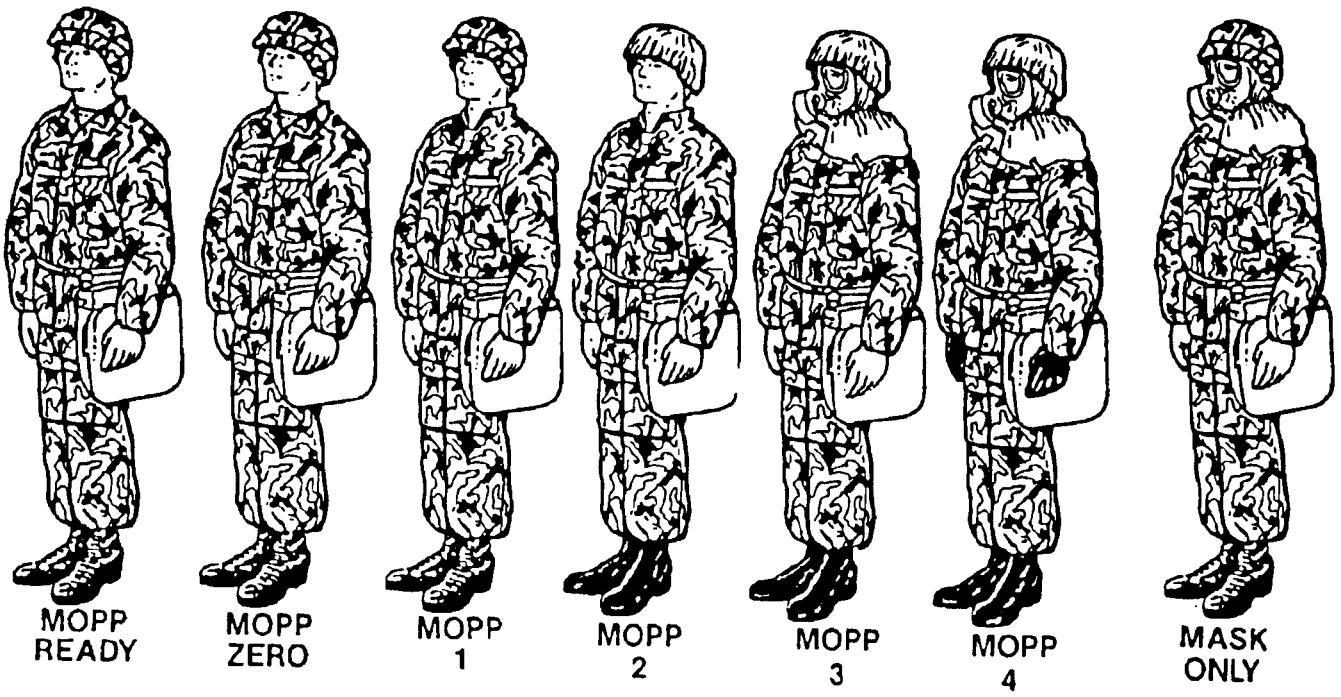
Soldiers will completely encapsulate themselves by closing their overgarments, rolling down and adjusting the mask hood, and putting on the NBC rubber gloves with cotton liners. MOPP4 provides the highest degree of chemical protection, but also has the most negative impact on an individual's performance.

Mask Only Command

The mask is worn. The Mask Only command is given under these situations:

- When RCAs are being employed and no chemical/biological threat exists.
- In a downwind vapor hazard of a nonpersistent chemical agent.

MASK ONLY is not an appropriate command when blister or persistent nerve agents are present.



MOPP Equipment	MOPP Levels						Command
	MOPP Ready	MOPP Zero	MOPP 1	MOPP 2	MOPP 3	MOPP 4	Mask Only
Mask	Carried	Carried	Carried	Carried	Worn[1]	Worn	Worn
Overgarment	Ready[3]	Available[4]	Worn[1]	Worn[1]	Worn[1]	Worn	
Vinyl Overboot	Ready[3]	Available[4]	Available[4]	Worn	Worn	Worn	
Gloves	Ready[3]	Available[4]	Available[4]	Available[4]	Available[4]	Worn	
Helmet Protective Cover	Ready[3]	Available[4]	Available[4]	Worn	Worn	Worn	
Chemical Protective Undergarment[2]	Ready[3]	Available[4]	Worn[2]	Worn[2]	Worn[2]	Worn[2]	

1 In hot weather coat or hood can be left open for ventilation.
2 The CPU is worn under the BDU (primarily applies to SOF, armor vehicle crewmen).
3 Must be available to the soldier within two hours. Second set available in 6 hours.
4 Within arm's reach of soldier.

Figure 2-1. Standardized MOPP levels.

Automatic Masking

Automatic masking is the act of immediately masking and assuming MOPP4 when encountering chemical attack indicators on the battlefield.

Before chemical weapons usage is confirmed, soldiers will don the mask only when there is a high probability of a chemical attack. High probability chemical attack indicators are -

- Sounding of a chemical agent alarm.
- Positive reading on chemical agent detector paper or chemical agent monitor.
- Soldiers experiencing symptoms of chemical agent poisoning.

When chemical agents have been employed, commanders at all levels may establish a modified policy of automatic masking by designating additional events as automatic masking criteria. Once this information is disseminated, soldiers will mask and assume MOPP4 automatically whenever one of these events occurs. Automatic masking criteria should be used by the commander as a decision tool and is based on NBC IPB, unit vulnerability analysis, and METT-T. Subordinate commanders may add automatic masking criteria at their discretion. For further guidance on NBC IPB consult FM 3-101, Chemical Staffs and Units.

MOPP System Flexibility

MOPP is not a fixed or rigid system. Flexibility is the key to providing maximum protection with the lowest risk possible while still allowing mission accomplishment. Flexibility allows subordinate commanders to adjust the amount of MOPP protection required in their particular situations and still maintain combat effectiveness. Additionally, commanders can place all or part of their units in different MOPP levels or authorize variations within a given MOPP level. For example, based on a high probability of a chemical attack, two soldiers man an observation post/listening post (LP/OP); one soldier wears a mask and the other does not. This ensures that if a sudden attack occurred, one soldier would already be masked and would not become a casualty. The masked soldier would be able to continue the OP/LP mission. This type of risk assessment, initiative, and flexibility is key to survival on today's fast-paced, highly mobile battlefield.

Using techniques described in this section (to vary the wearing of MOPP gear) reduces heat stress and soldier performance against the possible risk of contamination and mission accomplishment. Commanders make on-the-spot decisions on whether to modify MOPP. The following paragraphs describe suggested variations.

Soldiers may leave the overgarment jacket open at MOPP1, MOPP2, or MOPP3, allowing greater ventilation. Soldiers may leave the hood open or rolled at MOPP3. The various configurations of the MOPP levels with the hood rolled or open are referred to as "MOPP open." Commanders decide which of these variations to use based on the threat, temperature, and unit work intensity.

Soldiers wear protective gloves at MOPP1 through MOPP3 when handling equipment that has been decontaminated. This prevents contact with agent that may have been absorbed by equipment surfaces.

Where the hazard is from residual nuclear effects (for example, fallout), the commander modifies MOPP level based on his assessment of the situation and criticality of the mission. MOPP gear does not protect against gamma radiation. This fact is of immediate concern to the commander. Other risks include burns from beta particles and ingestion of alpha particles. Wearing of MOPP gear can reduce the risk of injury from these radiological hazards. A primary concern is to reduce the amount of radioactive contamination that contacts the skin and to prevent ingestion of radioactive particles.

Once it has been determined that only a low-level residual radiological hazard exists, the commander may decide to modify the unit's MOPP posture or procedures in fight of mission requirements. For example, soldiers are told to unmask, remove the hoods, and unbutton the BDOS. Soldiers can cover their noses and mouths with handkerchiefs or other material that provides dust protection in lieu of their protective masks. Wearing of full MOPP significantly reduces the beta bum and alpha particle ingestion hazard; performance degradation and heat stress increase. As in the case of protection from chemical hazards, achievement of radiological protection involves a tradeoff against the risk of MOPP: induced performance degration and heat illness.

One method of modifying the protective posture allows soldiers to wear the cloth liners from their butyl gloves. This prevents radiological contamination of as much exposed skin as possible. Soldiers issued the M291 kit should use field-expedient substitutes such as a wet handkerchief or commercial "wet-wipes" to remove radiological particles that accumulate on hairy areas of the body. The ration supplement sundries pack, NSN 8970-00-268-9934 for females and 8970-01-175-2509 for general use, contains a supply of the latter items.

Understanding and Managing Performance Problems in NBC Operations

Once an accurate assessment of the NBC threat has been made, the key to selecting an appropriate MOPP level lies in understanding factors contributing to performance degradation and heat casualties. MOPP4 protects soldiers by completely isolating them from the NBC environment. However, this encapsulation imposes both physiological and psychological stresses upon the wearer and interacts to degrade individual and unit performance. Other combat stress can further compound the strain of encapsulation. Lower MOPP levels reduce the stress associated with encapsulation but increase the risk of exposure to threat agents. Exposure to low levels of some agents can also lead to performance degradation. Leaders that understand the potential problems and how these problems are countered, are prepared to conduct the MOPP analysis procedures presented below. The successful leader will minimize performance problems and casualties through informed planning and thorough preparation.

Physiological Factors

Adding layers over the BDU (for example, protective overgarment, gloves, and overboots) increases the risk of heat stress, even at moderate environmental temperatures and work intensities. This increases the possibility of heat casualties and degrades performance. Hunger, thirst, and discomfort during sustained periods of MOPP wear can also seriously degrade performance.

Heat Stress in MOPP

Body temperature must be maintained within narrow limits for optimum physical and mental performance. The body produces more heat during work than rest. Normally, the body cools itself by evaporation of sweat and radiation of heat at the skin's surface. MOPP gear restricts these heat loss mechanisms because of its high insulation and low permeability to water vapor. In addition, physical work tasks require more effort when soldiers wear protective clothing because of added weight and restricted movement. This results in more body heat to be dissipated than normal and body temperature tends to rise quickly. The amount of heat acclimatization depends upon the amount of physical activity, the level of hydration, the clothing worn, the load carried, the state of heat acclimatization, physical fitness, and fatigue, as well as terrain and climatic conditions.

Adjusting the MOPP level by opening the BDO jacket, unblousing boots, rolling up the hood, and so forth will reduce barriers to body cooling. The decision process for selecting appropriate adjustments is covered under the section on MOPP analyses.

Work intensity is a major contributing factor to heat stress that can be managed by leaders. Military work is categorized as very light, light, moderate, or heavy. Table 2-1 provides examples that can be used as a guide in estimating the work intensity for a particular mission or task. The incidence of heat casualties can be reduced if soldiers can be allowed to lower their work intensity and/or take more frequent rest breaks. Tables 2-2 and 2-7 provide information necessary to calculate recommended work/rest cycles for various environmental conditions, clothing levels, and work intensities during daylight and night (or fully shaded) operations, respectively. The work/rest cycles specified in the tables are based on keeping the risk of heat casualties below five percent. Under some operational conditions, work/rest cycles offer no advantage to continuous work (see NL entries in Tables 2-2 and 2-7). There are conditions when work/rest cycles offer no advantage: for example, when the environmental and clothing conditions do not permit any cooling during rest (see NA entries in Tables 2-2 and 2-7); leaders may choose to use the estimated tolerance times such as maximum continuous work times specified in Tables 2-4 (daylight) and 2-9 (night or shade) to limit the risk of heat casualties to less than five percent.

Although strict adherence to work/rest criteria is possible during training exercises, this may not be possible during combat operations. Tables 2-4 and 2-9 provide guidance on tolerance tunes. For example, the maximum number of minutes of work before the risk of becoming a casualty exceeds five percent (1 of every 20 soldiers). These estimates, representing average expected values withing a large population, should be considered approximate guidance and not be used as a substitute for common sense or experience. Individuals will vary in their tolerance. Once the work time limit has been reached, soldiers should rest in the shade (using the guidance provided in Table 2-6) before returning to work. As Table 2-6 clearly shows, reduction of MOPP level during the rest period is the

Table 2-1. Work intensities of military tasks.

WORK INTENSITY IN MOPP 0-1	ACTIVITY	WORK INTENSITY IN MOPP 2-4
VERY LIGHT	Lying on Ground Standing in Foxhole Sitting in Truck Guard Duty Driving Truck	VERY LIGHT
LIGHT	Cleaning Rifle Walking Hard Surface/ 1m/s No Load Walking Hard Surface/ 1m/s 20 kg Load Manual of Arms Walking Hard Surface/ 1m/s 30 kg Load	LIGHT
MODERATE	Walking Loose Sand/ 1m/s No Load Walking Hard Surface/ 1.56 m/s No Load Calisthenics	MODERATE
	Walking Hard Surface/ 1.56 m/s 20 kg Load Scouting Patrol Pick and Shovel Crawling Full Pack Foxhole Digging Field Assaults	HEAVY
HEAVY	Walking Hard Surface/ 1.56 m/s 30 kg Load Walking Hard Surface/ 2.0 m/s No Load Emplacement Digging Walking Hard Surface/ 2.25 m/s No Load Walking Loose Sand/ 1.56 m/s No Load	The work intensity categories of this table are based on metabolic expenditures. Very Light = 105 to 175 watts Light = 172 to 325 watts Moderate = 325 to 500 watts Heavy = 500+ watts The weight of the chemical protective overboots is a primary contributor to increased workj intensity in MOPP.

key to maximizing the time troops can spend performing work.

In minimizing heat stress, work/rest schedules may be supplemented by microclimate cooling (MCC) systems in which an air or liquid cooled vest worn under the BDO removes body heat away from skin. MCC systems are available inside certain combat vehicles, but MCC options are not usually available for dismounted soldiers.

Even when work/rest schedules and MCC are used, an increased risk of performance degradation and heat casualties is inevitable when wearing MOPP in hot weather.

Dehydration

Because of higher body temperatures, soldiers in MOPP gear sweat considerably more than usual, often more than 1.5 quarts of water every hour during work. Water must be consumed to replace lost fluids or dehydration will follow. Even a slight degree of dehydration impairs the body's ability to regulate its temperature and nullifies the benefits of heat acclimatization and physical fitness, increases the susceptibility to heat injury, and reduces work capacity (including G-tolerance in pilots), appetite, and alertness. Even in soldiers who are not heat casualties, the combined effects of dehydration, restricted heat loss from the body, and increased work effort place a severe strain on the body's functions, and soldiers suffer from decrements in mental and physical performance.

The difficulty of drinking in MOPP increases the likelihood of dehydration. Thirst is not an adequate indicator of dehydration; soldiers will not sense when they are dehydrated and will fail to replace body water losses, even when drinking water is readily available. Unit chain of command must take responsibility for enforcing regular and timely fluid replacement in their soldiers.

Water requirements should be estimated using the guidelines provided in Tables 2-3, 2-5, 2-8, and 2-10. Base the recommended hourly replenishment on current work intensity, temperature, clothing layers, and light cycle. For example, at a moderate work intensity in MOPP4 (over underwear only) and a daylight wet bulb globe temperature (WBGT) of 80°F (27°C) a soldier should drink approximately 2.0 quarts of water per hour if working continuously or 1.0 quart per hour if working according to the work/rest schedule recommended in Table 2-2 (for example, 10 minutes work, 50 minutes rest). Note that continuous work under these conditions may lead to heat casualties after 49 minutes (Table 2-4).

Soldiers should drink as much as possible before donning the mask, and frequent drinking while working is more effective in maintaining hydration than waiting until rest periods to drink. The estimates in the tables will also provide the S4 with information he can use to calculate potential drinking water requirements and allocate assets needed to get the water to the soldier. Additional water should be made available for such things as hygiene, cooking, and medical requirements.

Training and Conditioning

Well-prepared soldiers suffer less stress when in MOPP4 than do troops who are less prepared. Well-prepared soldiers are those who are in good physical condition and have trained extensively in

Table 2-2. Number of minutes of work per hour in work/rest cycle (daylight operations).

		MOPP ZERO				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
78	82	NL	NL	NL	25	NL	30	10	5	NL	25	10	5
80	84			40	25		25	10	na		20	10	na
82	87			35	20		20	5			15	na	
84	89			30	20		na	na			na		
86	91			30	20								
88	94			20	15								
90	96			20	10								
92	98			10	10								
94	100		30	10	10								
96	103		10	na	na	na				na			
98	105		na										
100	107	na											

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb - °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
NL - No Limit (Continous Work Possible)
na - Work/Rest Cycle Not Feasible (See Maximum Work Time in Table 2-4)

INSTRUCTIONS AND NOTES
This table provides, for four levels of work intensity (see Table 2-1), the number of minutes of work per hour in work/rest schedules tailored to the conditions specified. The remainder of each hour should be spent in rest. This table was prepared using the prediction capability of the USARIEM Heat Strain Model. Assumptions used in generating this table include 1) troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2m/s; 4) clear skies; 5) heat casualties <5%. This guide should not be used as a substitute for common sense or experience. Individual requirements may very greatly. The appearance of heat causalties is evidence that the selected work/rest schedule is inappropriate for the conditions.
USARIEM 1/11/91

protective gear. Physically fit soldiers are more resistant to physical and mental fatigue and acclimatize more quickly to climatic heat or the heat associated with MOPP wear than less fit soldiers.

Units that anticipate deployment to regions where employment of chemical/biological agents is possible should augment physical training programs and increase their state of heat acclimatization. To optimize heat acclimatization, soldiers should progressively increase the duration (reaching two to four hours) and intensity of exercise in the heat over 7 to 14 consecutive days. Finally, when soldiers are required to routinely work in MOPP gear, it is important to practice good hygiene; keep skin clean to avoid developing heat rash that can dramatically reduce the ability to regulate body temperature.

Inadequate Nutrition

In addition to bodily requirements for electrolyte (salt) replacement caused by sustained and excessive sweating, the higher work intensities typical of operations in MOPP lead to an increased demand for calories. Lack of adequate energy supplies can lead to decrements in both physical and mental performance. The Army has tailored its field feeding menus to provide adequate amounts of both salts and calories to support MOPP operations. All rations served or issued must be consumed, however, and potential contamination of food supplies will make it difficult to maintain adequate nutrition while in MOPP.

The method selected to minimize feeding-related problems depends on availability of safe, uncontaminated areas, as well as other operational constraints. In a contaminated area where there is also a vapor hazard, move troops into a collective-protection facility to eat meals. Since collective-protection shelters have limited capacity, rotate small groups through these facilities. In a contaminated area with no collective protection available, relocate troops to a safe area for feeding by rotating small portions of the unit or by entire unit replacement. If soldiers are in a contaminated area

Table 2-3. Water requirements for work/rest cycles (qt/hr) (daylight operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
78	82	0.5	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
80	84	0.5	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	
82	87	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0		
84	89	1.0	1.0	1.0	1.0	1.0				1.0			
86	91	1.0	1.0	1.0	1.0	1.0				1.0			
88	94	1.0	1.5	1.0	1.0	1.5			na	1.5			na
90	96	1.0	1.5	1.0	1.0	1.5				1.5		na	
92	98	1.0	1.5	1.0	1.0	1.5	na	na		1.5	na		
94	100	1.0	1.5	1.5	1.0	1.5				1.5			
96	103	1.0	1.5										
98	105	1.5	na	na	na	na				na			
100	107	na											

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb - °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
na - Work/Rest Cycle Not Feasible (See Water Requirements in Table 2-5)
USARIEM 1/11/91

INSTRUCTIONS AND NOTES
Water requirements listed are for both the work/rest schedules specified in Table 2-2 for support of sustained work (shaded blocks), and work times unrestricted by thermal stress (unshaded, same as Tables 2-4 and 2-5). Work intensities may be estimated using Table 2-1. Drinking should be divided over course of each hour to replace water as it is lost to sweat. The table was prepared using prediction capability of the USARIEM Heat Strain Model; assumptions used in generating estimates include 1) troops fully hydrated, rested, and acclimated; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) clear skies; 5) heat casualties <5%. This guidance is not a substitute for comon sense or experience; appearance of heat casualties is evidence that safe work limits (<5% casualties) have been exceeded.

with no detectable vapor hazard or in a clean area where they are under a constant threat of NBC attack, use a rotating method for feeding about 25 percent at any one time and take care to prevent contaminating the food.

Psychological Factors

NBC warfare threat adds to an already stressful situation because it creates unique fears in soldiers and isolates them from their environment. MOPP4 reduces the ability to see and hear clearly and makes it more difficult to recognize and communicate with others. This creates or increases feelings of isolation and confusion. The awkwardness of wearing bulky, impermeable garments, gloves, and boots on top the BDU causes frustration in many soldiers and claustrophobia in some. Long periods of reduced mobility and sensory awareness degrade attention and alertness and create or increase feelings of alienation. Chemical filters in the protective mask make breathing more difficult; this too may create feelings of claustrophobia or panic. The enemy will use the chemical agent threat to exploit these weaknesses and to induce protective postures that reduce combat effectiveness.

The adverse impact of psychological stress during MOPP operations can be minimized by the experience and confidence that realistic training in MOPP4 provides. Wearing MOPP causes physical and emotional stress. Tough, realistic, METL-driven training using MOPP creates a stressful environment for soldiers and units. Successful training helps support unit preparations for battle stress encountered during conflict or war.

Combat Stress

The threat of NBC warfare increases the overall psychological and physiological stress that is an integral part of combat. Because MOPP4 is only worn when the threat of imminent attack is the greatest, encapsulation increases generalized fears and anxiety about combat. Combat stress or battlefield fatigue can cause significant numbers of psychiatric casualties; estimates range from 10 percent to 30 percent depending on the duration and intensity of battle (draft FM 8-51 discusses combat stress

Table 2-4. Maximum work times (minutes) (daylight operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
78	82			NL	65		177	50	33		155	49	32
80	84			157	61		142	49	32		131	48	32
82	87			114	56		115	47	31		110	46	30
84	89		NL	99	53	NL	104	45	30	NL	100	45	30
86	91	NL		87	50		95	44	29		93	44	29
88	94			74	45		85	42	28		83	42	27
90	96			67	43		79	41	27		78	41	27
92	98			60	40		75	40	26		74	40	26
94	100		193	55	37		70	39	25		70	39	25
96	103		101	48	33	203	65	37	23	194	65	37	23
98	105		82	44	31	141	62	36	22	140	62	36	22
100	107	261	70	41	28	118	59	35	21	118	59	35	21

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
Ta - Ambient Temperature (Dry Bulb - °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
NL - No limit to Continuous Work
USARIEM 1/11/91

INSTRUCTIONS AND NOTES
This table provides for four levels of work intensity (see Table 2-2), the maximum number of minutes work can be sustained in a single work period without exceeding a greater than 5% risk of heat casualties. This table was perpared using the prediction capability of the USARIEM Heat Stain Model. Assumptions used in generating this table include 1) all troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) clear skies. The guidance should not be used as a substitute for common sense or experience. Individual requirements may vary greatly. The appearance of heat casualties is evidence that the safe limits of work time have been reached.

in detail). Psychological stress stems not only from the death and destruction that characterize combat, but also from the challenging operational conditions: noise, confusion, and loss of sleep. Challenging operational conditions that create fatigue and cause changes in diet and personal hygiene cause physiological stress as well.

Use of short rest breaks to provide relief from MOPP, combined with adequate sleep (6 or more hours of uninterrupted sleep per 24-hour period is optimum; 4 hours is the minimum for a few days of sustained operations), food, and drink, can sustain performance at an optimal level. During the period of 0100 to 0700, leaders must be aware that the body experiences reduced mental concentration, confusion, nervousness, and lack of clear thinking. Leaders should plan activities to reduce boredom, fatigue, inattention, and discomfort; these are major contributors to ineffective performance.

Leaders can minimize the effects of combat stress by attaining and maintaining a high level of unit cohesion and individual identity. Units must train together frequently under demanding conditions. If soldiers know that they can overcome adversity together, unit cohesion will be high. Leaders must take a true interest in the welfare of their soldiers and build the confidence necessary to withstand the effects of stress. Leaders must keep soldiers informed about the tactical situation so that the adverse effects of ambiguity and uncertainty are minimized. Soldiers who become ineffective as a result of combat stress should be given a period of rest as close to the front as possible and given reassurance and support by all members of their unit.

Psychological Symptoms

Rarely will leaders on the integrated battlefield be able to distinguish between the different types of stress. For example, excessive sweating, nausea, and claustrophobia can be caused by fear and anxiety about combat, by dehydration and heat illness, by total encapsulation in MOPP4, or even by exposure to a chemical agent. Symptoms of stress with a psychological origin could include any of the following:

Mood

- Unusual impatience, frustration, or irritability.
- Unusual fatigue or sleepiness.
- Loneliness, isolation, or alienation.

Table 2-5. Water requirements for maximum work times (qt/hr) (daylight operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
78	82	.5	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
80	84	.5	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
82	87	1.0	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
84	89	1.0	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
86	91	1.0	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	2.0	2.0	2.0
88	94	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0
90	96	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0
92	98	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0
94	100	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0
96	103	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0
98	105	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
100	107	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb - °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
USARIEM 1/11/91

INSTRUCTIONS AND NOTES
Amounts listed are required to support maximum work times in Table 2-4; estimate work intensities using Table 2-1. Drinking should be divided over course of each hour. If water requirement is 2.0, sweat loss is greater than maximum water absorption during an hour, and troops will become increasingly dehydrated regardless of amount drunk; leaders should plan for an extended rest and rehydration period at work completion. The table was prepared using prediction capability of the USARIEM Heat Strain Model; assumptions used in generating estimates include 1) troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) clear skies; 5) heat casualties <5%. This guidance is not a substitute for common sense or experience; appearance of heat casualties is evidence that safe work limits (<5% casualties) have been exceeded.

- Feelings of helplessness.
- Claustrophobia.

Thinking

- Forgetfulness or absentmindedness (especially common are errors in map plotting and message coding).
- Impaired decision making, reasoning, or judgment.
- Disorientation, confusion, or panic.
- Hallucinations or paranoia.

Physical Signs

- Rapid breathing (hyperventilation) or rapid heart rate (tachycardia).
- "Cotton mouth" or nausea.
- Cramps or muscle tension.

Military Task Performance Problems in MOPP

Adding layers to the BDU reduces mobility, agility, coordination, and dexterity. Hundreds of military tasks have been tested to determine the degradation from wearing MOPP gear. Units operating in MOPP1 and MOPP2 generally do not experience significant time increases to perform a given task with one exception, Extensive foot travel in MOPP2 is slowed due to the effects of the overboot and GVOs.

Soldiers wearing MOPP4 will take about 1.5 times longer to perform most tasks. Therefore, leaders can estimate the time it will take to complete most tasks in MOPP4 by multiplying the time normally required to complete tasks by 1.5. Decision-making and precision control tasks are slowed even more than manual tasks. For decision-making and precision control (for example, typing a message or aiming) tasks, the normally expected completion time should be multiplied by 2.5 (or more, if soldiers have been in MOPP4 for an extended period or are overheated).

Soldiers depend on each other to ensure unit performance. Individual degradation will affect the unit as a whole. Unit performance will be significantly degraded due to behavioral changes and leader exhaustion.

Leaders must plan for a slower pace of operations in MOPP if accuracy is to be maintained. Repeatedly

Table 2-6. Recovery time estimates after maximum work (hours of rest in the shade).

WBGT	T_a	MOPP Zero	MOPP4
60	68	0.25	1.0
66	75	0.25	1.0
72	82	0.5	1.5
74	84	0.5	1.5
76	86	0.5	2.0
78	88	0.5	2.0
80	91	0.5	3.0
82	93	0.5	4.0
84	95	0.5	6.0
86	97	1.0	15.0
88	100	1.0	NCP
90	102	1.0	NCP
92	104	1.5	NCP
94	106	2.0	NCP
96	109	8.0	NCP
98	111	NCP	NCP
100	113	NCP	NCP

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F) As Measured in Shade (If Only Full Sun WBGT Is Available, Subtract 5°F WBGT Before Using This Table)
Ta - Ambient Temperature (Dry Bulb - °F)
MOPP Zero - Battal Dress Uniform Only
MOPP4 - Battle Dress Overgarment and Mask (Closed)
NCP - No Cooling Possible Under These Conditions - Seek Cooler Location and/or Remove BDO

NOTES AND INSTRUCTIONS
This table provides the number of hours rest in the shade that should be required after working the maximum work times specified in Table 2-4 or 2-9. This table was prepared using the cooling capacity equations of the USARIEM Heat strain Model. Assumptions used in generating this table include 1) troops fully hydrated and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) no solar load; 5) recovery of normal body temperature. This guidance should not be used as a substitute for common sense or experience. Individual requirements may vary greatly.

USARIEM 1/11/01

practicing critical tasks (for example, training well in excess of the standard) can offer some improvements, but this may or may not be sufficient, depending on mission requirements. Tasks that require manual dexterity and unrestricted hearing and vision should be simplified or modified.

In an NBC environment, command, control, and communications are difficult. Wearing the protective mask degrades hearing, vision, and speech; all are important to effective communication. Individuals are difficult to identify by name or rank, leading to confusion as well as contributing to failures in effective communication. Performance of command functions while in MOPP presents a problem all commanders must consider. A few of these challenges include the following:

- Heat stress causes personnel in leadership positions to tire rapidly and affects mental and physical capability.
- The mask voicemitter makes speech difficult to understand.
- The M17-series mask impairs voice communication in both volume and quality on radios and field phones.
- Eye lenses of the mask narrow the field of vision.

NOTE: The M40-series mask considerably diminishes the last three problems.

- The hood impairs hearing.

The following are ways in which leaders can minimize some of these difficulties. Delegate more responsibilities to reduce the stress of wearing MOPP over extended periods of time. Increase flexibility in MOPP wear as discussed earlier in this chapter. The unit SOP must include specific unit guidelines based on unit mission needs. When using the radio, ensure the microphone is held close to the voicemitter, particularly when wearing the M17-series mask. If possible, wear the microphone-equipped M24/M25-series mask or the M42-series mask, and use the vehicular communication system if operating in a combat vehicle. Enhance verbal communications by speaking more slowly than normal and having orders repeated. Hand and other visual signals can be effectively employed. Issue written orders, if time permits, to ensure instructions are understood. Use collective protection, as much as possible, to eliminate the burden of MOPP.

Identifying soldiers in MOPP by name and rank can be accomplished through various means. One way is to use tape showing the soldier's name and rank. Tape is normally available in some form, and there are advantages to using it. When soldiers are not in MOPP, a strip of tape with all the information already printed on it can be placed on the soldier's overgarment bag, as well as on the mask carrier. When the overgarments are

Table 2-7. Number of minutes of work per hour in work/rest cycle (night operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
60	68	NL	NL	NL	40	NL	NL	30	20	NL	NL	25	15
66	75				40			25	15			25	15
72	82				35			20	15			20	10
78	88				30			15	10			15	10
80	91				25			15	5			15	5
82	93				25		30	10	5		25	10	5
84	95			40	25		25	10	na		20	5	na
86	97			35	20		15	5			10	na	
88	100			30	20		na	na			na		
90	102			25	15								
92	104			20	15								
94	106			15	10								

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb - °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
NL - No Limit (Continuous Work Possible)
na - Work/Rest Cycle Not Feasible (See Maximum Work Time in Table 2-4)

INSTRUCTIONS AND NOTES
This table provides, for four levels of work intensity (see Table 2-1), the number of minutes of work per hour in work/rest schedules tailered to the conditions specified. The remainder of each hour should be spent in rest. This table was prepared using the prediction capability of the USARIEM Heat Strain Model. Assumptions used in generating this table include 1) troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) no solar load; 5) heat casualties <5%. This guidance should not be used as a substitute for common sense or experience; individual requirements may vary greatly. The appearance of heat casualties is evidence that the selected work/rest schedule and/or water consumption guidance (Table 2-3) is inappropriate for the conditions.

USARIEM 1/10/91

put on, soldiers can pull the tape off the overgarment bag and place it on their overgarment to further increase ease of identification. Other methods can be used as long as they suit the commander's needs in being able to identify his soldiers, do not damage or interfere with the use of other equipment, and allow soldiers to perform the mission unimpeded.

Miosis

Although MOPP gear may be the most common source of performance problems during NBC operations, some chemical agents, primarily the nerve agents, can produce performance decrements at exposure levels below that which would cause casualties. Very small amounts of nerve agent such as vapor or aerosol absorbed through the eyes will constrict the pupils. This condition is called miosis. It may or may not involve pain and/or headache. The pupil is unable to dilate normally, thus reducing night vision and the efficiency of using night vision devices. Miosis can reduce the efficiency of performance of other tasks at night: for example, navigating on foot, identifying and engaging targets, driving vehicles under blackout conditions, and flying that requires pilots to change focus frequently.

Symptoms of miosis range from minimal to severe, depending on the nerve agent dosage. Victims may experience headaches when exposed to bright light. Severe miosis and the consequent reduced ability to see in dim light may persist for 48 hours after onset. The pupil gradually returns to normal over several days. Full recovery may take 20 days or longer. Repeated exposures within this period cause cumulative effects.

Commanders must identify personnel performing critical tasks that are dependent on night vision and initiate certain precautions to minimize miosis. These precautions may include the following:

- Have key personnel mask whenever there is risk of encountering miosis-producing hazards such as when

Table 2-8. Water requirements for work/rest cycles (qt/hr) (night operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
60	68	0.25	0.25	0.5	1.0	0.25	1.0	1.0	1.0	0.25	1.0	1.0	1.0
66	75	0.25	0.25	1.0	1.0	0.5	1.0	1.0	1.0	0.5	1.0	1.0	1.0
72	82	0.25	0.5	1.0	1.0	0.5	1.0	1.0	1.0	0.5	1.0	1.0	1.0
78	88	0.25	0.5	1.0	1.0	1.0	1.5	1.0	1.0	1.0	1.5	1.0	1.0
80	91	0.5	1.0	1.5	1.0	1.0	1.5	1.0	1.0	1.0	1.5	1.0	1.0
82	93	0.5	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
84	95	0.5	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	
86	97	0.5	1.0	1.0	1.0	1.0	1.0	1.0		1.0	1.0		
88	100	0.5	1.0	1.0	1.0	1.0			na	1.0			na
90	102	1.0	1.0	1.0	1.0	1.0	na	na		1.0	na	na	
92	104	1.0	1.5	1.0	1.0	1.5				1.5			
94	106	1.0	1.5	1.0	1.0	1.5				1.5			

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb - °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
NL - No Limit (Continuous Work Possible)
na - Work/Rest Cycle Not Feasible (See Maximum Work Time in Table 2-4)
USARIEM 1/10/91

INSTRUCTIONS AND NOTES
Amounts listed are required to support work/rest schedules in Table 2-7; drinking should be divided over course of each hour to replace water as it is lost to sweat. Use Table 2-10 to determine water required to support maximum work times shown in Table 2-9. The table was prepared using prediction capabilities of the USARIEM Heat Strain Model; assumptions used in generating estimates include 1) troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) no solar load; 5) heat casualties <5%. This guidance is not a substitute for common sense or experience; appearance of heat casualties is evidence that safe work limits (<5% casualties) have been exceeded (that the selected work/rest cycle and/or water guidance is inappropriate for the conditions).

close to ground, equipment, or personnel known to have been contaminated with liquid nerve agent.

- After detailed equipment decon (FM 3-5), allow personnel to move away from their equipment. Have them move to a contamination-free area and conduct unmasking procedures. Residual contamination on decontaminated material may be sufficient to cause miosis. Soldiers should disperse in the open air and use the buddy system to observe for possible miosis symptoms.
- Use collective protection as much as possible.

Troop Preparation

It cannot be overemphasized that soldiers and their leaders must train in MOPP gear, including training in MOPP4 over extended periods of time. Further, soldiers cannot be expected to fight successfully in full MOPP gear if they have not trained as a team with their leaders and equipment. Leaders are critically aware of their key role under NBC conditions and their need to make timely and informed decisions.

Just as infantrymen train extensively with their individual weapon to become proficient in its use, individual soldiers should train in MOPP to become more confident and proficient on individual and team tasks. Training in MOPP4 helps leaders and soldiers understand the problems they will encounter when required to fight in MOPP. During preparation for combat, leaders gain knowledge of individual and unit training status and take actions such as individual training and battle drills to ensure maximum preparation prior to combat.

Leaders can ensure success on the NBC battlefield in many ways.

Train Thoroughly and Realistically

- Build confidence and unit cohesion through realistic training in MOPP4.

Table 2-9. Maximum work times (minutes) (night operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
60	68	NL	NL	NL	188	NL	NL	76	42	NL	NL	73	41
66	75				119			66	39			64	38
72	82				90			58	36			57	36
78	88				72			53	34			52	33
80	91				64			50	32			50	32
82	93				60		206	49	32		168	48	31
84	95			139	55		144	47	31		133	47	30
86	97			107	51		121	46	30		115	45	29
88	100			82	46		100	44	28		97	43	28
90	102			71	42		91	42	27		89	42	27
92	104			63	39		83	41	26		82	41	26
94	106			56	36		77	40	25		76	40	25

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
NL - No Limit (Continuous Work Possible)
USARIEM 1/10/91

INSTRUCTIONS AND NOTES
This table provides, for four levels of work intensity (see Table 2-1), the maximum number of minutes of work that can be sustained in a single work period without exceeding a greater than 5% risk of heat casualties. This table was prepared using the prediction capability of the USARIEM Heat Strain Model. Assumptions used in generating this table include 1) all troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) no solar load. The guidance should not be used as a substitute for common sense or experience. Individual requirements may vary greatly. The appearance of heat casualties is evidence that the safe limits of work time have been reached.

- Practice critical visual tasks (like marksmanship) in the protective mask until they become automatic.
- Attain and maintain peak physical fitness and acclimatization.
- Ensure radio telephone operators (RTOs) are trained in recognizing and transmitting NBC reports and know their importance to unit survival.
- Cross-train crews and other critical positions.

Plan Ahead

- Check NBC defense guidance in OPLAN/OPORD; anticipate projected work requirements in the next 24-48 hours.
- Ensure serviceability or shortfalls of equipment through precombat inspections of NBC equipment.
- Know the most current weather data, particularly wind direction.
- Plan work/rest cycles appropriate to the environment and the mission.
- Ensure deployment and mounting of alarms.
- Use SOPs to reduce command, control, and communication tasks.
- Keep plans simple

Think Teamwork

- Use methods of individual identification (name tags, personal items).
- Encourage "small-talk" while in MOPP.
- Pair an experienced soldier with an inexperienced "buddy" whenever possible.
- Use the buddy system to ensure that all members of the unit are regularly checked for signs of stress and agent exposure.

Work Smart

- Provide relief from MOPP4 as soon as the mission allows.
- Use work/rest ratios, slow work rate, and minimize work intensity.
- Work in the shade whenever possible.
- Enforce command drinking to reduce dehydration and heat casualties.

Table 2-10. Water requirements for maximum work times (qt/hr) (night operations).

		MOPP Zero				MOPP4 + Underwear				MOPP4 + BDU			
WBGT	T_a	VL	L	M	H	VL	L	M	H	VL	L	M	H
60	68	0.25	0.25	0.5	1.0	0.25	1.0	1.5	2.0	0.25	1.0	1.5	2.0
66	75	0.25	0.25	1.0	1.5	0.5	1.0	2.0	2.0	0.5	1.0	2.0	2.0
72	82	0.25	0.5	1.0	1.5	0.5	1.0	2.0	2.0	0.5	1.0	2.0	2.0
78	88	0.25	0.5	1.0	1.5	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
80	91	0.5	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
82	93	0.5	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
84	95	0.5	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
86	97	0.5	1.0	1.5	2.0	1.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0
88	100	0.5	1.0	1.5	2.0	1.0	2.0	2.0	2.0	1.0	2.0	2.0	2.0
90	102	1.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0	2.0	2.0
92	104	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0
94	106	1.0	1.5	2.0	2.0	1.5	2.0	2.0	2.0	1.5	2.0	2.0	2.0

KEY TO TABLE
WBGT - Wet Bulb Globe Temperature (°F)
T_a - Ambient Temperature (Dry Bulb °F)
VL - Very Light Work Intensity
L - Light Work Intensity
M - Moderate Work Intensity
H - Heavy Work Intensity
BDU - Battle Dress Uniform
NL - No Limit (Continuous Work Possible)
USARIEM 1/10/91

INSTRUCTIONS AND NOTES
Amounts listed are required to support maximum work times in Table 2-9; drinking should be divided over course of each hour. If water requirement is 2.0, sweat loss is greater than maximum water absorption during an hour, and troops will become increasingly dehydrated regardless of amount drunk; leaders should plan for an extended rest and rehydration period at work completion (see Table 2-6). This table was prepared using prediction capability of the USARIEM Heat Strain Model; assumptions used in generating estimates include 1) troops fully hydrated, rested, and acclimatized; 2) 50% relative humidity; 3) windspeed = 2 m/s; 4) no solar load; 5) heat casualties <5%. This guidance is not a substitute for common sense or experience; appearance of heat casualties is evidence that safe work limits (casualties) have been exceeded.

REMEMBER—the most motivated soldiers and leaders are the most likely to ignore their needs for food, water, and rest. They are the first casualties.

- Use collective protection as much as possible.
- Enforce good eating, drinking, and sleeping discipline.
- Rotate jobs and people during long shifts or periods of inactivity.
- Provide relief from extreme temperatures (hot or cold) as soon as possible.
- Remember that even short breaks from total encapsulation are effective in sustaining performance.
- Augment units or divide work between two units.
- Schedule work for a cooler time of day or at night.

MOPP

Analysis Procedures

Commanders must perform situation-based MOPP analysis to determine the appropriate MOPP level. This analysis enhances the probability of mission success by balancing the reduced risk of casualties due to chemical/biological agent exposure against the increased risk of performance decrements and heat strain casualties as MOPP levels increase from zero to MOPP4. Because there is no easy formula to use in deciding an appropriate MOPP level, commanders must consider three situation factors when performing MOPP analysis. The three situation factors are mission, environment, and soldier factors. The contributing factors to these situation factors are subject to complex interactions, and a full analysis is more suited to automated tactical decision aids, such as the Automated

Nuclear, Biological, and Chemical Information System (ANBACIS) currently in use by higher echelon planners, than the simplified figures and tables of this manual. At the small unit level this type of comprehensive analysis is not normally required. However, an understanding of the physiological and psychological factors that affect health and performance while in MOPP, coupled with experience gained in training under a variety of environmental conditions and mission work loads, will prepare you for the task.

The commander will need to consider mission, environmental, and soldier factors when performing MOPP analysis.

Mission Factors

Ask the following questions:

- What is the mission? Is it offensive or defensive?
- What is the likelihood of chemical agent employment?
- What agents are likely to be employed?
- What are the likely targets?
- What is the expected warning time for agent employment?
- What additional protection (such as shelter and cover) is available?
- How physically demanding is the work that must be performed?
- How mentally demanding is the work that must be performed?
- How quickly must the mission be accomplished?
- What is the expected duration of the mission?
- What is the likely follow-on mission?
- Are adequate water and food supplies available?

The mission will greatly influence the amount of protection needed by each soldier. How important is the mission, and what risks will it require? The answers to several of the mission-related questions will be provided in the IPB process.

Once commanders understand the nature of the threat and probability of NBC weapons use, they can proceed to weigh the other mission-, environment-, and soldier-related factors that influence selection of an appropriate MOPP level. For instance, is it day or night? The best time to use chemical agents is between late evening and early morning, when stable or neutral temperature gradients prevail. Under these conditions, agents tend to linger close to the ground and move horizontally with the wind. During unstable conditions in the heat of the day, agents rise rapidly. This rapid rise reduces the time on target and the agents' casualty-producing capabilities. Thus, it is more likely that agents will be employed during predawn darkness, and the environmental and other conditions influencing MOPP analysis can be more appropriately selected. For instance, the environmental heat load, as measured by the WBGT index, is lower at night. This implies that the degree of protection can be increased to match the magnitude of the threat, while achieving a lesser risk of performance problems and heat casualties.

Mission-related factors greatly influence the amount of protection needed by each soldier. When the threat of chemical/biological agent employment is high, and expected warning time for the unit is low, a high level of MOPP is dictated to provide adequate protection. However, increased MOPP levels can lead to performance degradation. Additionally, the incidence of heat casualties among soldiers performing physically demanding work becomes greater with increasing MOPP levels, especially in high ambient heat. The more critical the mission, the more thorough commanders must be in their analysis; the impact of decreased performance and heat casualties from MOPP must be weighted carefully against the risk of casualties and potential mission failure due to chemical agents.

MOPP analysis must consider the work intensity the mission will require and how long this work load must be maintained. Is time a critical factor in mission success? What will be required of the troops after achieving the mission objective? Can they rest? Must they dig-in and defend in place? These are some of the critical questions the commander must answer in proceeding with a MOPP Analysis. The commander can first estimate the work intensity required to perform the mission using Table 2-1 as a guide. Then, based on knowledge of the environmental conditions, Table 2-2 (daylight) or Table 2-7 (night or shade) can be used to provide guidance on work/rest cycles that can sustain work over long time periods. The guidance in that table assumes that the commander is unwilling to sustain more than minimal (5 percent) heat casualties.

If the time constraints of the mission are incompatible with the work/rest cycles predicted, the commander can assess the impact of conducting the operation using continuous work (for example, few or no rest breaks) using Table 2-4 (daylight) or table 2-9 (night or shade). In addition, Figures 2-2 and 2-3 graphically portray the impact of continuous work on the risk of expected casualties for MOPP zero and MOPP4 during daylight operations. These figures provide leaders with estimates on how long a unit can be expected to operate under varying work loads and temperatures without sustaining more than minimal (5 percent) heat casualties. For example, in Figure 2-2, heat casualties can be expected to occur after about 90 minutes if soldiers work continuously at a moderate intensity in BDUs with the WBGT at 85°F. For troops working under the same conditions, but in MOPP4, Figure 2-3 indicates that the

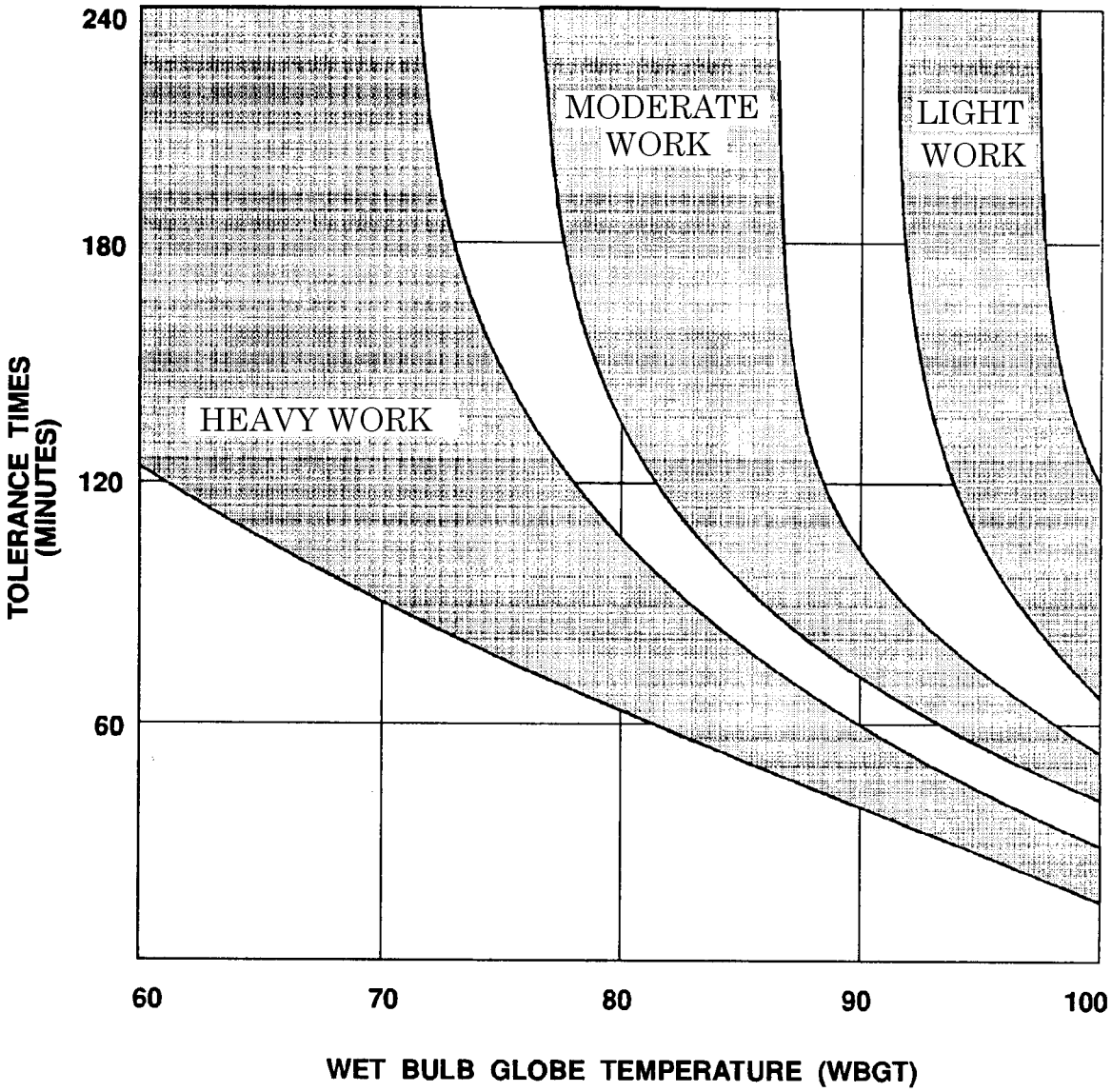


FIGURE 2-2. Estimated tolerance times at three work intensities in MOPP zero.

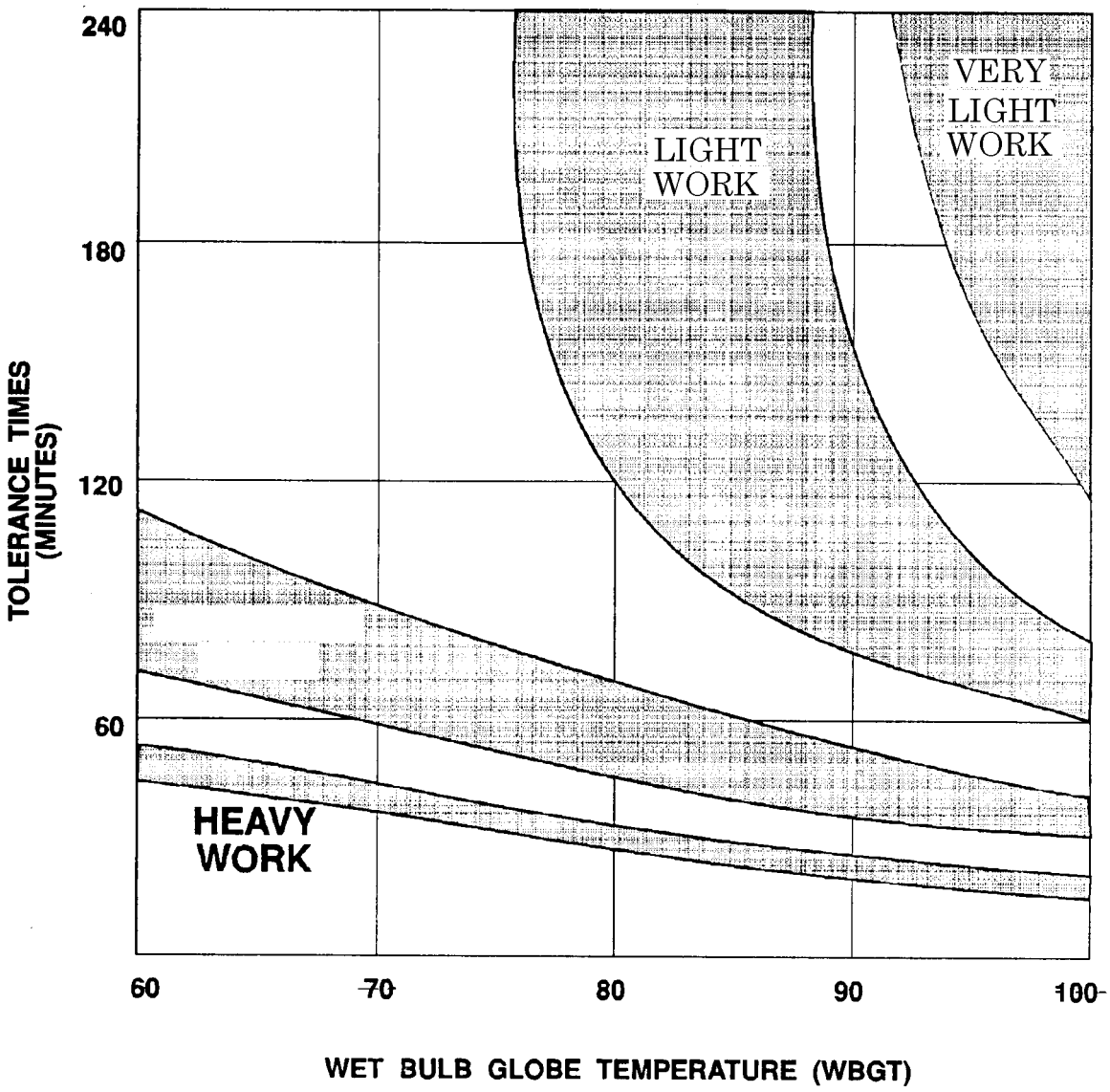


FIGURE 2-3. Estimated tolerance times at four work intensities in MOPP4.

unit can work for only 45 minutes before the risk of heat casualties exceeds 5 percent and for 60 minutes before the risk exceeds 20 percent.

Environmental Factors

Ask the following questions:

- What is the ambient air temperature?
- What is the humidity?
- What is the WBGT index reading for the unit's AO?
- Is it cloudy or sunny?
- Is it windy?
- Is it day or night?

The ambient environmental conditions (outside weather/inside vehicle) must be known before beginning assessment of how these conditions will affect the soldiers' ability to successfully complete a mission. Make sure you have accurate weather information for your location. Check the weather daily; variation in temperature, wind, and humidity can be substantial from region to region. Know what YOUR weather will be. Leaders at all echelons should use and support the extensive weather forecasting resources described in FM 34-81/AFM 105-4. WBGT information can also be obtained from the S2 or staff weather officer (SWO). See Appendix A for further information on operations in special environments.

Most Army guidance for prevention of heat injury and illness is based on WBGT readings (FM 21-10). The WBGT reading provides a single measure of the major determinants of environmental heat stress (for example, air temperature, wind speed, solar load, and humidity). Although the WBGT provides an adequate representation of the heat stress under most conditions, it is not perfect and should be interpreted as approximate guidance. For instance, it was not optimized for conditions commonly seen in environmental extremes, such as the desert. Guidance based on the WBGT is appropriate only for soldiers who are fully acclimatized, optimally conditioned, hydrated, and rested. Additionally, WBGT guidelines do not accurately forecast injury/illness rates under conditions of lower temperatures and high humidity such as may be experienced in the early morning hours; humidity levels over 75 percent substantially increase the risk of heat injury under all work conditions. Other critical items of weather information for the IPB and MOPP analysis are wind direction and speed. When the air temperature is below skin temperature (approximately 92°F), high winds aid in the dissipation of body heat. High winds also make use of chemical agents less effective, and thus decrease the probability of their use. All weather information should be current.

Using tables based on WBGT readings, the commander can better manage personnel resources and minimize the potential for heat casualties. Remember, these tables are only a guide and no substitute for experience.

Soldier Factors

Ask the following questions:

- Are the soldiers well hydrated and nourished?
- Are the soldiers well rested?
- Are the soldiers heat acclimatized?
- Are the soldiers physically fit and well trained?
- Are the soldiers healthy?

The maintenance of full hydration is the most important factor influencing the work performance of soldiers wearing MOPP in warm environments. Dehydration negates the advantages of heat acclimation and high physical fitness. Dehydration impairs the ability to regulate body temperature, reduces mental and physical work performance, and increases susceptibility to heat injuries/illnesses. These adverse effects become increasingly dangerous, as the level of dehydration becomes more severe. Even as little as a 2 percent loss of body weight due to dehydration degrades performance.

Leadership can minimize dehydration by establishing a policy of enforced drinking using the guidelines given in Tables 2-3 and 2-5. Leaders can reduce the likelihood of inadequate drinking in MOPP, especially when masked, by taking advantage of flexible masking policies (MOPP1—25 percent masked), rotating masked and unmasked soldiers often.

The work/rest and maximum continuous work time guidance provided in this chapter assumes that all troops are fully hydrated, heat acclimatized, physically fit, and fully rested. In those cases when the commander is aware that the assumptions of the guidance do not hold, the estimates in the tables must be adjusted upwards or downwards depending on the situation. Dehydration has the greatest impact on performance, but failure to meet the other factors will also impact upon thermoregulation and performance. For instance, going without sleep for more than 30 hours can impair one's ability to regulate body temperature and can reduce task performance.

[1] *If the wet globe temperature (WGT) kit ("Botsball," NSN 6665-01-103-8547,) is used, a correction procedure is required (reference message SGPS-PSP, 23 May 1990).*
WBGT = 0.8 x WGT + 0.2 x dry bulb.
Where dry bulb may be measured by removing the dial thermometer from the WGT Botsball and reading the air temperature after three minutes (shading the sensor from direct sunlight).

Thus, the performance degradation factors (1.5 for physical work and 2.5 for mental work) may require upward adjustment. On the other hand, a downward adjustment may be necessary in the cases of overtrained or experienced troops. Following are some examples.

Performance Time Critical. "An engineer unit has been, ordered to construct a river crossing site to provide a retrograde route for a unit that is already contaminated and which is conducting a rearward passage of lines. The threat has employed a persistent agent in the engineer unit's assembly point. The crossing must be completed in two hours, which will require the unit to work steadily at a moderate work load in MOPP4 in full daylight. The WBGT is 75°F."

The task normally takes 90 minutes to complete, but the performance degradation factor for physical work (cited above) is known to be 1.5. Multiplying the performance degradation factor by the normal time (1.5 x 90), the MOPP4 time to completion is 135 minutes. Thus, conducting the mission in MOPP4 will take longer than the commander's guidance permitted. Adjustments required to meet the mission guidance could include—

- Schedule additional engineer units to complete the job.
- Augment the unit with additional manpower.
- If the hazard of liquid contamination is low, adopt a lower MOPP posture. This may reduce the performance degradation factor and allow mission completion within the two-hour target.

Tolerance Time Critical. "Extensive work, estimated to take one hour in MOPP, is required to improve platoon battle position prior to a possible enemy assault within the next two hours of full daylight. The 1st and 2d platoons' assembly areas do not require soldiers to operate in MOPP, but the 3d platoon occupies contaminated terrain that is vital to the unit's defense. The terrain provides for no shade. The WBGT is 80°F."

If the commander considers MOPP4 for the 3d platoon, a review of Table 2-2 indicates that a work/rest schedule is inappropriate (no work/rest cycle is recommended for heavy work in MOPP4 at a WBGT reading of 80°F), and Table 2-4 shows that continuous work of only 32 minutes would be possible before incurring an initial risk (5 percent) of heat casualties.

This does not meet mission guidance, but several options are available. One alternative would be to relieve the 3d platoon with a fresh unit after 30 minutes. If this was not possible, the tables do indicate that MOPP zero would allow mission completion by 3d platoon, however. If the hazard was vapor only, a MOPP1-masked modified posture might provide a balance between the risk of chemical and heat hazards while assuring mission completion. A review of Table 2-6 indicates that if collective protection can be used to provide rest in the shade at a temperature at or below 84°F WBGT, the troops can cool off sufficiently in 30 minutes to repeat the 32 minutes maximum work period. Rest under cooler conditions and at a lower MOPP level can be very effective in sustaining the pace of operations in an NBC environment.

To gain a better appreciation of the risk of heat casualties in the 3d platoon, the commander next refers to the graphic in Figure 2-3. Entering the bottom of the chart at 80°F and reading up until the lower edge of the shaded area for heavy work is encountered, the maximum work time for light (5 percent) casualties can be noted on the right axis. Continuing upward along the 80°F line to the limit of the shaded area, the time at which 20 percent of the unit would be placed at risk for heat illness can be found at about 40 minutes. The analysis indicates the combination of adopting MOPP4 and working continuously at a heavy work load will place greater than 20 percent of the unit at risk of becoming casualties to heat. This risk must be balanced against the risk of becoming a chemical casualty using the procedures in Chapter 3 before deciding on an optimal MOPP level for the 3d platoon.

The process is repeated for the 1st and 2d platoons. A very low MOPP level is clearly indicated for these units and a work/rest cycle of 30 minutes work/30 minutes rest, although not ideal, could be implemented to allow the work to be completed with minimal casualties and degradation. If these units did not take any rest breaks, any heat exhaustion casualties might not recover in the remaining hour, even with complete rest and dehydration in the shade, unless cooling systems and intravenous fluids were utilized.

Heat Casualties Critical. "Your platoon has been working at a moderate intensity in MOPP4 for 45 minutes under clear, sunny skies. Hostilities are not imminent, but the task is time sensitive. The WBGT reading is 70°F. Two cases of heat exhaustion have occurred in the past five minutes; many others have slowed the pace of work. "

Using the graphic in Figure 2-3, you determine the unit should have been able to work for an additional 15 minutes at this pace before casualties were noted. You remember that one heat casualty is often quickly followed by many others. Realizing that the guidance in the figure is approximate, and not absolute, you call for a rest break. Lack of adequate rest, slight dehydration, individual variance, and an underestimate of the work intensity are among the potential explanations for the mismatch between guidance and reality. If mission success depended on completion of the task, you are

confident of the work intensity estimate, and a 20 percent casualty rate is deemed acceptable, you can estimate the time remaining for work from Figure 2-3 by first finding the point where the lower (5 percent) limit of the shaded area crosses the 45-minute line. Reading up from this point (an "effective" WBGT of 85°F) you note that 15 minutes of work may be possible before the 20 percent casualty risk point is reached.

Use Of MOPP Guidance

As stated before, higher headquarters provides directives to each battalion-size element that will include a MOPP level and a percentage of soldiers to be masked at all times. Subordinate units apply flexibility and initiative to this guidance to account for local conditions. Failure to do this exposes units to far greater hazards in the form of heat casualties, direct fire losses, and mission failures. The following techniques are to be used by units in applying guidance received from higher commands to meet their needs.

Once MOPP1 or 2 is established by higher headquarters, subordinate units may not downgrade from this level except for the following reasons:

- Units may temporarily reduce MOPP levels to conduct decontamination operations such as MOPP gear exchange.
- Soldiers inside enclosures may reduce MOPP level at the discretion of the platoon leader or higher commander. The enclosure need not be airtight but should be capable of protecting against the initial liquid hazard.
- Soldiers may reduce MOPP for medical reasons, including such things as foot care, at the discretion of the senior leader present. When possible, complete on a rotating basis.

Increase MOPP in response to direct threats only. The protective posture recommended by higher headquarters is intended to provide an adequate level of protection against the assessed threat of chemical attack. If your unit is at that recommended level, then a chemical attack will probably produce few casualties. Increasing your units' protective posture will increase the time it takes to accomplish your units' mission. Proper MOPP levels based on the assessed direct threat will increase chances of victory.

Increase your protective posture when encountering contamination or before entering an area that is believed to be contaminated (for example, go from MOPP2 to MOPP3). You should have soldiers mask if they are in a downwind hazard area, and they have not deployed detectors. Units should not increase protective postures simply to defend against a perceived, but unconfirmed, chemical attack on their positions.

Battalions and Companies

Many decisions on increasing or modifying MOPP posture are made at squad and platoon level. Squads and platoons frequently conduct independent operations; therefore, the unit leader's training and experience are essential to successful operations under NBC conditions. Directives received by platoons and squads will also indicate a minimum MOPP level and if needed, a percent of soldiers masked. In some cases the guidance received by battalion will be passed unaltered down to squad level.

However, in some circumstances battalion and company commanders may modify this guidance. For example, brigade guidance is for all units to assume MOPP1 with 25 percent of soldiers masked. The battalion commander has three maneuver companies. Two units are in defensive positions, and one is moving to a reserve position. The commander knows that the two companies in defensive positions are well protected (dispersed, covered, concealed) from conventional munitions. From IPB templating, the enemy is expected to attack in our sector with a regimental-size force (in a supporting attack) along two battalion-size avenues of approach within the hour. The battalion commander anticipates that the greatest chemical threat to his two defending companies is the enemy's potential use of lethal, persistent agents; therefore, he decides to place his two companies in defensive positions at MOPP2—25 percent masked. He directs the rest of the battalion to be at MOPP1—0 percent masked. The unit moving into a reserve position remains at MOPP zero—25 percent masked only until they have closed on the designated position. The commander determined that speed was essential; therefore, he did not put the third company into MOPP2 until they were at their position.

Note in the above example that the battalion commander's modification results in fewer soldiers being masked than would have occurred if the brigade guidance had been followed exactly. This is as it should be. In this example, the battalion commander understands the intent of the brigade commander's guidance. Understanding that intent, he then applies sound tactical judgment to the situation. In this case, although fewer soldiers are masked, those units most vulnerable are better protected. The unit that is least vulnerable to chemicals but most vulnerable to other hazards is allowed to operate at maximum effectiveness.

Both battalion and company commanders should implement guidance from their commander in a way that provides greater protection to their most vulnerable units and allows maximum effectiveness for their units that most require it. Units should try to mask a percentage of soldiers close to that directed by brigade, but should the

tactical situation dictate modification, sound judgment must prevail. Avoid issuing guidance that uses unworkable masking percentage figures. A platoon leader can easily implement guidance to mask 33 percent, or one in three of his soldiers. Guidance to mask 21 percent of the platoon presents obvious, unnecessary problems.

Platoons and Squads

These units implement guidance from higher headquarters immediately upon receipt and in some cases without modification. Unit soldiers will attain the appropriate MOPP level and establish a rotation schedule that ensures that the proper percentage of soldiers are masked. Sleeping soldiers are not included as a part of this percentage. For example, a squad has ten soldiers, three of which are sleeping. It is directed to mask 25 percent of its soldiers, which means that two of its seven soldiers need to mask. This posture will be maintained unless one of the following events occurs:

- If the unit detects the presence of a chemical hazard, soldiers will automatically mask and attain MOPP4 as soon as possible.
- If the unit witnesses a chemical attack or there are indications one has occurred, then the unit will mask and attain MOPP3 and MOPP4 as rapidly as possible.
- Units in a downwind hazard area will mask if they have no warning system in place.
- Units may unmask whenever they become involved in a, direct fire engagement if no chemical weapons have been used or no contamination hazards exist. This can be done as long as some soldiers are unmasked at the time that the engagement begins.
- Units that masked due to being in a downwind hazard area may unmask if collocated alarm systems have not sounded. For example, an armored unit is advancing within a downwind hazard area. Its crews are masked, but the unit has alarms mounted on their upwind vehicles. None of these alarms have sounded when an enemy force is encountered. This unit may unmask to better tight the battle.
- Units may unmask when it is essential to mission accomplishment. For example, an infantry platoon has been directed to attain MOPP2 with 50 percent of soldiers masked. This platoon is preparing to defend against an enemy force expected within the hour. These preparations are going slowly and efforts to speed the work are frustrated by the high protective posture. The soldiers are becoming exhausted. The platoon leader has his unit unmask. During this time, he requires all soldiers to drink water. He issues instructions and discusses his battle plans with unmasked soldiers who can now hear and speak clearly. After 10 minutes he has 25 percent of the platoon mask. The unit is less fatigued.

As only one in four soldiers is masked, a higher work rate is maintained. As the most labor-intensive tasks are completed, squad leaders order masking for 50 percent of their personnel.

Alarms for Unit Defense

Chemical agent alarms/detectors area critical element of a unit's chemical defense. Without them, a unit cannot be alerted and cannot detect chemical agents until symptoms appear. Once chemical warfare has been initiated, alarms/detectors of some type must either already be in use or ready to be used. The alternative is to have the unit mask. There are numerous types of chemical agent alarms/detectors available to a soldier and a unit. This equipment provides them with that NBC defense necessary to ensure adequate prior warning.

The M8A1 chemical agent alarm is unique in that it is the only automatic chemical agent alarm presently available that provides a unit with an early warning capability of a possible vapor hazard (nerve agents only). Employment techniques and procedures are discussed in detail in FM 3-3. Additional chemical agent detectors are discussed in further detail in Chapter 1.

Once soldiers are under attack, it is important to warn others of the hazard. Early warning gives others more time to react. This additional time saves lives and increases mission effectiveness. The following rules apply when giving the alarm:

- Give the alarm as soon as an attack or a hazard is detected.
- Use an alarm method that cannot be confused easily with normal combat signals or sounds.
- All who hear or see the alarm must repeat it swiftly throughout the unit because of its limited range.
- Supplement the alarm over radio and telephone nets.

The four types of signals for warning personnel of an attack are vocal, sound, visual, and audiovisual. Personnel should warn others, using one or a combination of these signals.

Vocal

The spoken word (vocal alarm signal) is the first way of informing troops of an NBC hazard or attack. The vocal alarm for any chemical or biological hazard or attack is the word gas. The person giving the alarm masks first and then shouts "gas" as loudly as possible. Everyone hearing this alarm immediately masks and then repeats the alarm.

The vocal alarm for the arrival of radiological contamination in a unit, area is the word fallout. The first soldier to detect the arrival of fallout will usually be a radiological monitor operating a radiacmeter at the unit command post (CP). When this radiacmeter records an

increase in dose rate to 1 centigray per hour or higher, the monitor should immediately alert unit personnel, using this warning should relay the warning to others, and take cover immediately.

Sound

Sound signals reinforce the vocal alarm to warn of the imminent arrival or the presence of NBC hazards. Sound signals consist of a succession of short signals. The following are examples:

- Rapid and continuous beating on any metal object or any other that produces a loud noise.
- A succession of short blasts on a vehicle horn or other suitable device.
- An interrupted 10 warbling siren sound and vocal alarms in situations in which the sound is lost because of battlefield noises or in which sound signals are not permitted. The standard hand-and-arm signal for NBC hazards consists of the following steps:
- Put on the protective mask.
- Extend both arms horizontally sideways with double fists facing up.
- Move fists rapidly to your head and back to the horizontal position.
- Repeat as necessary.

Visual and Audiovisual

If the automatic chemical agent alarms are in operation, detected agents will trigger a visual and auditory alarm unit. The person who sees or hears an alarm signal from the alarm unit immediately masks and augments this signal with the vocal signal. Radio/telephone operators who hear the vocal signal immediately mask and relay the signal over the unit radio and telephone nets. Personnel reinforce this signal with other sounds or visual signals.

Unmasking Procedures

Unmasking procedures should be conducted after all available methods of agent detection have failed to indicated any agent. Unmasking should be conducted as soon as possible to alleviate soldiers' encapsulation as quickly as possible. The following two unmasking procedures will determine if unmasking is safe.

Unmasking Procedures Using the M256-Series Chemical Detector Kit

The M256-series chemical detector kit does not detect all agents. Therefore, use an unmasking procedure also, even if the detector is available. These procedures take approximately 15 minutes. After all tests with the kit, including a check for liquid contamination, have been performed and the results are negative, the senior person should select one or two soldiers to start the unmasking procedures. If possible, move to a shady place. Bright, direct sunlight can cause pupils in the eyes to constrict, giving false signs of nerve agent exposure. It is prudent to have the selected soldiers disarm before instructing them to unmask. The selected soldiers unmask for five minutes, reseal, and clear their masks. Observe them for ten minutes. If no symptoms appear, it is safe to give the all clear signal and unmask. Continue to watch the soldiers for possible delayed symptoms. Always have first-aid treatment immediately available in case it is needed.

Unmasking Procedures Without an M256 Chemical Detector Kit

If an M256-series kit is not available, the unmasking procedures take approximately 35 minutes. Find a shady area. Use M8 paper to check the area for possible liquid contamination. When a reasonable amount of time has passed after the attack, the senior person should select one or two soldiers. The selected soldiers take a deep breath and break their mask seals, keeping their eyes wide open, for about 15 seconds. They then clear and reseal their masks. Observe them for ten minutes. If no symptoms appear, the selected soldiers unmask for five minutes and then remask. If no symptoms appear in ten minutes after remasking, everyone can unmask. Continue to observe the selected soldiers in case delayed symptoms develop.

In both cases, if soldiers display symptoms of agent poisoning, ensure first-aid treatment is available and provided. If agent is still present, the senior person present must make a decision of selecting one of these options:

- Move to a new area and retest.
- If mission dictates that movement cannot be conducted, a retest can be conducted after one hour.
- Use collective-protection equipment if available.

Filter Exchange Criteria

Filter exchange criteria for all NBC filters in the inventory, from the mask filters to the filters on the simplified collective-protective equipment (SCPE), are based on design, physical condition, climatic conditions, and the possible threat agent that could be employed. information in the following paragraphs addresses peacetime, transition-to-war, and wartime exchange criteria.

Peacetime

When assessing filter exchange criteria, several factors must be considered. Commanders and NBC personnel must monitor replacement schedules for pieces

of NBC equipment having filters. Peacetime exchange criteria for all filters is one year or when the following conditions are applicable:

- Physical damage occurs.
- Filters have become water logged/wet.
- High resistance to airflow is observed.
- Directed by higher headquarters.
- Listed as unserviceable in SB 3-30-2.

Transition to War

Commanders will determine when their units should remove their training filters and replace them with filters from unit contingency stocks. This guidance should be reflected in an SOP or order. Factors for filter exchange consideration are: unit location, unit readiness/deployability alert status, last filters exchange, threat, time available, and stocks available. For example, a forward deployed unit commander, based on an enemy chemical capability in the area of operation, directs by SOP that his unit install its contingency set of filters. Alternatively, a CONUS based unit commander determines that the basis for installing contingency filters would occur upon an increase in unit alert status for deployment to an area with an NBC threat.

Before initiating filter exchange, leaders consider the implications for their units. Some considerations are:

- Mission - What is the unit mission?
- Enemy - What is the current NBC threat assessment; is our unit likely to be attacked on arrival in the operational area?
- Terrain - Where should filters be exchanged? At home station, enroute, or in the operational area?
- Time - When should filters be exchanged When will there be adequate time to exchange filters?
- Troops Available - Do we have the right people available to conduct the exchange?

Table 2-11. Wartime climatic filter exchange intervals when blood agent threat is high (given in weeks).

	CLIMATE CATEGORY				
FILTER	COLD HUMID	WARM MODERATE	HOT DRY	HOT HUMID	SYSTEM
C-2/M13A2	52	52	39	10	M40IM42/M43IM17-series protective mask
M10A1	52	52	52	13	M24/M25 protective mask
M18 Gas	52	39	26	4	Filter comp of M13 tank GPFU
M12A1 Gas	52	39	26	4	Fixed site filter used in structure and building
M48 Gas/Particulate	52	52	39	10	MIAI tank overpressure system
MCPE Gas/Particulate	52	39	26	4	Modular collective-protection equipment
HSFC Gas/Particulate	52	39	26	4	Simplified-protection equipment M20IM28
M23 Gas	52	39	26	4	M51 shelter
M10 Gas	52	39	26	4	Fixed-site shelter
C-22 R1 Gas	52	52	52	13	GPFU M46 fixed-site filter

CLIMATIC DEFINITIONS		
CATEGORY	MEAN TEMP (F)	MEAN RELATIVE HUMIDITY (%)
Cold Humid	< -15	<90
Warm Moderate	<60	<70
Hot Dry	<98	<27
Hot Humid	>96	>76

Wartime

The decision to change filters is driven by two considerations: the amount of chemical agent the filter has been exposed to, and the time the filter has been exposed to the atmosphere. These separate considerations are based on the two mechanisms by which the filter provides protection from chemical agents. For all agents, the filter uses mechanical filtration and absorption as the protection mechanism. Additionally for blood agent CK, the filter uses a chemical reaction. The chemical reaction mechanism is degraded by prolonged exposure to CK and the absorption capacity, by exposure over time to air, particularly hot humid air (see table 2-11).

Based on these factors, the following filter change criteria applies:

- In an area of operation with no chemical attacks confirmed and no CK threat, change filters annually.
- In an area of operation with no chemical attacks confirmed and a CK threat, change the filters IAW Table 2-11.
- For units that have received chemical attacks, change all filters every 30 days.

Information available to the commander to confirm that his unit has been attacked with chemicals would include alarms from chemical agent detectors, positive results from the M256 series chemical agent detector kit, or soldiers experiencing chemical agent symptoms.