

## CHAPTER 2

**Chemical****Atmospheric Stability Charts****Temperature Gradients**

**Inversion Temperature Gradient (Stable-S).** This condition usually exists on a clear or partially clear night when middle and low clouds cover less than 30 percent of the sky, and on early mornings until about 1 hour after sunrise when the wind speed is less than 5 kmph--ideal for enemy employment of chemical agents.

**Neutral Temperature Gradient (Neutral-N).** This condition usually exists on heavily overcast days or nights at 1 or 2 hours before sunset or 1 to 2 hours after sunrise when the middle and low clouds cover more than 30 percent of the sky. Independent of cloud cover and time of day, a neutral condition may also exist when the wind speed is greater than 5 kmph. Additionally, periods of precipitation are normally accompanied by a neutral condition. A neutral temperature gradient is most favorable for enemy use of biological agents.

**Lapse Temperature Gradient (Unstable-U).** This condition normally exists on a clear day when the middle and low clouds cover less than 30 percent of the sky and when the wind speed is less than 5 kmph. It is the least favorable condition for the enemy to employ chemical or biological agents. When a lapse condition exists, area coverage without diffusion will be enhanced with a steady low wind speed of 3 to 7 kmph.

To obtain the air stability category, refer to Table 2-1. Enter Table 2-2 with the category obtained from Table 2-1. Select the appropriate weather and terrain conditions from Table 2-2. Read across to where the columns intersect and extract the final stability category. For more information on field expedient behavior of chemical agents, see FM 3-6 or from CDM.

**Table 2-1. Air stability category basic chart**

Air Stability Category Basic Chart		U = Unstable N = Neutral S = Stable		
Time of day° and angle of sun	Condition of Sky			
	Less than half covered	More than half covered	Overcast	
<b>M O R N I N G</b>	≤ 4°	S	S	N
	>4° ≤ 32°	N	N	N
	>32° ≤ 40°	U	N	N
	>40°	U	U	N
<b>E V E N I N G</b>	>46°	U	U	N
	>35° 46°	U	N	N
	>12° 35°	N	N	N
	>5° 12°	S	N	N
	≤ 5°	S	S	N

° At night, use 4°

**Table 2-3. Downwind distance of warning area**

Means of Delivery (from line G of the NBC 1 or NBC 2)	Distance (km) from the center of the attack area along the downwind axis, when the stability condition is—		
	U	N	S
Artillery, bomblets, and mortars	10	30	50
Multiple rocket launchers, missiles, bombs, and unknown munitions.	15	30	50

**Table 2-2. Air stability category adjustment chart.**

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

Once the proper stability condition is determined, use Table 2-3 to compute the downwind distance for Type A attacks.

Plotting Chemical Agent Hazards

Classification of chemical agents:

- Persistent
- Nonpersistent
- Dusty

Table 2-4. Threat chemical agents.

Types of agent	Symbol	Symptoms in man	Effects on man	Rate of Action	How normally disseminated	Protection required	Decon	Means of identification
Nerve	GA GB GB  VX	Difficulty breathing, sweating, drooling, nausea, vomiting, convulsions, and dimming of vision	Incapacitates at low concentration; kills if inhaled or absorbed through the skin or eyes	Very rapid by inhalation, slower through skin  Delayed through skin; rapid through eyes	Aerosol or vapor	Protective mask and protective clothing	STB slurry; household bleach; 10% solution of lye or washing soda; DS2; steam and ammonia in confined area; hot, soapy water; M25B-series kit; M291 kit	M256, M18A2, CAM, MB/M9 paper, MBA1 alarm
Blood	AC CK	Rapid breathing, convulsions, and coma	Kills if high concentrations are inhaled	Rapid	Aerosol or vapor	Protective mask	None needed in field.	M256, M18A2
Blister	HD HN HL L  CX	No early symptoms. Searing of eyes and stinging of skin  Powerful irritation of eyes, nose, and skin	Blisters skin and respiratory tract; can cause temporary blindness. Some agents sting and form welts on the skin.	Blisters delayed hours to days; eye effects more rapid. Mustard lewisite, and phosgene oxime very rapid	Liquid or droplets	Protective mask and protective clothing	STB; DS2; household bleach; M25B-series kit; Try lye; fire. Wash with soap and water.	M256, M18A2, CAM, MB/M9 paper

**Chemical Hazard Plotting Steps**  
**Air-Contaminating Agents--Type A**

Type A agents normally are dispersed as aerosols or vapor clouds with little or no contamination on the ground.

**Ground-Contaminating Agents--Type B**

Type B agents normally are expected to be dispersed in liquid form to contaminate surfaces.

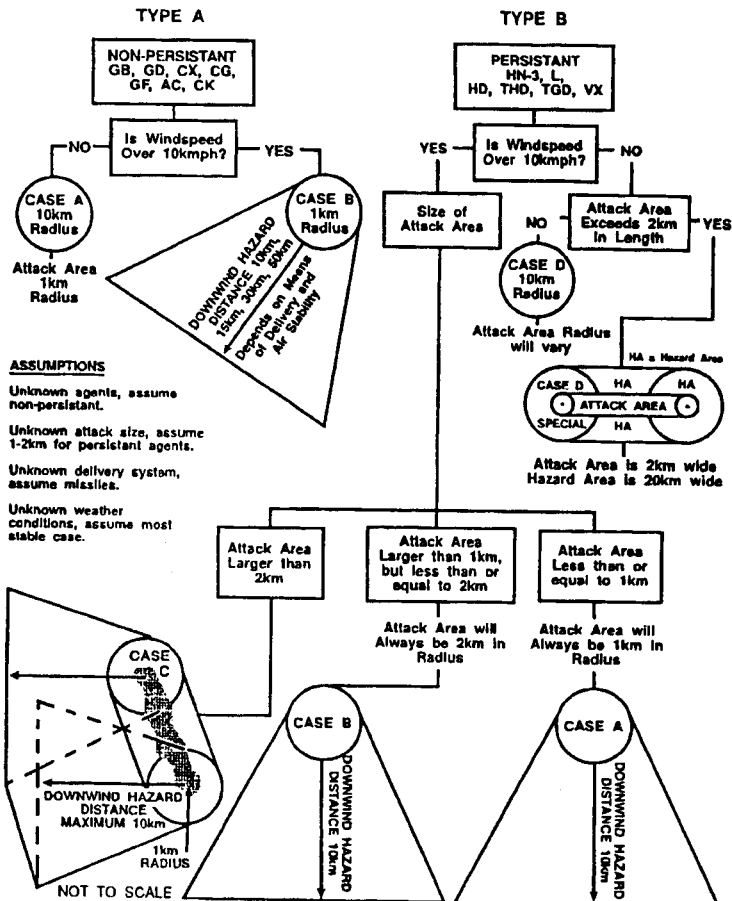
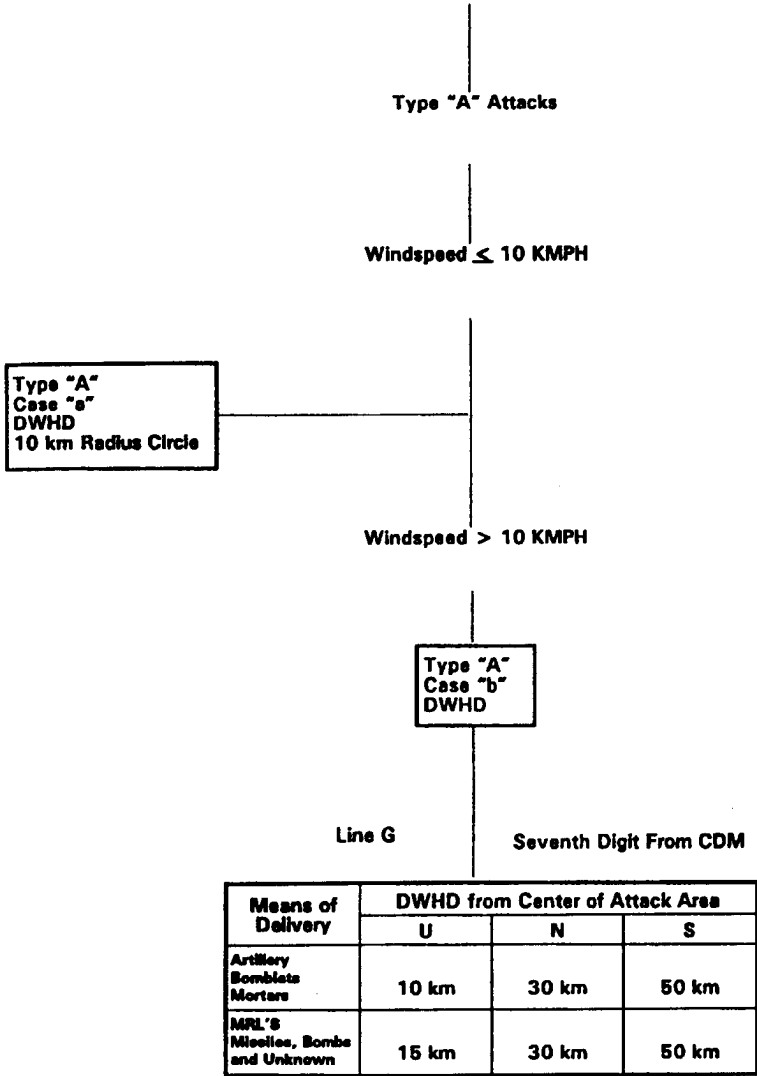


Figure 2-1. Flow chart. Chemical Hazard Prediction

**Chemical Hazard Prediction  
Ground Burst Non-Persistent Agent**



*Figure 2-2. Flow chart, type A attack.*

Plotting Downwind Hazard

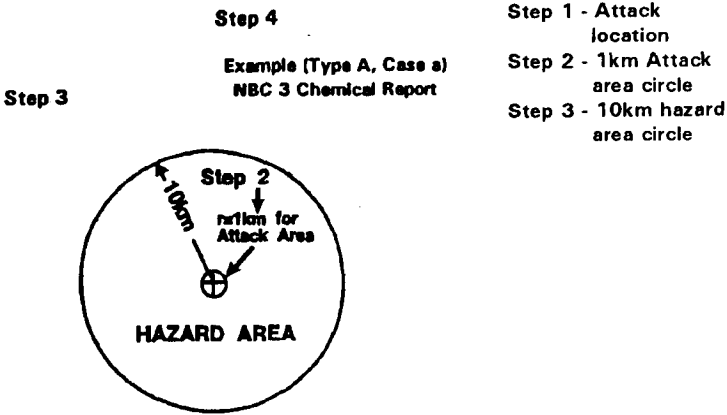


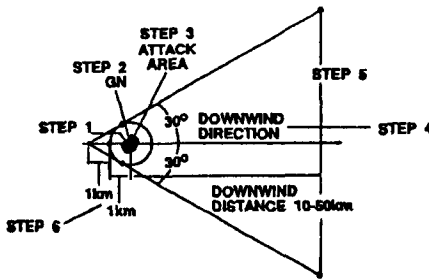
Figure 2-3. Type A, Case a.

**STEP 7**  
Example (Type A, Case b) NBC 3  
Chemical Report

A 002  
D 271647Z  
F LB580750 Actual  
H Nerve, NP, Ground Burst  
\*PA LB566751  
LB566754  
LB532774  
LB510684  
LB568747

Y 0106 Deg. 022kmph  
ZA 21824Z  
ZB Type A Case B

\* Coordinates points of line PA.

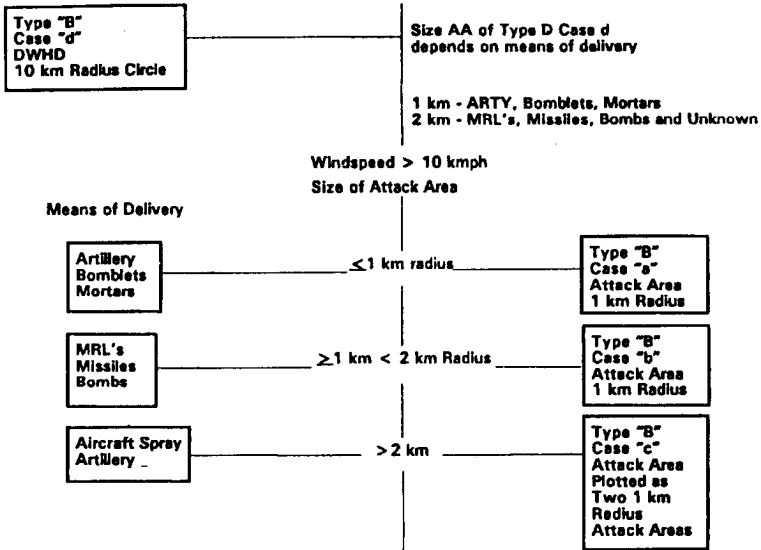


**Step 1 - Attack location**  
**Step 2 - Grid north line**  
**Step 3 - 1km attack area circle**  
**Step 4 - Downwind direction and speed**

**Step 5 - Downwind distance**  
**Step 6 - Extended upwind intersection point**  
**Step 7 - Tangent lines**

Figure 2-4. Type A, Case b.

**Chemical Hazard Prediction  
Air Burst Persistent Agent  
Type "B" Attack  
Windspeed  $\leq$  10 kmph**

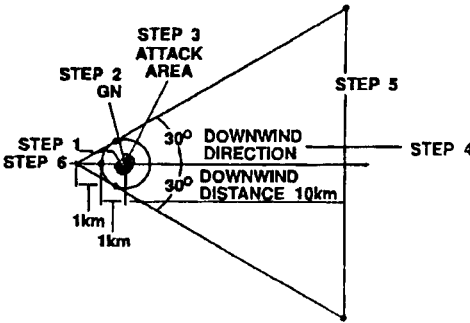


\* All Type "B" Downwind Distance is 10 km  
\* Size of Attack Area Unknown. Use Type "B" Case "b"

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

Figure 2-5. Flow chart, type B attack.





**STEP 7**

Example (Type B Case a) NBC 3  
Chemical Report

A 002  
D 271472  
F LB560750 Actual  
H Nerve, NP, Ground Burst  
PA LB556751  
LB559754  
LB632774  
LB610694  
LB558747  
Y 0105 Deg, 022 kmph  
ZA 218242  
ZB Type B Case A  
• Coordinate points of line PA.

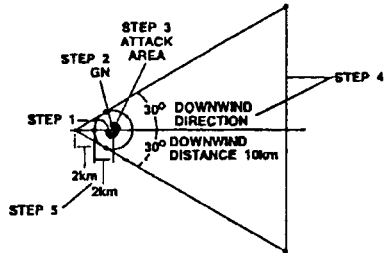
Plot the same as type A, Case b  
Maximum downwind distance is 10km

*Figure 2-6. Type B, Case a.*

**STEP 6**

Example (Type B Case b) NBC 3  
Chemical Report

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



Step 1. Attack location  
Step 2. Grid north line  
Step 3. 2km circle

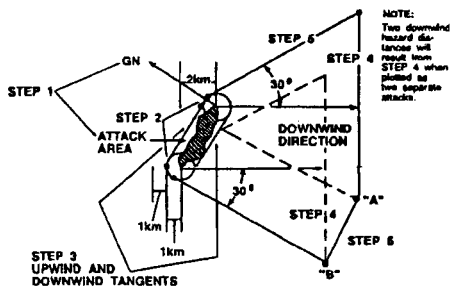
Step 4. Downwind direction and distance  
Step 5. Extended upwind intersection point  
Step 6. Tangent lines

*Figure 2-7. Type B, Case b.*

STEP 6

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

A 007  
D 141550Z  
F UC310060 to  
UC370061 est  
H Nerve, V, Spray  
PA UC313068  
UC303068  
UC298059  
UC305938  
UC365939  
UC481014  
PB Attack Area 2-4 Days  
Hazard Area 1-2 Days  
Y 0147 Degrees,  
012 kmph  
ZA 216862  
ZB = Coordinate Points For  
Line PA



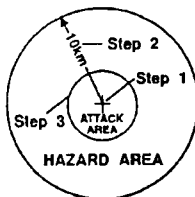
- Step 1. Attack area
- Step 2. 1km circles
- Step 3. Downwind direction lines

- Step 4. Downwind distance
- Step 5. Tangent lines

Figure 2-8. Type B, Case c.

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

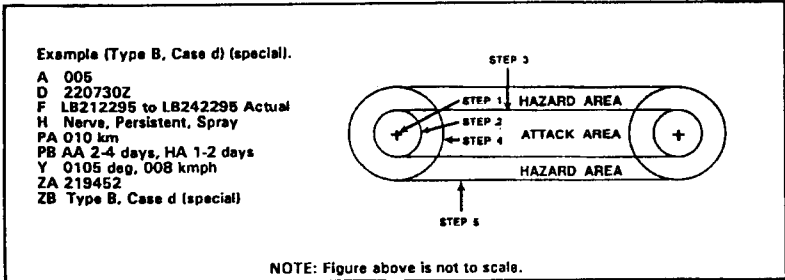
A 005  
D 220730Z  
F LB212295 est  
H Nerve, V, Airburst  
PA 010 km  
Y 0105 Deg, 008 kmph  
ZA 219452  
ZB Radius of Attack Area 1 km, Type B  
Case d



NOTE: Attack area radius depends on means of delivery.

- Step 1. Attack location
- Step 2. 10km circle
- Step 3. Attack area circle

Figure 2-9. Type B, Case d.



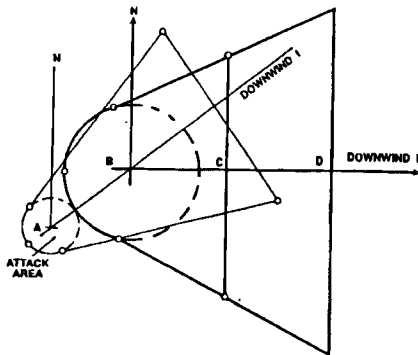
- Step 1. Attack area (Start/end points)
- Step 2. Start/end point 1 km circles
- Step 3. Attack area
- Step 4. Start/end point 10km circles
- Step 5. Hazard area

**Figure 2-10. Type B, Case d (Special).**

### Adjusted Hazard Prediction

Adjust hazard predictions when:

- Windspeed change of 10 kmph or more
- Wind speed increases from less than 10 kmph to more than 10kmph or the reverse.
- Change of air stability category (Type A attacks only)
- Downwind direction change of 30° or more.



**Figure 2-11. Recalculation of downwind hazard area, Type A attack, after change in downwind direction at Point B.**

### Persistency of Chemical Agents

Table 2-5 shows persistency of chemical agents for moderate contamination. As a rule of thumb, cooler conditions increase the persistency of chemical agents. Persistency triples as contamination levels increase from moderate to heavy. Chemical agent persistency data in Table 2-5 is for surface winds of 10 kmph and considers weathering only (without decon). For other surfaces use the following multiplication factors for the times given: alkyd paint = 1.3, bare soil = 4.0. Agent HL is not shown. To approximate HL, use GD persistency times. Concentrations of contamination are considered to be heavy at (10 grams per square meter. One week is considered to be 168 hours. One month (30 days) is equal to 720 hours.

**Table 2-5. Chemical Agent Persistency in Hours on CARC Painted Surfaces**

Temperature		GA/GF <sup>1</sup>	GB <sup>2,3</sup>	GD <sup>2,3</sup>	HD <sup>1</sup>	VX <sup>2,3</sup>
C°	F°					
-30	-22	*	110.34	436.69	**	***
-20	-4	*	45.26	145.63	**	***
-10	14	*	20.09	54.11	**	***
0	32	*	9.44	22.07	**	***
10	50	1.42	4.70	9.78	12	1776
20	68	0.71	2.45	4.64	6.33	634
30	86	0.33	1.35	2.36	2.8	241
40	104	0.25	0.76	1.25	2	102
50	122	0.25	0.44	0.70	1	44
55	131	0.25	0.34	0.51	1	25

<sup>1</sup> For grassy terrain multiply the number in the chart by 0.4  
<sup>2</sup> For grassy terrain multiply the number in the chart by 1.75  
<sup>3</sup> For Sandy terrain multiply the number in the chart by 4.5  
 \* Agent persistency time is greater than 1.42  
 \*\* Agent is in a frozen state and will not evaporate or decay  
 \*\*\* Agent persistency time exceeds 2,000 hours

### Time of Arrival for Chemical Hazards

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

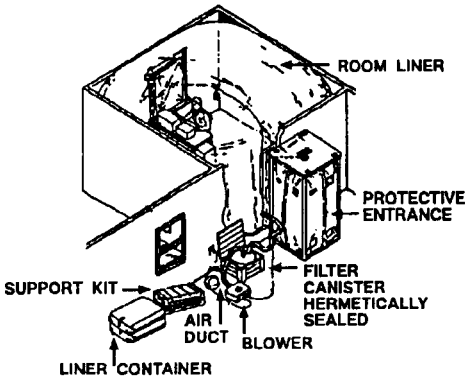
$$10 \text{ km} \div (2 \times 5 \text{ kmph}) = 1 \text{ hour}$$

## Collective Protection

**Table 2-6 Types of collective-protection systems for vehicles and fixed facilities.**

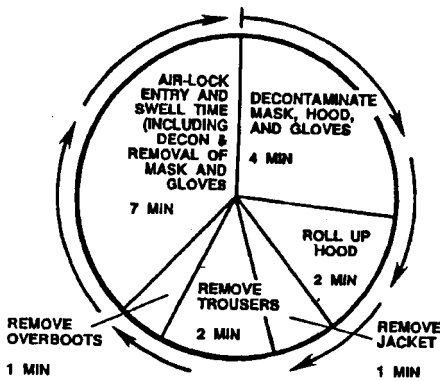
System	Description	conditions Justifying the Requirement	Example Systems
Ventilated-faceplate	Series of individual respiratory systems (or masks) serviced by a common filter.	<ul style="list-style-type: none"> <li>• Clean working area subject to inadvertent entry of contamination.</li> <li>• High work rate, reduced breathing resistance.</li> <li>• Frequent entry and exit movements.</li> <li>• Brief inside occupation.</li> </ul>	<ul style="list-style-type: none"> <li>• Infantry fighting vehicles.</li> <li>• Self-propelled howitzers.</li> </ul>
Overpressure	A collective NBC filter and overpressure system inside a vehicle or shelter	<ul style="list-style-type: none"> <li>• Critical manual dexterity skills.</li> <li>• Limited entry and exit movements.</li> <li>• Lengthy inside occupation.</li> </ul>	<ul style="list-style-type: none"> <li>• Air defense.</li> <li>• Communications.</li> <li>• Medical.</li> <li>• Patient evaluation vehicles.</li> <li>• Maintenance and supply sites.</li> <li>• Rest and relief.</li> </ul>
Hybrid	Combination of overpressure and ventilated-facepiece system.	<ul style="list-style-type: none"> <li>• Flexibility.</li> <li>• Lengthy inside occupation.</li> <li>• Emergency entry and exit movements.</li> </ul>	<ul style="list-style-type: none"> <li>• Armored fighting vehicles (tanks).</li> <li>• Helicopters.</li> <li>• Air defense.</li> <li>• Multiple launcher rocket system.</li> </ul>
Total	Hybrid or overpressure plus an environmental control system. Other categories may also incorporate environmental control; for example, ventilated facepiece and microclimatic cooling.	<ul style="list-style-type: none"> <li>• Same as hybrid.</li> <li>• Extreme climates.</li> </ul>	<ul style="list-style-type: none"> <li>• Same as hybrid.</li> </ul>

<i>Table 2-7. GPFU fielded systems.</i>	
Number of GPFUs/System	System
1	M60 Tank
1	M60A1 Tank
1	M60A2 Tank
1	M60A3 Tank
1	M728 Combat Engineer vehicle
1	M1 Tank
1	M1A1 Tank



*Figure 2-8. Simplified collective-protection equipment.*

*Table 6-5. Entry process times.*



*Figure 2-12. Entry process times.*

**Table 2-13. Modular CPE examples of application.**

System	Set-Up <sup>1</sup>		Tear-Down	
	Personnel in MOPP4	Time (min)	Personnel in MOPP4	Time (min)
Simplified Collective-Protection Equipment M20	2	30 <sup>2</sup>	2	10 <sup>3</sup>
Modular Collective-Protection Equipment	2	10 <sup>4</sup>	2	5
M51 Shelter	5	30 <sup>5</sup>	5	30

<sup>1</sup> Only set-up time and not fully operational time.  
<sup>2</sup> Does not include time to seal a room when the liner is not used.  
<sup>3</sup> Based on disposing of the room liner in place.  
<sup>4</sup> Protective entrance only.  
<sup>5</sup> Site-prep and stake-down times not included.

**Table 2-14. Collective-protection MOPP levels.**

Soldiers Not in Collective Protection			Soldiers in Collective Protection	
MOPP Level	MOPP Gear		Ventilated Facepiece	Overpressure
Zero	Overgarment Overboots Mask & Hood Gloves	carried carried carried carried	• Assume MOPP zero.	• Assume MOPP zero. • Overpressure off.
1	Overgarment Overboots Mask & Hood Gloves	worn carried carried carried	• Assume MOPP 1.	• Assume MOPP zero or MOPP 1. • Overpressure on.
2	Overgarment Overboots Mask & Hood Gloves	worn worn carried carried	• Assume MOPP2.	• maintain MOPP zero or MOPP1. • Overpressure on. • Entry exit procedures not required.
3	Overgarment Overboots Mask & Hood Gloves	worn worn worn carried	• Assume MOPP3. • When mounted, connect ventilated facepiece to mask.	• Maintain MOPP zero or MOPP1 unless interior is contaminated. • Overpressure on. • Exit/entry procedures required if an attack occurs.
4	Overgarment Overboots Mask & Hood Gloves	worn worn worn worn	• Assume MOPP3 or MOPP4.* • When mounted, connect ventilated facepiece to mask.	• Maintain MOPP zero or MOPP1 unless interior is contaminated. • Overpressure on. • Entry/exit procedures required if an attack occurs.

\* During an engagement, the commander may allow personnel protected from liquid agents to operate temporarily without protective gloves. This option could slightly increase the potential for casualties.