Chapter 1

Vulnerability Analysis

The focus of this field manual is nuclear contamination avoidance. Like most concepts in the Army, contamination avoidance is a process. This process involves:

- Identifying the threat facing friendly forces.
- Identifying whether friendly units are a target.
- Understanding the operational concerns and impact of nuclear contamination.
- Locating nuclear hazards on the battlefield.

By identifying and locating nuclear hazards on the battlefield, units will be able to either avoid the hazard or implement the protective procedures outlined in FM 3-4 to minimize the affects. It should be emphasized, at this point, that if threat forces posses nuclear weapons, they also probably possess chemical and/or biological weapons as well. Therefore, US forces must be prepared to operate in an NBC environment. But, for the purpose of this manual, contamination avoidance principles will center only on nuclear operations.

Before we begin the discussion of contamination avoidance, we must first discuss two critical, often overlooked, aspects of successful operations on the contaminated battlefield. These two aspects are nuclear threat assessment and vulnerability analysis. Both are described in this chapter.

With the current trend in nuclear proliferation, the nuclear threat now and in the future will be global. The proliferation of nuclear-capable nations in all contingency regions increases the likelihood of US forces being targets of nuclear attack. The extensive development worldwide of nuclear power plants presents an additional nuclear hazard condition if these facilities are damaged deliberately, inadvertently, or by industrial accident.

As Chapter 1 to FM 3-100 points out, nuclear weapons technology proliferation is increasing. Deploying US forces must be capable of accurately assessing the nuclear threat imposed by the opposing force and be capable of addressing unit vulnerability to attack. Chapter 2 in FM 3-100 describes in detail how nuclear weapons may be used and how their use may shape the battle.

When planning operations, commanders must consider the potential effects of nuclear weapons on personnel and equipment. In conventional operations, concentration of forces increases the chance for success, but this same concentration increases the effects of nuclear attacks and the likelihood of their occurrence. Commanders must decide what size of force to use and when they should be concentrated.

To assess a unit's vulnerability to nuclear attack, the commander determines how well protected the unit is and the type and size of weapon likely to be used against it. The commander then weighs various courses of action and determines which presents an acceptable risk to allow accomplishment of the mission. This whole process starts with the Intelligence Preparation of the Battlefield (IPB) and an initial assessment of the nuclear threat.

The IPB Process

The IPB process is a staff tool that helps identify and answer the commander's priority intelligence requirements (PIR). It's part of the operational planning that is necessary for battle management.

IPB is initiated and coordinated by the S2 and used to predict battlefield events and synchronize courses of action. IPB is designed to reduce the commander's uncertainties concerning weather, enemy, and terrain for a specific geographic area in a graphic format. It enables the commander to see the battlefield: where friendly and enemy forces can move, shoot, and communicate; where critical areas lie; and where enemy forces (and his own) are most vulnerable. IPB guides the S2 in determining where and when to employ collection assets to detect or deny enemy activities. These assets, working collectively, fulfill intelligence requirements and answer the PIR. IPB is the key for preparing for battle. It analyzes the intelligence data base in detail to determine the impact of enemy, weather, and terrain on the operation and presents this information graphically. It is a continuous process which supports planning and execution for all operations. IPB consists of a systematic five-function process:

- Evaluation of the battlefield (areas of operation and influence).
- Terrain analysis.
- Weather analysis.
- Threat evaluation.
- Threat integration.

On the battlefield, units will have incomplete intelligence concerning enemy nuclear capabilities and/or intentions. Commanders must ensure that the IPB becomes an integrated process through which key members of the staff contribute. IPB is a process involving intelligence and operations personnel. It must also be integrated with input from chemical officers.

Chemical officers and NCOs, in coordination with the S2/3, must address nuclear warfare during all phases of the battle. This is accomplished only by direct participation in the IPB process. Working with the S2, the chemical staff accomplishes the following:

- Generate template(s) of potential nuclear targets or areas of contamination.
- Designate templated areas that influence the scheme of maneuver as named areas of interest (NAIs).
- Include NAIs in the collection plan, and identify indicators.
- Include designated NAIs in the reconnaissance and surveillance (R&S) plan, and designate responsibility for confirming or denying the template.

Using the IPB process, the chemical officer or NCO provides the commander updates on the nuclear situation.

Based on the time periods of interest, the chemical staff will provide the battle commander the following:

- Detailed information on enemy nuclear capabilities, based on the type of units and weapons the enemy has available in the area of operations/area of influence (AO/AI) during a selected period.
- How the enemy would employ nuclear weapons to support his battle plan.
- 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, and how they could impact on nuclear weapons.
- Templates of predicted fallout data which are updated as conditions change.
- Alternative actions the commander can initiate prior to the phase time line in question so as to minimize degradation of forces.
- Continuous monitoring of intelligence messages and radio traffic for any nuclear related information that could be important to the unit's mission.

It is important that the chemical officer/NCO be succinct during the commander's briefing or have his information presented by the S3 during his portion of the briefing. Therefore, for input to be addressed, chemical personnel must be players in the IPB process. Although it is developed under the direction of the S2, once completed, the decision support template (DST) becomes an operational document and is briefed to the commander by the S3. If the chemical staff is an active participant in the IPB process, and is determined to serve the commander, then they must work within that process in developing the DST and R&S plan. Through this participation, the chemical staff best serves the commander as special staff warfare experts. The DST must include nuclear concerns and visually present them to the commander.

During battle management activities, the chemical staff advisor works with the S2 on the IPB. He or she coordinates with the intelligence officer to analyze and identify nuclear targets based on threat, terrain, and the AO. Potential threat nuclear targets could be key terrain, choke points, command and control facilities, counterattack routes, mobility corridors, troop concentrations and/or rear area assembly points.

A nuclear vulnerability assessment constitutes an important part of battlefield assessment and risk analysis and is a primary means through which the chemical staff advisor participates in the battlefield assessment process. In this assessment, the chemical officer must develop information for integration into the various staff estimates. From the S2, the chemical officer or NCO obtains—

- Time of interest.
- Threat probable courses of action and intent.
- NAIs and target areas of interest (TAIs).
- Summary of enemy activity, including any nuclear attacks, movement of nuclear equipment or material, presence and level of training of threat forces, and indicators of enemy nuclear warfare comments, such as queuing up weather radar.

Specific items of interest from the S2 would be—

- Direction and speed of winds between O and 30,000 meters above the surface.
- How weather conditions may affect fallout patterns.
- Terrain.
- Transportation assets (railways, airfields, road networks) available for shipment of nuclear munitions.
- Availability and location of industrial assets capable of producing and/or weaponizing nuclear warfare material.
- Availability y of nuclear weapons, delivery systems, and location of stockpiles.

From the fire support officer (FSO), the chemical officer obtains information on casualty percentages from friendly and threat conventional munitions. Examples of information obtained include casualty percentages based on target size and casualty percentages based on weapon systems.

The chemical staff also should prepare a list, general in nature, of information compiled from various sources (such as news bulletins, spot reports, and intelligence summaries (INSUMs)). This information, when viewed as single events, may appear to be meaningless. However, when added to other pieces of information it may provide the key that connects the information and present the best view of the enemy's intent. Items of general information include, but are not limited to, the following:

- Availability of nuclear defense equipment to enemy forces.
- Amount of overhead cover or collective protection shelters or systems. If enemy forces seek overhead cover or move into

collective protection shelters, it may indicate that the enemy intends to use nuclear weapons.

- The enemy's stated national policy or philosophy on the use of nuclear weapons: Has the enemy declared a no-use, first-use, or limited-use only-for-retaliation-in-kind policy? Does the enemy consider the use of flame or smoke as NBC agents?
- Leadership. Is the enemy's national or military leadership willing to use nuclear weapons on their own territory or expose their own populations to the hazards generated by nuclear munitions?
- If the enemy does not possess munitions, the capability to deploy such munitions or expertise to employ them, have attempts been made to gain this ability? Reports indicating the presence of advisors from other nations working with enemy forces, international trade agreements or shipments of equipment (such as, fuzes, weapons-grade uranium) may provide insight to the enemy's intent.

Once information is gathered, it will provide input to the formulation of the nuclear threat status.

Nuclear Threat Status (STANAG 2984)

US forces may not have to carry nuclear defense equipment (radiac equipment) based on the initial threat estimate. If the threat condition changes and indicators suggest the possible use of nuclear weapons by threat forces, this equipment would be deployed forward (to the division support area or to the brigade support area). These weapon stocks may be pre-palletized for immediate deployment by aircraft to the affected unit if required. However, this decision must be made based on available aircraft or other transportation systems. This could be done so that the forces would not have to carry the radiac equipment or dosimeters in their field packs or ruck sacks.

The minimum nuclear threat status is set at division or separate brigade level and is a flexible system determined by the most current enemy situation, as depicted by the continuously updated IPB process. This allows local commanders to increase the threat status if conditions change in their areas of operation. Threat status governs the initial deployment of nuclear defense assets (equipment or units) and the positioning of those assets on the battlefield or in the operational area. The nuclear threat status serial numbers are for planning purposes according to STANAG 2984. These numbers, however, may be substituted for a color code (Serial 0 = white; Serial 1 = green, etc.). It does, however, require chemical personnel at brigade and division level to stay abreast of the intelligence picture. The nuclear threat status is outlined in the following paragraphs:

Serial 0 (none).

The opposing force does not possess nuclear defense equipment, is not trained in nuclear defense or employment, and do not possess the capability to employ nuclear weapons or systems. Further, the opposing force is not expected to gain access to such weapons; and if they were able to gain these weapons, it is considered highly unlikely that the weapons would be employed against US forces.

Under this status, a deploying force would not have to carry nuclear defense equipment. However, protective masks should be carried. Chemical personnel should possibly concentrate efforts in chemical or biological operations, smoke, herbicides, flame field expedients (FFE), and monitoring threat communication channels for nuclear threat indicators.

Serial 1 (low).

The opposing force has an offensive nuclear capability, has received training in defense and employment techniques; but, there is no indication of the use of nuclear weapons in the immediate future. This indication may be based on whether nuclear munitions are dispersed or deployed, or the stated objectives and intent of opposing forces.

Given this threat status, all personnel carry their personal defense equipment, or nuclear defense equipment stockpiles are identified and would be readily available for deployment to the operational area if the threat status should increase. NBC reconnaissance systems deploy to the operational area of interest to continue to provide a monitoring capability of the opposing force. Chemical personnel continue to concentrate their efforts in the areas listed under Serial 0.

Serial 2 (medium).

The opposing force is equipped and trained in nuclear weapons defense and employment techniques. Nuclear weapons and employment systems are readily available. Nuclear weapons have been employed in other areas of the theater. Continued employment of nuclear weapons is considered probable in the immediate future. Indicators would be—

- Nuclear munitions deployed to either field storage sites or firing units.
- Enemy troops carrying protective equipment.
- Nuclear recon elements observed with conventional recon units.
- Decon elements moved forward.

Unit nuclear defense equipment should be either pre-palletized and located forward for easy access or issued to the soldiers responsible for use within the unit. Personnel and equipment should be kept under cover as much as possible to protect them from contamination.

Effective downwind messages (EDMs) should be sent out to subordinate units. Decontamination assets, NBC recon assets and smoke support should be deployed as part of the force structure. Detection and monitoring equipment should be issued to the operators. Unit should improve fighting positions and harden shelters if mission permits.

Serial 3 (high).

The opposing force possesses nuclear weapons and delivery systems. Nuclear defense equipment is available and training status is considered at par or better than that of the United States. Nuclear weapons have already been employed in the theater and attack is considered imminent. Indicators are—

- Nuclear attack in progress; but not in your area of operation.
- Nuclear warnings/signals to enemy troops.
- Nuclear munitions delivered to firing units within range of friendly forces.
- Movement of surface-to-surface missiles to launch sites.

US forces should deploy with nuclear defense equipment in the unit load. This will depend on the nuclear threat to the airfield or port at which they land. Soldiers should ensure radiac equipment is serviceable prior to deployment. Decontamination and nuclear recon assets should be task organized and moved forward. Contingency stocks of nuclear defense equipment may be moved forward to the battalion trains. EDMs are initiated. Place collective protection systems into a state of readiness, including those systems in combat vehicles.

A threat status number can be used to represent a combined status for NBC, or it can be several numbers used to represent each category. It is possible to have a Chemical/Biological (CB) status of three and a nuclear status of zero. This threat status provides the commander with guidance for deployment and operational purposes. It allows the commander to tailor chemical units to fit any situation.

It also must be understood that the threat status can change rapidly. Although a nuclear status of zero may exist during deployment, the opposing force may seize industrial products or obtain nuclear weapons from a sponsoring nation. Therefore, the ground commander must be capable of upgrading the NBC defense posture quickly.

To assist in the formulation of the threat status, the chemical staff, (in conjunction with the S2) must analyze all information received. A tool in this analysis is the Threat Status Matrix in Figure 1-1.

More than one matrix may be necessary to determine the threat status for nuclear, biological, and chemical attack.

To use the matrix, place an "X" in the appropriate block. Add each column; and whichever column has the most X's provides a means to identify what threat status serial number could be used to indicate the enemy force intent. If an overall threat status cannot be determined due to an informational shortfall, collection assets should be reallocated or positioned to gain the needed information.

Once the threat status estimate has been assessed, the chemical staff must analyze the protection level required for friendly forces. This is accomplished by modifying the MOPP analysis process contained in FM 3-4. Key factors include analyzing mission, environment, and soldier factors. These key factotrs are discussed in FM 3-4 and listed below:

- Understanding the mission and commander's intent for friendly forces.
- Capabilities and level of training of friendly forces.

Condition	Serial Number			
	0	1	2	3
A. Enemy force information: • Training status • NBC equipment availability. • In collective protection shelters, in Positions with overhead cover, or exposed				
B. Nuclear weapon systems: • Availability of nuclear weapons. • Nuclear weapons moved forward to firing units or launch sites? • Weather radars queued? • Decon/recon assets forward?				
C. Enemy CB Policy and Capabilities: • What is enemy's stated policy on nuclear weapons employment? • Can enemy produce nuclear weapons? • Has industrial output increased or changed for production of nuclear munitions or protective equipment?				
D. Current Situation: • Have nuclear weapons been used in theater? • Is weather favorable for nuclear attack? • Is terrain favorable for nuclear attack?				
E. Totals (circle current status).				

Figure 1-1. NBC threat status matrix.

- Availability of nuclear defense equipment and decon assets. In this regard, information may be obtained from the S2 or G5.

Other factors include—

- Location and availability of additional building materials to harden shelters.
- Location of civilian chemical manufacturing and storage facilities. In the event of a nuclear attack, these areas may be targeted or damaged, multiplying the hazard to friendly forces. Also, chemicals or hazardous materials stored in these facilities may produce areas of contamination if storage containers leak (either intentional or unintentional). To assess these hazards and how such a leak may impact on operations, refer to DOT Regulation 5300.3 and DOD Regulation 4145.19-R-1.
- Availability of civilian contracted labor and water transport for decon operations.
- For urban areas, location of car washes. These car washes may be used in lieu of operational decon stations. Obtain data on local fire hydrants (location, type of connections, etc.). Hydrants may be used to provide water for decon operations.

The chemical staff must properly prepare the threat status and identify the protection level required for friendly forces to withstand a nuclear attack. This information is vital to the commander and for the successful accomplishment of the mission. The commander may be required to reallocate or position units on the battlefield to reduce vulnerability to an attack.

Nuclear Vulnerability Analysis

A unit's vulnerability to nuclear attack depends on the yield of the warhead likely to be used, the protection available to the unit, and how well dispersed the unit is. Tables 1-1 through 1-3 help estimate the damage caused by a nuclear detonation. This information will help the commander determine unit vulnerability to nuclear attack. These tables are simplified and safesided. They assume that the worst case of a nuclear burst will occur at ground zero (GZ) (see FM 101-31-1) and that all target elements will be dispersed uniformly throughout the target area.

Immediate Permanent Ineffectiveness (IP)—Personnel become ineffective within 3 minutes of exposure and remain ineffective until death. Death usually occurs within one day.

Immediate Transient Ineffectiveness (IT)—Personnel become ineffective for any task within 3 minutes of exposure and remain so for approximately 7 minutes. Personnel recover to greater than 75 percent of their pre-exposure performance levels after about 10 minutes and remain so for about 30 minutes. Then their performance degrades for around 5 hours, for undemanding tasks or 2 hours for demanding tasks, when radiation sickness becomes so sever that they are ineffective. They remain ineffective until death, which usually occurs in 5 to 6 days.

Latent Lethality (LL)-is the physiological response from a dose of 650 cGy (RADs). For physically undemanding tasks, performance degrades about 3 hours after exposure and remains so for approximately 2 days, when personnel will recover combat effectiveness for 6 days or so. Then they relapse into degraded performance and remain so for 4 weeks after exposure when radiation sickness becomes so severe that they are ineffective. They will remain ineffective until death approximately 6 weeks after exposure. For physically demanding tasks, personnel performance degrades about 2 hours after exposure and remains so for three weeks, when radiation sickness becomes severe enough to render the personnel ineffective. They remain ineffective until death approximately 6 weeks after exposure.

Physically Demanding Tasks-Personnel become less than 25 percent effective within 2 hours of exposure and remain so for 3 weeks, at which time radiation sickness symptoms will be present in sufficient severity to render them ineffective. Personnel will remain ineffective until death in approximately 6 weeks.

Radiation casualties, with these three categories in mind, become performance-based. Recent studies by the Defense Nuclear Agency and the Ballistic Research Laboratory reveal that lethal dosage varies from subject to subject and according to the physical demands of the task to be performed. Thus, dosage is expressed in terms of LD 50/30: the dose that will prove to be lethal to 50 percent of the exposed population within 30 days.

In an active nuclear environment, the more concentrated a unit is, the more lucrative the target becomes. If the unit itself is not the target,

Table 1-1. Radiation casualty criteria (performance-based).

Response	Criteria Initial Dose in Centigray (cGy)
Immediate Permanent Ineffectiveness	8,000
Immediate Transient Ineffectiveness	3,800
Latent Lethality	650

but falls within the fallout pattern, unit monitors will be capable of providing the commander with essential information regarding the hazard. Nuclear hazard prediction is covered in more detail in Chapter 3.

Based on vulnerability radius and unit size, commanders may determine the risk to the unit from a nuclear attack and whether or not to adjust unit dispersion. However, personnel may not be the target. Often, a unit's equipment, due to sensitivity and vulnerability, may be the target.

Additional information concerning planning factors and operational exposure guidance may be obtained in Appendix A to this FM. Additional information concerning shielding afforded by particular vehicles and structures, commonly referred to as transmission factors, can be found in Chapter 3 and Appendix B.

A more detailed discussion of nuclear vulnerability analysis can be found in FM 101-31-1. The information presented in Tables 1-2 and 1-3 (below and next page) are for planning purposes only. See FM 101-31-2 (S) for actual vulnerability radii.

Casualty and Damage Assessment

When assessing casualties or damage, the coverage tables consider only blast and nuclear radiation effects. The combined coverage of the two effects is listed. Thermal casualty data are included in the effects tables.

Safety Distance Assessment

Blast, thermal radiation, and nuclear radiation were considered for assessing safety distances, and the largest radius of safety is listed. For calculations, friendly troops

Table 1-2. Radii of vulnerability (distance in meters).

Category	Personnel In—(LL) (Based on governing effect)					Moderate Damage				Severe Damage		
						Wheeled Vehicles		Tanks	Towed Arty	Supply Depot	Randomly Parked Helicopters	
Yield (KT)	Open	Open Foxholes	APC	Tanks	Earth Shelter	Exp	Shld				Cargo Trans	Light Observ
0.1	700	600	600	500	300	200	150	100	100	100	400	500
0.5	900	800	800	700	450	300	250	200	200	200	500	800
1	1,200	900	900	800	500	400	350	300	250	250	700	1,100
2	1,700	1,000	1,100	900	600	500	450	400	300	300	850	1,300
3	2,000	1,100	1,200	1,000	700	600	500	500	400	450	1,000	1,600
5	2,500	1,200	1,250	1,100	800	700	600	600	500	500	1,200	1,900
10	3,200	1,300	1,300	1,250	900	800	700	700	600	600	1,500	2,500
15	3,700	1,400	1,400	1,300	950	900	800	800	700	700	1,800	2,800
20	4,000	1,500	1,450	1,400	1,000	1,000	900	900	800	800	1,900	3,400
30	5,000	1,600	1,500	1,500	1,100	1,200	1,100	1,000	900	950	2,200	3,700
40	5,500	1,700	1,600	1,600	1,200	1,400	1,250	1,100	1,000	1,200	2,500	4,100
50	6,000	1,800	1,700	1,700	1,300	1,700	1,500	1,200	1,200	1,400	2,700	4,500
100	8,000	1,900	1,800	1,800	1,400	2,200	1,900	1,300	1,300	1,700	3,200	5,700
200	12,000	2,000	1,900	1,900	1,500	2,500	2,000	1,500	1,500	1,900	3,700	6,200
300	14,000	2,100	1,950	1,50	1,600	3,000	2,100	1,600	1,600	2,000	3,800	7,100

Note: 1. Radii listed are distances at which a 5 percent incidence of effect occurs.
2. Height of Burst (HOB) used is 60W1/3 meters.

To obtain a radius of vulnerability, enter the Yield column at the nearest listed yield. If your yield is exactly halfway between listed yields, enter with the larger yield. Data listed in Table 1-2 is for training use only. Use the data in FM 101-31-2 (S) whenever possible.

Table 1-3. Comparable target table.

Secondary Targets (from Effective Tables)			Primary Targets in Coverage Tables					
			Exposed Personnel	Personnel in Open Foxholes	Personnel in Tanks	Moderate Damage to Tanks	Moderate Damage to Towed Artillery	Moderate Damage to Wheeled Vehicles
			LL	IT	IT			
Factories (25-50 ton Crane Capacity)	All Yields	Severe Damage				●		
Fixed Bridges	≤55 KT	Severe Damage					●	
Floating Bridges	≤55 KT	Severe Damage					●	
Missile/Rockets In Open	≤100 KT	Severe Damage						●
Railroad Boxcars and Flat Cars (loaded)	All Yields	Severe Damage						●
Tracked Vehicles (not tanks)	All Yields	Severe Damage					●	
Heavy Towed and Self-Propelled Artillery	All Yields	Moderate Damage				●		
Personnel in Brick Apartment Buildings	≤55 KT	LL	●					
	≤10 KT	IP			●			
Personnel in APCs	≤100 KT	IP		●				
Personnel in Earth Shelters	All Yields	LL		●				

Methodology for Obtaining Comparable Target Coverage from Covered Tables

1. The radius of damage for the listed secondary targets will equal the radius of damage for the primary target. Therefore the coverage for the secondary target will be at least that shown for the corresponding primary target in the appropriate coverage table.
2. For other secondary targets that have not been tabulated above, there is no general relationship between the secondary target response function and a primary response function. However, there is a methodology with which an approximate coverage can be obtained from the coverage tables for some of these targets. If more accurate target analysis is required, the numerical method should be used.

The procedure is outlined below:

a. From a coverage table of the weapons system and yield being analyzed, determine the height of burst for the gun/launcher-target range.
b. Use the effects tables to detemine the desired radius of damage for the secondary target using the height of burst just selected.
c. Find the radius of damage for a primary target that comes closest to the secondary radius of damage. (Stay at the same height of burst, yield and system.) For radiation sensitive secondary targets use only radiation primary targets and for blast sensitive targets, use only blast primary targets.
d. Enter the coverage table for the primary target catagory selected and for the radius of target in question, read the appropriate coverage (If the primary target radius of damage used is less than that of the secondary target, then the coverage to the secondary target will be at least that of the primary target. If the primary target radius of damage used is greater than that of the secondary target, then the coverage to the secondary target will be at most that of the primary target.)

are assumed to be in one of three vulnerability categories and exposed to one of three levels of risk.

Vulnerability Categories

Unwarned, Exposed—Personnel standing in the open at time of burst, but drop to prone position before the blast wave arrives. They may have areas of bare skin exposed to direct thermal radiation and may suffer temporary loss of vision. This category also applies to civilian personnel in open areas.

Warned, Exposed—Personnel prone on open ground, with all skin areas covered, and with an overall thermal protection at least equal to that provided by a two-layer, summer uniform. Troops have been warned, but do not have time to dig foxholes.

Warned, Protected—Personnel have some protection against heat, blast, and radiation. Protected categories include tanks, armored personnel carriers, foxholes, weapons emplacements, and command posts and shelters.

Risk Criteria

Negligible Risk —Largest radius corresponding to 1 percent casualties or 2.5 percent nuisance effects.

Moderate Risk —Largest radius corresponding to 2.5 percent casualties or 5 percent nuisance effects.

Emergency Risk —5 percent casualties (nuisance effects not specified).

Nuclear Radiation Safety

Negligible Risk —50 cGy for previously unexposed troops.

Moderate Risk —70 cGy for previously unexposed troops.

Emergency Risk —150 cGy for previously unexposed troops.

Primary Targets

For personnel primary targets, the combined effects of blast casualties and radiation casualties are considered in coverage and effects tables. For materiel primary targets, only blast is considered.

Exposed Personnel. Unless otherwise stated, this term refers to personnel in the open, regardless of physical posture or uniform. Radiation casualties are determined based on free-in-air doses sufficient to cause IP (8,000 cGy), IT (3,000 cGy), or LL (650 cGy), as identified in Table 1-1. Blast casualties are determined from overpressures sufficient to cause severe injury from decelerative tumbling or lung damage.

Personnel in Foxholes. This term refers to personnel in 1.8-meter-deep open foxholes, each with a 0.3-meter-firing step. Blast overpressures of 296 kilopascals (kPa) (43 psi) cause lung hemmorage, which is the blast injury mechanism for producing casualties to personnel in foxholes. Nuclear radiation radii is computed, using foxhole transmission factors. Foxhole collapse is no longer considered the governing casualty producing effect.

Personnel in Tanks. Severe damage to tanks was used to find blast radii for casualties to personnel in tanks. Nuclear radiation radii were computed, using transmission factors for medium tanks with radiation liners.

Moderate Damage to Wheeled Vehicles. Although the term "wheeled vehicles" originally referred to 2-1/2-ton trucks and l/4-ton vehicles other than WWII jeeps, it also applies to HMMWV and other vehicles smaller than 2 tons.

Targeting Terms and Criteria

Definitions for Structures

Severe Damage (Sev). A degree of structural damage that precludes further use of a structure for the purpose for which it was intended, without essentially complete reconstruction. Generally, collapse of the structure is implied.

Moderate Damage (Mod). A degree of structural damage to principal load-carrying members (trusses, columns, beams) and walls that precludes effective use of a structure for the purpose for which it was intended, until major repairs are made.

Light Damage (Lit). A degree of damage that results in broken windows, slight damage to roofing and siding, blowing down of light interior partitions, and slight cracking of curtain walls in buildings. Generally, structures receiving light damage can be used as intended, with only minor repairs and removal of debris.

Definitions for Vehicles

Severe Damage (Sev). Damaged, nonfictional, very difficult to repair. At least one subsystem is nonfunctional and not repairable.

Moderate Damage (Mod). Damaged, nonfunctional, repairable with special tools, skills, and parts. At least half of all subsystems (engine, power-train, tracks, etc.) are not functional, but are repairable.

Analysis of Friendly Unit Vulnerability

Two techniques to evaluate friendly unit vulnerability to nuclear detonations are (1) a technical approach (unit dispositions are compared with the effects of an expected weapon yield), and (2) an operational approach (unit dispositions are compared with targeting criteria used by the threat target analyst).

Vulnerability Analysis

The primary tool for analysing friendly dispositions is the radius of vulnerability (RV). RV is the radius of the circle within which friendly troops will be exposed to a risk equal to, or greater than, the emergency risk criterion (5-percent combat ineffectiveness) and/or within which material will be subjected to a 5-percent probability of the specified degree of damage. See Table 1-2 or 1-3 version of the RV table in FM 101-31-2, Chapter 15. The GZ for the RV is always assumed to be the point where detonation will do the greatest damage to the friendly unit or installation. Delivery errors are not considered.

Analyzing the vulnerability of friendly dispositions and installations consists of—

- Determining the appropriate threat yields based on current intelligence.
- Determining the disposition of personnel in friendly units.
- Obtaining the appropriate vulnerability radii from the RV table.
- Estimating fractional coverage for each target category, using the visual, numerical, or index technique. For the purposes of this discussion, the visual technique will be used. Although this technique is considered the least accurate, it is the easiest method to use for the field commander. For additional information concerning the visual, numerical, or index, refer to FM 101-31-1, Chapter 4.
- Recommending ways to decrease vulnerability or increase protection if the estimated damage exceeds the acceptable loss criteria established by the commander.

Visual Technique

Outline the unit battle position on the tactical map. Using a compass, a piece of plastic with the radius of vulnerability drawn to scale on it, or a circular map scale. Superimpose the radius of vulnerability chosen from Table 1-2 or 1-3 over the target area.

The GZ used for the analysis is the location that would result in the highest fractional coverage of the target.

From this worst-case GZ and the appropriate RV, an estimation of the percentage of casualties or materiel damage that might result from an enemy nuclear strike may be determined.

Using the center point of the compass, template, or circular map scale as the GZ, choose the GZ that would result in the highest fractional coverage of the target area. Visually estimate the percent of the unit covered by the RV.

If this fractional coverage yields unacceptable losses of personnel or equipment, the commander must then make a decision on how to best reduce this casualty rate. This may be done by adding shielding as outlined in Appendix B, erecting the vulnerability reduction measures outlined in FM 3-4, or highlighted later in this chapter. A tactical decision may also be made to reduce vulnerability.

If a mechanized battalion occupies a battle position 5 km wide, and 2.5 km deep, it could be positioned as in Figure 1-2. Target elements are uniformly dispersed in the area. In this example, the RV or personnel in APCs to a 5-kt weapon is shown with GZ at worst case. Since 50 percent

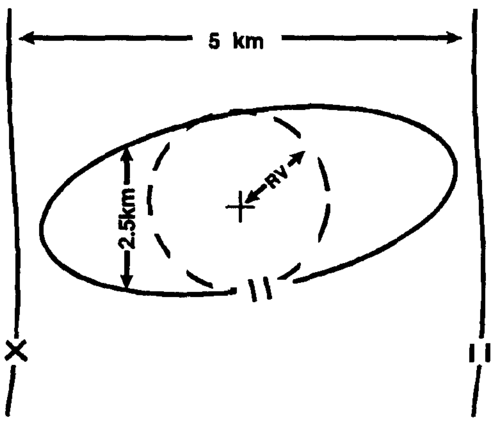

Figure 1-2.

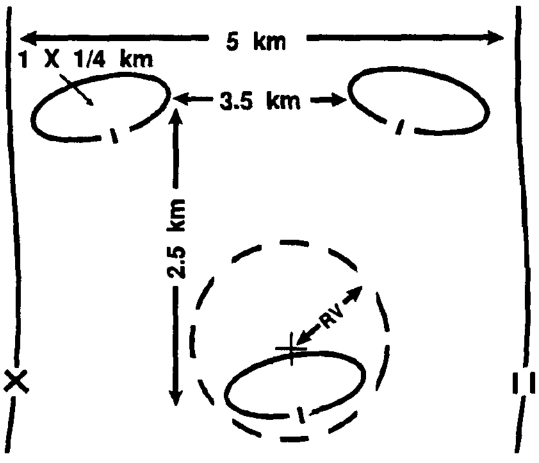

Figure 1-3.

of the battalion is covered by the RV of the 5-kt weapon, then up to 50 percent of the battalion's personnel in APCs could become casualties. Obviously, the risk to a unit in this particular battle position is extreamly high.

When the same battalion deploys in three company or team battle positions in depth, the distances between positions significantly reduce the damage, even assuming the weapon detorates at the optimum GZ. In Figure 1-3 although one company is 100 percent vulnerable, the battalion is only 33 percent vulnerable. Thus, one company may have up to 100 percent casualties, but the battalion may only have 33 percent casualties.

When the estimated fractional coverage exceeds acceptable loss criteria, develop alternate courses of action (COAs) to reduce the nuclear vulnerability of the friendly unit or facilities by—

- Dispersal
- Increased protection
- Maintaining positions in close proximity to enemy forces
- Using passive measures such as operational sedcurity (OPSEC), deception, and/or camouflage.

When mitigation actions are taken, reanalyze, using adjusted data.

Vulnerability Reduction

Active measures prevent the enemy from using nuclear weapons. Passive measures increase survivability. Individual and unit collective measures are only discussed briefly here. See FM 3-4 for detailed information.

Active Measures

Active measures are those taken to find and destroy either the munitions or the delivery systems. Destruction of delivery systems and munitions is the best method of reducing the chances of being attacked.

The destruction of stockpiles of nuclear munitions and production facilities is usually beyond the capabilities of lower level commanders. Echelons above corps (EAC) have the responsibility and sufficient assets for finding and destroying these targets.

Corps and divisions do not have the capability to locate and destroy stockpiles or production facilities; but they do have the capability to find and destroy delivery systems. Recon flights, counterbattery radar, and other intelligence collection assets are used to find delivery systems, such as long-range cannons and missile systems.

Passive Measures

It is not possible to destroy all threat nuclear munitions and/or delivery systems. Units must always take precautions to avoid being targeted or to reduce the effects of an attack if one does occur. These are passive measures. All units must use passive measures as part of normal operations to reduce the effects of operating under nuclear conditions. These measures include—

- Plan ahead.
- Avoid detection.
- Provide warning.
- Maintain discipline.

H Seek protection.

- Disperse.
- Remain mobile.
- Cover supplies and equipment.
- Limit exposure.
- Prevent spread of fallout.
- Follow unit SOPs.
- Camouflage.

Plan Ahead

Tasks take longer to perform in a nuclear environment. Again, FM 3-4 contains tables to help commanders estimate how long it takes to accomplish missions in a nuclear environment. Commanders must take time to carefully think out courses of action and allow for the additional time requirement. This is commonly referred to as wargaming. A bad decision could cause the unit to become needlessly contaminated or suffer casualties. Use the nuclear threat status for planning and stocking nuclear defense equipment. Units must prepare to continue the mission after a nuclear attack. Following an enemy nuclear strike, commanders must quickly assess the damage and reconstitute lost or weakened units.

Avoid Detection

Avoiding detection is the best way to prevent nuclear attacks. Do this by employing good OPSEC measures. These include camouflage, light discipline, and especially, signal security. Both active and passive measures must be used to prevent the enemy from gaining target information. Use defensive electronic warfare; electronic countermeasures (ECM) and electronic counter-countermeasures (ECCM) to reduce the chances of identification and location. In the nuclear environment, it is even more important that commanders consider displacing if detection and/or identification is suspected.

Provide Warning

If the unit is unable to avoid a nuclear attack, early warning of battlefield hazards is very important. The NBCWRS notifies units that adjacent units have been attacked or that a downwind hazard is present. When no NBCWRS warning is received, periodic monitoring, discussed later in this manual, is essential. Troops must be able to identify nuclear attacks and take appropriate actions. NBC recon teams, using the NBC Reconnaissance System (NBCRS), alert moving units before they enter contaminated areas.

Maintain Discipline

The unit must maintain discipline and confidence in its ability to survive and operate if it is to overcome the shock of a nuclear attack and continue the mission. Commanders must be able to rely on their troops not to give up hope or lose the sense of duty. Again, plan ahead. Use these plans whenever possible during unit training. Use the information contained in FM 3-4 to assist in developing unit plans.

Seek Protection

Natural terrain may provide shelter from the effects of nuclear weapons. Ditches, ravines, and natural depressions reduce initial nuclear effects.

Foxholes with solid overhead cover and shelters offer good protection against nuclear weapons. However, any overhead cover such as tents, tarpaulins, and ponchos offer at least some protection from fallout. Use NBC protective covers (NBC-PCs) to protect equipment whenever possible.

Disperse

Combat service support (CSS) installations and troops in compact assembly areas are vulnerable to nuclear weapons. Commanders must determine how much dispersion is needed. Dispersion must reduce vulnerability but not hinder operations or prevent the unit from concentrating when necessary. Supplies, especially food, POL, and ammunition, must be dispersed so they will not all be destroyed at once. The more dispersed a unit is, the longer it will take to do even routine tasks. The degree of acceptable dispersion depends upon mission, enemy, terrain, troops, and time available (METT-T).

Remain Mobile

Tactical mobility gives the commander the best chance for avoidance. Constant movement prevents the enemy from pinpointing locations and accurately employing nuclear weapons. However, the battlefield will be a difficult place in which to maneuver. Contaminated areas, tree blowdown, urban rubble, fires, flooding, fallout, and craters are obstacles that must be dealt with. NBC recon teams and the serving S2/G2 can provide useful information. The best source of information on mobility routes, however, is the movement control center (MCC).

Cover Supplies and Equipment

Store supplies and equipment under cover to prevent contamination. Buildings offer excellent protection from fallout. Field expedient methods are abundant.

NBC protective covers, tarpaulins, pallets, packing materials, dunnage, and plastic (sheets, bags, and rolls) all can be used. Field expedient covers, especially canvas and cardboard, provide protection from fallout for a short period. Contamination seeps through all such covers; however, NBC-PCs provide protection for up to 24 hours. Units must replace covers as soon as possible after heavy contamination. Although these covers may provide protection against fallout, a contact hazard will remain until the dust on the ground and on the protective cover has decayed.

Limit Exposure

All plans should include postattack procedures for limiting exposure to radiological hazards. Amount of exposure is important. Every minute spent in a radiologically contaminated environment increases a person's total radiation dose. Only personnel required to accomplish a mission are sent into a contaminated area.

Limit exposure with time. By waiting to enter a contaminated area, the contamination level will decay and with it the chance of exposure. Exposure can also be accidental. Personnel may not know that equipment is contaminated. Usually, this can be prevented by always marking contaminated equipment. But there are places where nuclear contamination hazards can accumulate, such as air filters. All engines have air filters that trap nuclear contaminants. These contaminants accumulate. So even if the hazard area is small, it can be deadly. Persons working around equipment should be aware of hidden hazards. Always dispose of contaminated collectors, such as air filters, as contaminated waste.

Prevent Spread of Contamination

Limiting the number of personnel and amount of equipment in the area helps prevent the spread of contamination. Make every effort to confine nuclear contamination to as small an area as possible. This begins with monitoring to determine the amount and extent of contamination. It also reduces the amount of decon required. Units moving from a contaminated area into a clean area should decontaminate at or near the edge of contamination. Mark all contaminated areas, and report them to other units to keep them from entering the contaminated area unknowingly.

Contaminated material presents additional problems to limiting the spread of contamination. If the situation permits, material can be left and allowed to decay. If the equipment is mission essential, it must be decontaminated on the spot or brought back to the rear and decontaminated.

If the situation permits, decontaminate as far forward as possible. If this is not possible, then material may have to be transported to the rear for decontamination. If contaminated material must be moved, keep in mind that the amount of contamination transferred to the road network or ground surface is directly proportional to the amount of contamination on the material, location of the contamination, and type of surface on which the contamination is present. Precautions or safety measures to take, when moving this equipment are—

- Notify the MCC of contaminated vehicles or contaminated routes.
- Use as few transport vehicles as possible.
- Use one route (especially around congested areas).
- Monitor the route periodically for contamination.
- Cover the material to keep contamination from being blown onto the road. (Weigh the risk of ground contamination with the additional burden of decontamination / disposing of potentially contaminated covering material).
- Warn personnel downwind if a vapor hazard is present.
- Monitor and decontaminate transport vehicles before transporting noncontaminated material.
- Ensure transport crews wear protective masks to reduce the hazard from airborne radioactive particles.

There may be instances in which contaminated material or waste material must be disposed of or destroyed. Bury the contaminated material. Burial is effective for all types of contamination. Mark and avoid the area where contaminated waste is buried. Procedures for marking contaminated waste burial sites is outlined in FM 3-5. This consists of submitting an NBC 5 nuclear report, outlining the contaminated waste burial site. However, this report must be sent by the NBCC, so that line item Alpha, (strike serial number) may be assigned. The unit, therefore, that closes the decontamination site must notify the NBCC.