Chapter 4

Nuclear Protection

There are three types of radiation:
ALPHA — Travels only a few centimeters, internal hazard only.
BETA — Travels a few meters in air, limited penetrating power, external and internal hazard.
GAMMA — Travels speed of light, cannot be totally shielded.

Actions Before an Attack:

The best defense against a nuclear attack is to dig in. Unit defensive positions, which vary from soldier's foxholes to improved defensive positions, should be prepared whenever the tactical situation permits.

Foxholes: A deep, round foxhole with overhead cover offers the best protection from blast, thermal radiation, initial nuclear radiation, and fallout.

Field shelters: Well-constructed fighting positions and bunkers provide excellent protection against all the effects of a nuclear detonation.

Tunnels, caves, culverts, and storm drains provide good shelter.

Armored personnel earners, infantry fighting vehicles, and tanks (in a hull-down defilade) give excellent protection.

Weapons, individual equipment, clothing, and other items should be secured in their foxholes. Supplies, explosives, and flammables should be dispersed and protected or shielded. If left unsecured, these may become lethal weapons from the blast wave.

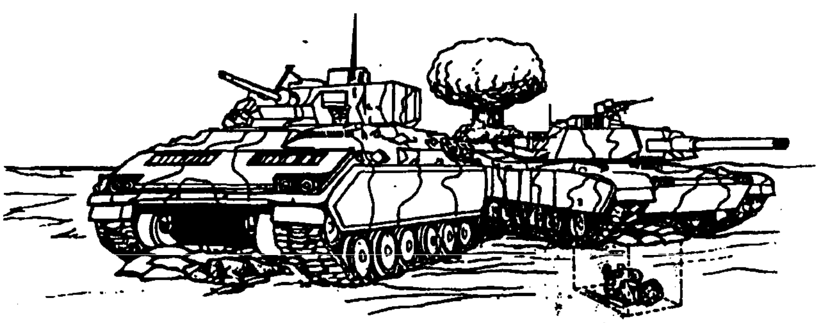

Figure 4-1. Tracked vehicle as expedient overhead cover.

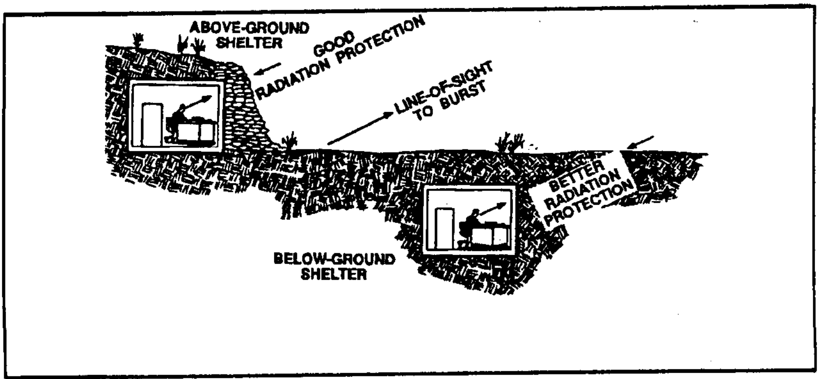

Figure 4-2. Section views of shelters.

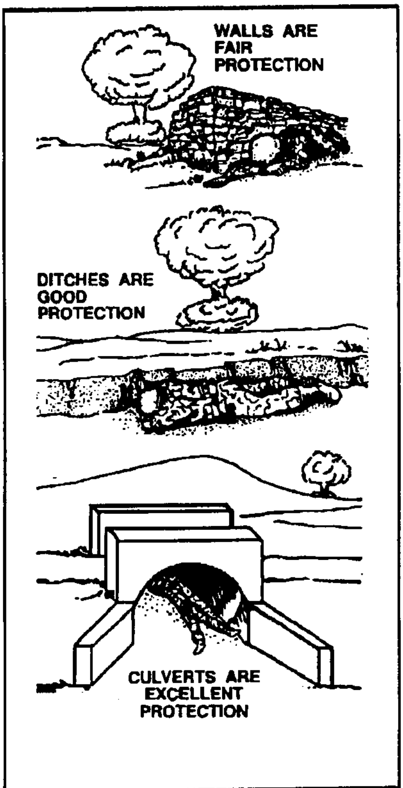

Figure 4-3. Expedient cover against blast and thermal effects.

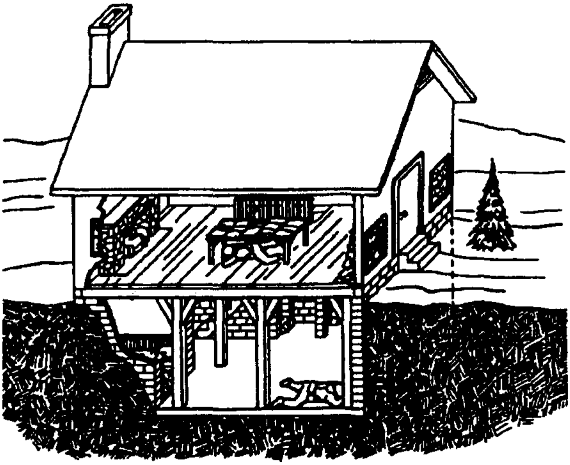

Figure 4-4. Shelter in a building.

Table 4-1. Shielding values of earth cover for a 2,400-centigray free-in-air dose.

Soldier in	Radiation Protection Factor	Resultant Dose cGy
Open	one	2,400
Open foxhole, 4' deep	8	300
Same with 6" earth cover	12	200
Same with 12" earth cover	24	100
Same with 18" earth cover	48	50
Same with 24" earth cover	96	25

Table 4-2. Radiation protection factors of sand-or clay-filled sandbags.

Soldier In	Radiation Protection Factor	Resultant Dose cGy
Open	None	2,400
Open foxhole, 4' deep	8	300
Same with 1 layer (4 inches)	16	150
Same with 2 layers (8 inches)	32	75
Same with 3 layers (12 inches)	64	38

Table 4-3. Comparison of blast casualties from a 10-kiloton fission weapon.

Range (meters)	200	300	400	700	800	900	1,000	1,400
Personnel in open (percentage)	100	80	41	11	8	5	4	0
Personnel in wheeled vehicle (percentage)	10	100	100	99	80	62	43	1

Actions During an Attack

- Immediately drop face down.
- Close eyes.
- Protect exposed skin.
- Wait until blast wave passes and debris stops falling.
- Stay calm, check for injury.
- Check weapons and equipment.
- Prepare to continue the mission.

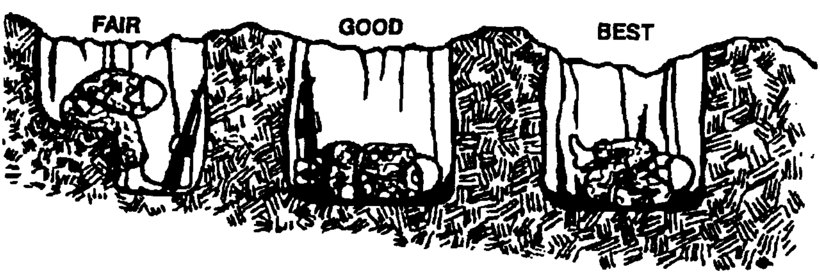

Figure 4-5. Recommended body positions in a foxhole.

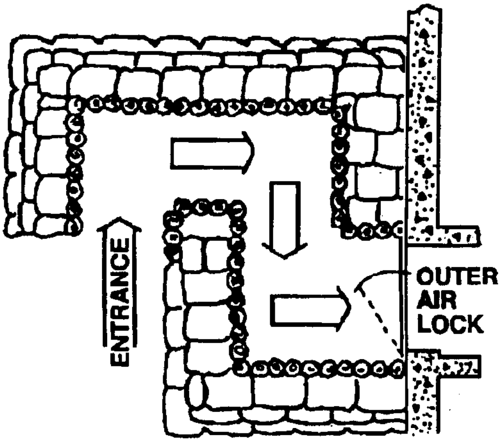

Figure 4-6. Protection from blast flow into shelters.

Actions After an Attack

- Begin continuous monitoring.
- Organize survivors.
- Secure and organize equipment.
- Cover mouth with handkerchief.
- Assist casualties.
- Send NBC 1 report.
- Improve protection against possible fallout.
- Conduct damage assessment and restoration of combat power.

Simplified Fallout Prediction (M5A2)

1. Information required: NBC 2 nuclear report and effective downwind message (EDM).
2. Record date-time of burst, GZ, and wind direction on M5A2.
3. Determine Zone I from the nomogram printed on the M5A2, draw arc on M5A2,

and label.

4. Zone II = 2 x Zone I; draw an arc, and label.

5. Draw tangents from cloud radius to end of Zone I.

6. Darken the perimeter.

7. Draw time-of-arrival arcs and label.

8. Orient azimuth on predictor with grid north.

Significance of Predicted Fallout Zones

Exposed, unprotected personnel may receive the following doses from fallout:

Zone I— Immediate operational concern. More than 150 centigray (cGy) within 4 hours.

Zone II— Secondary hazard. Less than 150 cGy within 4 hours. More than 50 cGy within 24 hours.

Outside the predicted area— No more than 50 cGy in 24 hours. No more than 150 cGy for an indefinite period.

Detailed Fallout Prediction (Unit Level)

1. Obtain a valid NBC 3 report.

2. Determine scale at which the prediction will be drawn (must be the same as the map on which it will be displayed.)

3. On overlay paper, mark GZ.

With Line YANKEE (from NBC 3 report):

4. Mark grid north.

5. Extend radial lines at their proper azimuths from GZ (from line YANKEE).

6. Using GZ as center, draw Zone I arc (from line ZULU) between radial lines.

7. Using GZ as center, draw Zone II arc (2 x Zone I) between radial lines.

8. Using GZ as center, draw circle with radius equal to the cloud radius (from line ZULU).

9. Draw two tangent lines from the GZ circle to the points of intersection of the two radial lines with the Zone I arc.

10. Using GZ as center, draw dashed time-of-arrival arcs (from line ZULU). No arcs are drawn beyond the end of Zone II.

11. Label zones, times of arrival.

12. Add marginal information:
    a. Strike serial number (from line ALFA).
    b. Date-time of attack (from line DELTA).
    c. GZ coordinates (from line FOXTROT).
    d. Scale.

Without Line YANKEE:

4. Using GZ as center, draw Zone I circle (the only 3 digits on line ZULU).

5. Using GZ as center, draw Zone II circle (2 x Zone I).

6. Label zones and GZ.

7. Add marginal information:
    a. Strike serial number (from line ALFA).
    b. Date-time of attack (from line DELTA).
    c. GZ coordinates (from line FOXTROT).
    d. Scale.

NOTE: If you need more detailed information on fallout prediction, see FM 3-3-1. Figure 4-6. Four parts of completing a fallout prediction.

Marginal Information

- Map designation
- Grid reference data
- Nuclear burst ground zero identification
- H-hour
- Reference time
- Decay rate (exponent)
- Time of preparation
- Validity time
- Source of contamination (fallout, neutron-induced, or radiological agents)
- Dose rate information

Radiological Monitoring

Periodic monitoring (readings at least once every hour) is done when–
- Intelligence indicates a threat of nuclear war.
- Nuclear war has been initiated or NBC threat status (nuclear) is Serial 3.
- Continuous monitoring falls below 1 centigray per hour (cGyph).

Continuous monitoring is done when—
- A nuclear detonation is seen, heard, or reported.
- Periodic monitoring records 1 cGyph or higher.
- Ordered by the unit commander.
- A warning of expected contamination (NBC 3) is received.

Automatic NBC 4 reports are—
- Initial report.
- Peak report.
- Special reports--send when a condition exists that warrants the commander's attention—for example, when the commander's operational exposure guidance (OEG) is exceeded.

Additional directed reports are—
- Series reports.
- Summary reports.
- Verification reports.

Radiological Survey Briefing

1. Situation: Enemy and contamination situation

2. Mission: Who, what, when, where, and why

3. Execution:
   (a) Concept of operation
   (b) Assignments
   (c) Coordinating instructions:
      (1) Time of departure
      (2) Primary and alternate routes
      (3) Coordination required
      (4) OEG, turn-back dose (D_{tb}), turn-back dose rate (R_{tb}
      (5) Actions on reaching D_{tb} or R_{tb}
      (6) Areas requiring marking
      (7) Debriefing - when, where, by whom

4. Service Support: Forms, equipment, POL, decontamination, and so forth

5. Command Signal:
   a. Command. Location of control party
   b. Signal:
      (1) Reporting requirements
      (2) SOI
      (3) Codes and call signs
      (4) Primary and alternate communication means

Aerial Radiological Survey Briefing

Control party briefing includes—

- Time of departure.
- Course legs and routes.
- Tentative height.
- Coordination required.
- OEG.
- Actions on reaching D_{tb} or R_{tb}.
- Debriefing: when, where, by whom.
- Height of aircraft (150 meters AGL [above ground level] maximum, 60 meters AGL optimal).
- Ground speed (53 knots [98 kmph] maximum; slower is more accurate).
- Establishment procedures for the air-ground correlation factor (AGCF).
- Time interval between readings (500 meters maximum).

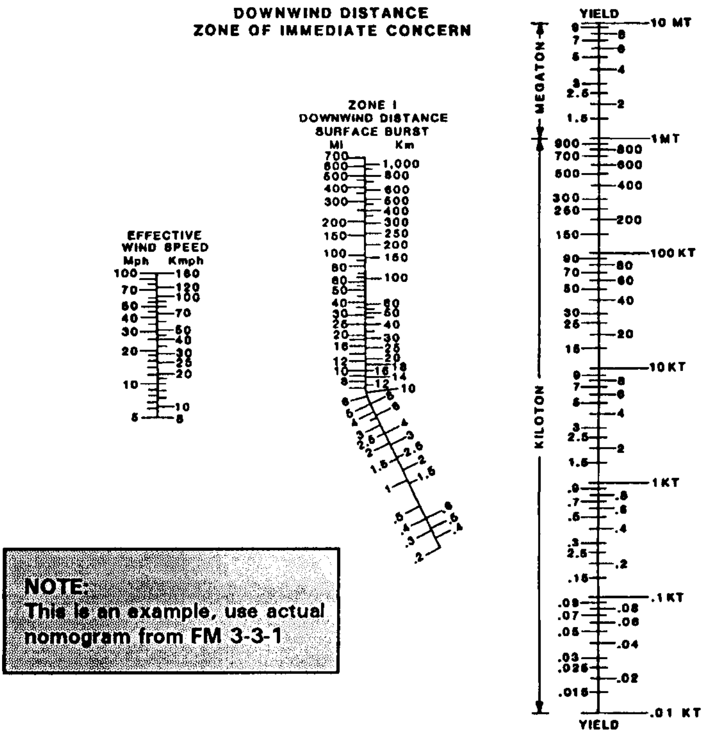

Figure 4-7. Downwind distance of Zone I (km).

To use the above table to find the downwind distance of Zone I, enter the left-hand column with the yield as indicated on line NOVEMBER of the NBC 2 nuclear report. Read across the top to locate the nearest wind speed (always round UP to safe-side). Where the two columns intersect is the Zone I distance Distances are in kilometers.

$$\text{Time of arrival (TARR)} = \frac{\textit{Distance From GZ (KM)}}{\textit{Effective Wind Speed (kmph)}}$$

$$\text{Transmission factor} = \frac{\textit{Indise Dose or Dose Rate (ID)}}{\textit{Outside Dose or Dose Rate (OD)}}$$

Inside dose or dose rate = Outside dose or dose rate x transmission factor

$$\text{Outside dose or dose rate} = \frac{\textit{Inside Dose or Dose Rate}}{\textit{Transmission Factor}}$$

Radiological Calculations*
(For use with pocket calculator)

Decay

Kaufman Equation: $R_1 = R_t \times t_n$ $R_t = R_1/t_n$ $t = \frac{R_1}{t_n}$

R_1 = Dose rate measured at H + 1.
R_t = Dose rate measured at time (t) after burst (other than H + 1)
t = Time that Rt was measured (in H +m- hours after burst).
n = Decay exponent (use 1.2 if unknown).

Total Dose**

Use if $T_e \leq H + 25$: $D = (R_1/1-n)\ (T_x 1-n - T_e 1-n)$
Use if $T_e > H + 25$: $D = R_{Te} X\ T_s$
D = Total dose.
T_X = Time of exit from area (in H + number of hours after burst).
T_e = Time of entry into area (in H + number of hours after burst).
T_s = Time of stay in area (hours).

Decay Rate of Fallout (n)

$n = \text{Log}\ (R_a/R_b)\ /\ \text{Log}\ (T_b/T_a)$
R_a = Dose rate measured at time a (T_a) (after peak dose rate).
R_b = Dose rate measured at time b (T_b) (last dose rate).
T_a = time (in H + number of hours after burst) that R_a was measured.
T_b = time (in H + number of hours after burst) that R_b was measured.

*** For neutron induced radiological calculations, use nomograms in FM 3-3-1.**
**** When decay constant n = 1, use 1.000001 for the above equation.**

Validity Time for Decay Rate (T_p)

$T_p = 3 (T_b - T_a) + T_b$

T_a = Time (in H + number of hours after burst) that R_a was measured.
T_b = Time (in H + number of hours after burst) that R_b was measured.

Table 4-4. Normalizing Factors (NFs)
(Correlation to H + 1 Hour)

TIME AFTER BURST	DECAY EXPONENT (n) 0.600	0.800	1.000	1.200	1.400	1.600	1.800	2.000
10 min	0.341	0.238	0.167	0.116	0.081	0.057	0.040	0.028
20 min	0.517	0.415	0.333	0.268	0.215	0.172	0.138	0.111
30 min	0.660	0.574	0.500	0.435	0.379	0.330	0.287	0.250
40 min	0.784	0.723	0.667	0.615	0.567	0.523	0.482	0.444
50 min	0.896	0.864	0.833	0.803	0.775	0.747	0.720	0.694
1 hr 0 min	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1 hr 10 min	1.090	1.130	1.160	1.200	1.240	1.280	1.320	1.360
1 hr 20 min	1.180	1.250	1.330	1.410	1.490	1.580	1.670	1.770
1 hr 30 min	1.270	1.380	1.500	1.620	1.760	1.910	2.070	2.250
1 hr 40 min	1.350	1.500	1.660	1.840	2.040	2.260	2.500	2.770
1 hr 50 min	1.430	1.620	1.830	2.070	2.330	2.630	2.970	3.360
2 hr 0 min	1.510	1.740	2.000	2.290	2.630	3.030	3.480	4.000
2 hr 15 min	1.620	1.910	2.250	2.640	3.110	3.660	4.300	5.060
2 hr 30 min	1.730	2.080	2.500	3.000	3.600	4.330	5.200	6.250
2 hr 45 min	1.830	2.240	2.750	3.360	4.120	5.040	6.170	7.560
3 hr 0 min	1.930	2.400	3.000	3.730	4.650	5.800	7.220	9.000
3 hr 15 min	2.020	2.560	3.250	4.110	5.200	6.590	8.340	10.560
3 hr 30 min	2.120	2.720	3.500	4.490	5.770	7.420	9.530	12.250
3 hr 45 min	2.210	2.870	3.750	4.880	6.360	8.280	10.790	14.060
4 hr 0 min	2.290	3.030	4.000	5.270	6.960	9.190	12.120	16.000
4 hr 20 min	2.410	3.230	4.330	5.810	7.790	10.440	14.000	18.770
4 hr 40 min	2.520	3.420	4.660	6.350	8.640	11.760	16.000	21.770
5 hr 0 min	2.620	3.620	5.000	6.890	9.510	13.130	18.110	25.000
5 hr 20 min	2.730	3.810	5.330	7.450	10.410	14.560	20.350	28.440
5 hr 40 min	2.830	4.000	5.660	8.010	11.340	16.040	22.690	32.110
6 hr 0 min	2.930	4.190	6.000	8.580	12.280	17.580	25.150	36.000
6 hr 20 min	3.020	4.370	6.330	9.160	13.250	19.170	27.720	40.110
6 hr 40 min	3.120	4.560	6.660	9.740	14.230	20.800	30.410	44.440
7 hr 0 min	3.210	4.740	7.000	10.330	15.240	22.490	33.200	49.000
7 hr 20 min	3.300	4.920	7.330	10.920	16.270	24.230	36.100	53.770
7 hr 40 min	3.390	5.100	7.660	11.520	17.310	26.020	39.110	58.770
8 hr 0 min	3.480	5.270	8.000	12.120	18.370	27.850	42.220	64.000
9 hr 0 min	3.730	5.800	9.000	13.960	21.670	33.630	52.190	81.000
10 hr 0 min	3.980	6.310	10.000	15.840	25.110	39.810	63.090	100.000
11 hr 0 min	4.210	6.800	11.000	17.760	28.700	46.360	74.900	121.000
12 hr 0 min	4.440	7.300	12.000	19.720	32.420	53.290	87.600	144.000

1. Use next higher time if time falls in between.
2. Interpolating NF of odd decay rates will be approximations only.

Normalizing Factor Formulas

For H + l: NF = (T^{2})
or H + 48: NF = $(T^{2}/48)$
T2 = Elapsed time after burst
n = Decay Exponent
$R_1 = R_t \times NF$

Aerial Survey Calculations

$$\text{Minimum number of readings} = \frac{\textit{leg or route length (km)}}{\textit{.5 km}} + 1$$

Time between readings (sec) =

$$\frac{\textit{Leg or Route Length (km)} \times 3{,}600\ (\textit{sec/hr}) \times (\textit{no. readings} - 1)}{\textit{Windspeed of Aircraft (kmph)}}$$

Distance between readings (km) =

$$\frac{\textit{Time Between Readings (sec)} \times \textit{Aerial Aircraft Speed (kmph)}}{3.6\ (\textit{sec/hr})}$$

$$\text{Plotting interval between readings (km)} = \frac{\textit{Leg or Route Length (km)}}{\textit{no. Readings} - 1}$$

$$\text{Turn-back dose } (D_{tb}) = \frac{OEG}{2}$$

$$\text{Turn-back dose rate } (R_{tb}) = \frac{2 \times \textit{OEG} \times \textit{Speed (kmph)}}{\textit{Distance (km)}}$$

Table 4-5. Transmission Factors for Residual Radiation.

M1 tank	.04
M60 tank	.04
M2 IFV	.2
M3 CFV	.2
M93 NBC Recon (Fox)	.2
M113 APC	.3
M109 SP howitzer	.2
M88 recovery vehicle	.09
M548 cargo vehicle	.7
M577 carrier; command post	.3
M551 Armored Recon Airborne Assault Vehicle	.2
M728 Combat Engineer Vehicle	.04
M9 ACE	.3
Grader	.8
Bulldozer	.5
Scraper	.5
HMWWV	.6
CUCV	.6
2½-ton truck	.6
4- to 7-ton truck	.5
Multistory building	
Top floor	.01
Lower Floor	.1
Frame house	
First floor	.6
Basement	.1
Urban area (in open)	.7*
Woods	.8*
Underground shelter (3-foot earth cover)	.0002
Foxholes	.1

* These factors do not apply to ground survey dose rates.
Note: The above TFs are for planning purposes only. Calculate the actual TF for a given shelter using the following transmission factor formulas.

$$TF = \frac{ID\ (Inside\ Dose\ Rate)}{OD\ (Outside\ Dose\ Rate)} \qquad ID = OD \times TF$$

Table 4-6. Correlation Factors for Residual Radiation. *		
Shielding	**Location of Survey Meter**	**Correlation Factor**
M1 tank (Abrams)*		20.0
M60 tank	Turret, rear top	25.0
	Turret, front	53.0
	VDR2 mount, left of driver intercom box	23.0
M2 IFV (Bradley)	AN/VDR2 mount on hull wall	9.1
M3 CFV	AN/VDR2 mount on hull wall	9.1
M113 APC	AN/VDR2 mount on hull wall by heater	3.6
M109 SP howitzer	Near driver, left side	9.1
	Rear right side	3.5
M88 recovery vehicle	Commander position	3.4
M577 command post Carrier	AN/VDR2 mount above TC's intercom box	6.9
551 armored recon	Near driver, right side	2.5
airborne assault vehicle		4.6
HUMMWV family (M998)	AN/VDR2, by radio mount	1.7
2½-ton truck		1.7
4- to 10-ton truck		2.0
M1008 CUCV Series	AN/VDR2 mount on cab floor	2.0
Multistory building		
Top floor		10.0
Lower floor		2.0
Frame house		
First floor		2.0
Basement		10.0
Underground shelter (3-foot earth cover)		5,000.0
Foxholes		10.0

* These CFs are for planning purposes only. Calculate the actual CF for a given shelter, using the following correlation factor formulas.

$$CF = \frac{OD\ (Outside\ Dose\ Rate)}{ID\ (Inside\ Dose\ Rate)} \quad OD = ID \times CF$$

Table 4-7. AN/VDR2 Attenuation Factor DIP Settings.			
	Row G	**Row H**	**Row J**
M577	0	4	0
M60 Tank	2	3	0
M1 Tank	2	0	0
M113	0	3	6
M2/M3	0	9	1
M151	0	1	3
M880/M1008	0	2	0
M998	0	1	7

Table 4-8. Dose Criteria for Placing a Unit in a Radiation Exposure Status Category.	
Radiation Exposure Status	**Numerical Criteria Total Cumulative Dose (cGy)**
RES Zero	0 (no exposure)
RES1	> 0 - ≤70
RES2	> 70 - ≤150
RES3	>150

Table 4-9. Nuclear radiation degree-of-risk exposure.		
Radiation status category (See A&B)	Total past cumulative dose (cGy) (See C)	Possible exposure criteria for a single operation that will not result in exceeding the dost criteria for the stated degree of risk (cGy) (See D&E)
RES-0 Units	No explosure	Negligible risk: ≤ 50 Moderate risk: ≤ 70 Emergency risk: ≤ 150
RES-1 Units	More than 0, but less than or equal to 70	Negligible risk: ≤ 10 Moderate risk: ≤ 30 Emergency risk: ≤ 110
RES-2 Units	More than 70, but less than or equal to 150	Any further exposure is considered to exceed a negligible or moderate risk. Emergency risk: ≤ 40
RES-3 Units	More than 150	All further exposure will exceed the emergency risk.

NOTES:
A. Radiation status categories are based on previous exposure to radiation.
B. Reclassification of units from one radiation status category to a less serious one is made by the commander, upon advice of the surgeon, after ample observation of actual set of health of exposed personnel.
C. All exposures to radiation are considered total body and simply additive. No allowance is made for body recovery from radiation injury.
D. Risk levels are graduated within each status category to provide more stringent criteria as the total radiation dose accumulated becomes more serious. The exposure criteria given for RES-1 and RES-2 units should be used only when the numerical value of a unit's total past cumulative dose is unknown.
E. Each of the degrees of risk can be applied to radiation hazards resulting from enemy or friendly weapons, or both, and from initial nuclear radiation resulting from planned friendly supporting fire.

Radiation Injury

Immediate Injury but Delayed Effects

Since a radiation injury victim does not show symptoms immediately after exposure, except for nausea and vomiting, these initial symptoms are not reliable by themselves to evaluate casualties or treat patients. Currently, the only available method to quickly estimate the radiation injury to a soldier is with a personnel dosimeter. Without this dosimetry, many days must pass before definitive diagnostic techniques of the secondary radiation exposure symptoms can provide an accurate estimate of radiation injury.

Tolerance:

IM93 ± 10% certified and leak checked
IM147 ± 10% certified and leak checked
DT236 ± 30% or ± 30 cGy, whichever is less, with 95% confidence after 24 hours

Self-aid and Buddy Aid

Key Factor in Nuclear Combat

Nuclear detonations can produce large numbers of blast, bum, and projectile injuries that initially must be managed by individual soldiers trained in critical frost-aid procedures.

Critical Period

The great physical damage to the surrounding area as a result of a nuclear detonation will increase delays in medical assistance and evacuation. Quality self-aid and buddy aid will improve casualty survival rates and conserve medical resources. Prompt stabilization will ensure casualties can better withstand evacuation to appropriate medical treatment facilities.

Radiation Guidance

Radiation guidance is the advice by the medical staff officer to the commander concerning the medical effects of predicted and actual radiation received by a unit. Commanders use medical advice and information to weigh the options of retaining soldiers with radiation injury (with the possibility of increasing lethality) versus entry into the medical support system.

Importance of Fitness and Wellness

The percentage of deaths that will occur from a given exposure is not a constant value, and it is, in fact, changed by many conditions. For healthy soldiers, LD + 50 is estimated to be about 450 cGy if no medical care is provided, if there are no other injuries, and if they are required to perform little physical labor. If, however, soldiers with no other injuries are worked to exhaustion or are in poor general health, LD + 50 is be reduced to approximately 300 cGy. Soldiers in good health, promptly evacuated to a CONUS hospital, and provided extensive medical care are expected to have their LD + 50 increased to 600 cGy. Soldiers' fitness and health are, therefore, critical factors for survival on a nuclear battlefield.

Table 4-10. Effects of radiation exposure on combat personnel.				
Dose* Range (cGy)	**Initial Symptoms****	**Time of Initial Symptoms (approx)**	**Performance Capability (mid-dose range)**	**Final Disposition**
0 to 70	None to slightincidence of transient headache and nauses, vomiting in up to 5% of personnel in upper part of range	6—12 hours	Combat effective	Duty
71 to 150	Transient mild nausea and vomiting in 5%—30% of personnel, vomiting in up to 5% of personnel in upper part of range.	2—20 hours	Combat effective	Duty. No deaths.
151 to 300	Transient mild to moderate nausea and vomiting in 20%—70% of personnel, mild to moderate fatigue and weakness in 25%—60% of personnel.	2 hours to 2 days	DT: PD from 4 hours until recovery. UT: PD from 6 hours until 1 day. PD: 6 weeks until recovery.	Duty; less than 5% deaths at low end of exposure range; death may occur in 10% of personnel.
301 to 500	Transient moderate nausea and vomiting in 50%—90% of personnel, moderate fatigue in 50%—90% of personnel.	2 hours to 3 days	DT: PD from 3 hours until 2 weeks, for death or recovery. UT: PD from 4 hours to 2 weeks until death or recovery.	Duty at low end of exposure range; less than 10% deaths. At high end of exposure range, death may occur in more than 50% of personnel beginning after 4 weeks.
501 to 800	Moderate to severe nausea and vomiting in 80%—100 of personnel.	Within 1 hour	DT: PD from 2 hours until 3 weeks. CI from 3 weeks until death.	At low end of exposure range death may occur in more than 50% of personnel beginning after 4 weeks. At high end of exposure range 99%, beginning after 3 weeks.

Table 4-10. Effects of radiation exposure on combat personnel (continued)

Dose* Range (cGy)	Initial Symptoms**	Time of Initial Symptoms (approx)	Performance Capability *(mid-dose range)*	Final Disposition
801 to 1,500	Moderate to severe fatigue and weakness in 90%—100% of personnel.	2 hours to 6 weeks	DT: PD from 2 hours to 2 days and 7 days until 4 weeks.	
	Moderate to severe nausea, vomiting, disorientation, and *dizziness in* 100% of personnel; moderate fluid loss in 80% of personnel.	45 minutes to 2-1/2 days	DT: PD 1 hour until 6 hours and 1-1/2 days until 1 week. CI: 6 hours until 1-1/2 days and 1 week until death. UT: PD 1-1/2 hours until 8 days. CI: 8 days until death.	1,000 cGy; death in 1 to 3 weeks.

DT = demanding task
UT = undemanding task
PD = performance decrement (25% - 75% of preirradiation performance level)
CI = combat ineffective (< 25% of preirradiation performance level)

* Doses are free-in-air dose values.
** Vomiting and nausea from tension or fear was reported by 20% of US combat troops in a survey of WWII veterans, particularly in the presence of horrible sights and smells. Extreme fatigue and weakness are also common symptoms of combat stress (battle fatigue). Therefore, none of these symptoms alone are a reliable indicator of the amount of radiation exposure a person may have received.
The effects listed in Table 4-10 represent a continuous exposure spectrum broken into dose range segments. When looking at symptoms/performance, the high end of one segment is very close to the low end of the next segment.

Table 4-11. Radii of Vulnerability.

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	850	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	1,950	1,600	3,000	2,100	1,600	1,600	2,000	3,800	7,100

NOTES:
1. Radii listed are distances at which a 5 percent incidence of effect occurs.
2. HOB used is 60W 1/3 meters.
3. To obtain a radius of vulnerability, enter the Yield Column of the nearest listed yield. If exactly halfway between yields, enter with larger yield. Data listed in table above is for training use only. Use the data in FM 101-31-2 (S) whenever possible.
4. All values have been rounded up to the next 10 meters.