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DEPARTMENT OF THE ARMY
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HEALTH SERVICE SUPPORT IN A NUCLEAR, BIOLOGICAL, AND CHEMICAL ENVIRONMENT

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HEALTH SERVICE SUPPORT IN A NUCLEAR, BIOLOGICAL, AND CHEMICAL ENVIRONMENT

1. FM 8-10-7, 22 April 1993, is changed as follows:

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PREFACE

Purpose and Scope

The purpose of this manual is to provide doctrine and tactics, techniques, and procedures for medical units and personnel operating in a nuclear, biological, and chemical (NBC) environment. This manual is intended for all echelons of health service support (HSS). It discusses the operational aspects of the following HSS activities: Medical treatment, medical evacuation, health service logistics, combat stress control, and preventive medicine, veterinary, dental, and medical laboratory services.

Use of Trade Names or Trademarks

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The proponent of this publication is the US Army Medical Department Center and School (AMEDDC&S). Send comments and recommendations on DA Form 2028 directly to Commander, US Army Medical Department Center and School, ATTN: HSMC-FCD, Fort Sam Houston, Texas 78234-6100.

Standardization Agreements

This manual implements North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 2866, Medical Effects of Ionizing Radiation. It is also in consonance with the following NATO STANAGs and Quadripartite Standardization Agreements (QSTAGs):

TITLE	NATO STANAG	QSTAG
Warning Signs for the Marking of Contaminated or Dangerous Land Areas, Complete Equipments Supplied and Stores		2002
Emergency War Surgery	2068	322
Commander's Guide on Nuclear Radiation Exposure of Groups	2083	
Reporting Nuclear Detonations, Biological and Chemical Attacks, and Predicting and Warning of Associated Hazards and Hazard Areas	2103	
Friendly Nuclear Strike Warning	2104	
Radiological Survey	2112	
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Gender Statement

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

CHAPTER 1

MEDICAL THREAT AND NUCLEAR, BIOLOGICAL, AND CHEMICAL WARFARE

1-1. General

a. Since World War II, the Soviet Union has represented the principal threat to the national security interests of the US. During this period, the military capability of the Soviet Armed Forces grew enormously. Starting in the later years of the 1980's, the international security environment has undergone rapid, fundamental, and revolutionary changes. The Soviet Union has disintegrated with the collapse of Soviet communism as a viable economic and political system. The Warsaw Pact has dissolved as a political and military entity. The central Soviet government has been replaced by the Commonwealth of Independent Republics (CIR), currently dominated by the Russian Republic. The cohesion of Soviet strategic military capability has been fractured by—

- The dissolution of central Soviet control.
- The formation of the CIR.
- The unpredictability associated with uncertain loyalties and low morale.

The ultimate outcome of these events in terms of US national security interests is unclear. The military capabilities of independent republics like Russia, Ukrainia, Kazakhstan, and Byelorus remain formidable. The capabilities include strategic nuclear and impressive conventional, biological, and chemical warfighting capabilities.

b. From a global perspective, the economic power and influence of developing and newly industrialized nations will continue to grow. Centers of power (global or regional) cannot be measured solely in military terms. Nation states will pursue their own political, ideological, and economic interests; they may become engaged in director indirect competition and conflict with the US. More nations have acquired significant numbers of modern, lethal, combat weapon systems; developed very capable armed forces; and become more assertive in international tiairs. In the absence of a single, credible, coercive threat, old rivalries and long repressed territorial ambitions will resurface, causing increased tensions in many regions. Political, economic, and social instability and religious, cultural, and economic competition will continue to erode the influence of the US over the rest of the world. This erosion will also reduce the US influence of traditional regional powers over their neighbors. This environment will encourage the continued development, or acquisition, of modern armed forces and equipment by less influential nations, including the spread of NBC weapons; thus raising the potential for internal conflict and armed confrontations in developing regions of the world.

1-2. Medical Threat

a. Medical threat is the composite of all ongoing or potential enemy actions and environmental conditions that will reduce combat effectiveness through wounding, injuring, causing disease, and/or degrading performance. Soldiers are the targets of these threats. Weapons or environmental conditions that will generate wounded, injured, and sick soldiers, beyond the capability of the HSS system to provide timely medical care from available resources, are considered major medical threats. Weapons or environmental conditions that produce qualitatively different wound or disease processes are also major medical threats. Table 1-1 presents medical threats from both environmental and adversary sources. Elements of medical threat are used to define the vulnerability of and the risk to the soldier associated with deployment outside the US.

Table 1-1. Medical Threat from Environmental and Adversary Sources

ENVIRONMENTAL RELATED	ADVERSARY RELATED
Naturally occurring diseases	Small arms and fragmentation ordnance and munitions
Environmental extremes	Biological warfare
Hazardous plants and animals	Chemical warfare
Other environmental hazards (dust, water, and air pollution)	Flame and incendiary
	Blast effect munitions
	Directed energy devices
	Nuclear warfare
Sustained operations/combat stress*	

*Applicable to both environmental and adversary related conditions.

b. Enemy combat operations that disrupt HSS operations, or threaten the HSS organizations survival are considered threats to the medical mission. These threats, however, are not considered to be “medical threats”.

1-3. Nuclear, Biological, and Chemical Threat—The Health Services Perspective

a. Nuclear Weapons Threat. Since the breakup of the Soviet Union, the number of countries with known nuclear capable military forces has almost doubled. Available information suggests that a number of countries in the Middle East, Asia, and Africa may have nuclear weapons capability within the next decade. Table 1-2 lists those countries known to have, or suspected of possessing, nuclear weapons. Planners can expect a minimum of 10 to 20 percent casualties within a division-sized force that has experienced a nuclear strike. In addition to casualties, a nuclear weapon detonation can generate an electromagnetic pulse (EMP) that will cause catastrophic failures of electronic equipment components.

Table 1-2. Countries Having or Seeking Nuclear Weapons

KNOWN TO POSSESS	SUSPECT OR SEEKING
United States of America	Iraq
Russia	North Korea
Ukraine	Pakistan
Byelorus	India
Kazakhstan	Iran
People’s Republic of China	Libya
France	Algeria
United Kingdom	South Africa
	Israel

b. Biological Warfare.

(1) Biological warfare (BW) is defined by the US intelligence community as the intentional use of disease-causing organisms (pathogens), toxins, or other agents of biological origin (ABO) to incapacitate, injure, or kill humans and animals; to destroy crops; to weaken resistance to attack; and to reduce the will to fight. Historically, BW has primarily involved the use of pathogens as sabotage agents in food and water supplies to spread contagious disease among target populations.

(2) For purposes of medical threat risk assessment, we are interested only in those BW agents that incapacitate, injure, or kill humans or animals.

(3) Known or suspect BW agents and ABOs can generally be categorized as naturally occurring, unmodified infectious agents (pathogens); toxins, venoms, and their biologically active fractions; modified infectious agents; and bioregulators. See Table 1-3 for examples of known or suspected threat BW agents. Also, Table 1-4 presents possible future agents in BW development.

Table 1-3. Examples of Known or Suspect Biological Warfare Agents

PATHOGENS	TOXINS
Bacillus anthracis (Anthrax)	Botulinum toxin
Francisella tularenius (Tularemia)	Mycotoxins
Yersinia pestis (Plague)	Enterotoxin
Brucella species (Brucellosis)	Ricin
Vibrio cholerae (Cholera)	

Table 1-4. The Future of Biological Warfare Agents

CURRENT THREAT	FUTURE
Pathogens	Modified Pathogens
Limited Number of Toxins	Expanded Range of Toxins (Organo-toxins)
	Protein Fractions
	Agents of Biological Origin

(4) Many governments recognize the industrial and economic potential of advanced biotechnology and bioengineering. The same knowledge, skills, and methodologies can be applied to the production of second and third generation BW agents. Naturally occurring infectious organisms can be made more virulent and antibiotic resistant and manipulated to render protective vaccines

ineffective. These developments complicate the ability to detect and identify BW agents and to operate in areas contaminated by the BW agents.

c. Chemical Warfare.

(1) Since World War I, chemical warfare (CW) has been publicly held in disrepute by most western political and military leaders. However, evidence accumulated over the last 50 years does not support the position that public condemnation equates to limiting development, or use of offensive CW agents. The reported use of chemical agents and toxins in Southeast Asia by Vietnamese forces; the confirmed use of CW agents by Egypt against Yemen; and later by Iraq against Iranian forces; and the probable use of CW agents by the Soviets in Afghanistan indicate a heightened interest in CW as a force multiplier. Mso, an offensive CW capability is developed as a deterrent to the military advantage of a potential adversary. Table 1-5 list the most common CW agents. Table 1-6 lists those countries known or suspected of having offensive chemical weapons.

Table 1-5. Common Chemical Warfare Agents

COMMON NAME	EFFECT	TIME TO EFFECT
Tabun (GA) Sarin (GB) Soman (GD) V-Agents	Lethal nerve agents	Inhalation: Seconds to Minutes Topical: Minutes
Hydrogen cyanide	Lethal blood agent	Minutes
Mustard Lewisite	Blister agents	1 to 12 Minutes Minutes
LSD and BZ	Incapacitating agents	15 to 60 Minutes
Phosgene Chlorine	Lung-damaging (choking)	Minutes

Table 1-6. Some of the Nations Known or Suspected of Having Chemical Weapons

United States of America	People's Republic of China
Russia	North Korea
France	Egypt
Libya	Israel
Iraq*	Taiwan
Syria	Burma
Iran	Ethiopia

* Following the Persian Gulf War (1990-91), the United Nations (UN) began destroying CW munitions discovered during inspection visits to Iraq by UN arms control inspectors. Included among the CW munitions discovered were some 2000 aerial bombs and 6200 artillery shells filled with mustard and several thousand 122mm rocket warheads filled with GB. Iraq also declared SCUD warheads filled with GB and GF.

(2) The Russian Republic of the former Soviet Union has the most extensive CW capability in Europe. Chemical strikes can be delivered with almost any type of conventional fire support weapon system (from mortars to long range tactical missiles). Agents known to be available in the Russian inventory include nerve agents (VX, thickened VX, GB, thickened GD); vesicants (thickened Lewisite and a mustard-Lewisite mixture); and choking agent (phosgene). Although not considered CW agents, riot control agents are also in the Russian inventory.

CHAPTER 2

NUCLEAR, BIOLOGICAL, AND CHEMICAL WEAPONS EFFECTS

2-1. General

Nuclear weapons are the most destructive weapons available for use on the battlefield today. Biological agents are easy to disperse on the battlefield without immediate detection; however, their effects on exposed troops can change the course of the battle. As more nations enter the arena of developing biological and chemical weapons, their potential effects on our troops will increase. Biological and chemical weapons/agents may be employed by terrorists, or in any level of conflict (low-, mid-, or high-intensity). Consideration of both the physical and biological effects of these weapons is required for HSS operations.

2-2. Physical Effects of Nuclear Weapons

a. The principal physical effects of nuclear weapons are blast, thermal radiation (heat), and nuclear radiation. These effects are dependent upon the yield (or size) of the weapon expressed in kilotons (KT), physical design of the weapon (such as conventional and enhanced), and upon the method of employment. For a low altitude detonation of a moderate-sized (3 to 10 KT) weapon, the energy is distributed (Figure 2-1) as follows:

(1) Fifty percent as blast.

(2) Thirty-five percent as thermal radiation; made up of a wide spectrum of electromagnetic radiation, including infrared, visible, and ultraviolet light and some soft x-ray radiation.

(3) Fourteen percent as nuclear radiation, 4 percent as initial ionizing radiation composed of neutrons and gamma rays emitted within the first minute after detonation, and 10 percent as residual nuclear radiation (fallout).

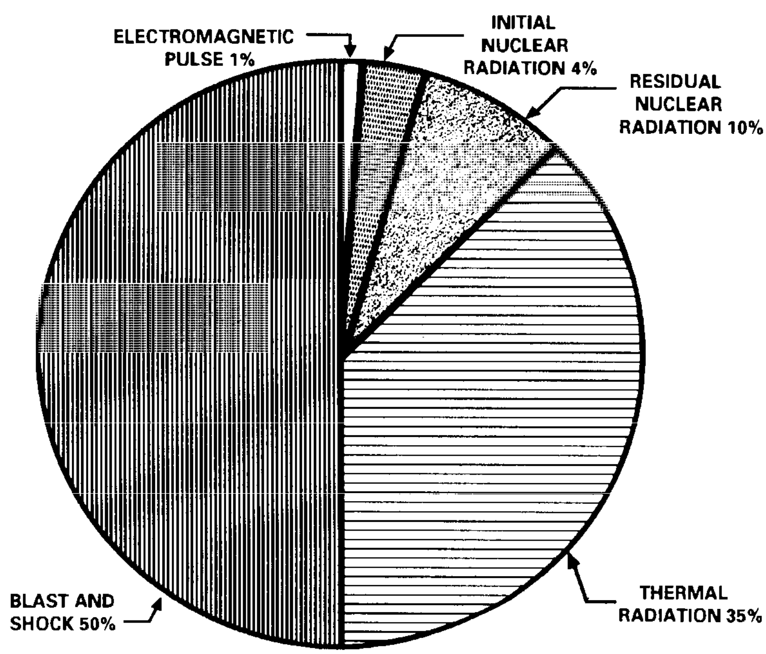

Figure 2-1. Distribution of energy.

(4) One percent as EMP.

b. Larger weapons are more destructive than smaller weapons, but the destructive effect is not linear. Table 2-1 presents a comparison of three aspects of nuclear weapons effects with yield.

Table 2-1. Comparison of Weapons Effects (Radii of Effects in Kilometers—Airburst)

	1 KT	20 KT	100 KT	1 MT	10 MT
NUCLEAR RADIATION (1,000 cGy)	0.71	1.3	1.6	2.3	3.7
BLAST (50% INCIDENCE OF TRANSLATION WITH SUBSEQUENT IMPACT WITH A NON-YIELDING SURFACE)	0.28	1.0	1.4	3.8	11.7
THERMAL (50% INCIDENCE OF 2ND-DEGREE BURNS TO BARE SKIN, 10 KM VISIBILITY)	0.77	1.8	3.2	4.8	14.5

c. The effects of blast, heat, and nuclear radiation are also determined by the altitude at which the weapon is detonated. Nuclear blasts are classified as air, surface, or subsurface bursts.

(1) An airburst is a detonation in air at an altitude below 30,000 meters, but high enough so that the fireball does not touch the surface of the earth. The altitude is varied to obtain

the desired tactical effects. Initial radiation will be a significant hazard, but there is essentially no local fallout. The ground immediately below the airburst may have a small area of neutron-induced radioactivity. This may pose a hazard to troops passing through the area.

(2) A surface burst is a detonation in which the fireball actually touches the land or water surface. In this case, the area affected by blast, thermal radiation, and initial nuclear radiation will be smaller than for an airburst of comparable yield; however, in the region around ground zero, the destruction will be much greater and a crater is often produced. Additionally, a significant amount of fallout is created and can be a hazard downwind.

(3) *A* subsurface burst is an explosion in which the detonation is below the surface of land or water. Cratering usually results. If the burst does not penetrate the surface, the only hazard is from the ground or water shock. If the burst penetrates the surface, blast, thermal, and initial nuclear radiation will be present, though less than for a surface burst of comparable yield. Local fallout will be heavy over a small area.

2-3. Physiological Effects of Nuclear Weapons

The physiological effects of nuclear weapons result from: direct physical effects from the blast; the thermal radiation; the ionizing radiation (initial or residual); or a combination of these. For smaller weapons (less than 10 KT), ionizing radiation is the primary creator of casualties requiring medical care, while for larger weapons (greater than 10 KT), thermal radiation is the primary cause of injury.

a. The rapid compression and decompression of blast waves on the human body results in transmission of pressure waves through the tissues. Resulting damage *is* primarily at junctions between tissues of different densities (bone and muscle), or at the interface between tissue and airspace. Lung tissue and the gastrointestinal system (both contain air) are particularly susceptible to injury. The tissue disruptions can lead to severe hemorrhage or to air embolism; either can be rapidly fatal. Direct overpressure effects do not extend out as far from the point of detonation and are often masked by the drag force effects. Atypical range of probability of lethality, with variation in overpressure for a 1 KT weapon, is shown in Table 2-2.

Table 2-2. Range of Lethality of Peak Overpressures

LETHALITY (APPROXIMATE %)	PEAK OVERPRESSURE (ATMOSPHERES)	DISTANCE FROM GROUND ZERO; METERS
1	2.3 - 2.9	150
50	2.9 - 4.1	123
100	4.1 +	110

(1) The significance of the data is that the human body is relatively resistant to static overpressure compared to rigid structures such as buildings. For example, an unreinforced cinder block panel will shatter at 0.1 to 0.2 atmospheres.

(2) Overpressures lower than those in Table 2-2 can cause nonlethal injuries such as lung damage and eardrum rupture. Lung damage is a relatively serious injury, usually requiring hospitalization, even if not fatal; whereas eardrum rupture is a minor injury, often requiring no treatment at all.

(a) The threshold level of overpressure for an unreinforced, unreflected blast wave which can cause lung damage is about 1.0 atmosphere.

(b) The threshold level for eardrum rupture is around 0.2 atmospheres; the overpressure associated with a 50 percent probability of eardrum rupture is about 1.1 atmospheres.

(3) Casualties requiring medical treatment from direct blast effects are produced by overpressures between 1.0 and 3.5 atmospheres. However, other effects (such as indirect blast injuries and thermal injuries) are so predominate that patients with only direct blast injuries make up a small part of the patient work load.

b. The drag forces (indirect blast) of the blast winds are proportional to the velocities and duration of the winds. The winds are relatively short in duration, but can reach velocities of several hundred kilometers (km) per hour, Injury can result either from missiles impacting on the body, or from the physical displacement of the body against objects and structures.

(1) The distance from the point of detonation at which severe indirect injury occurs is greater than that for equally serious direct blast injuries. A high probability of serious indirect injury can occur when the peak overpressure is about 0.2 atmospheres. This range will increase with the increased size of the weapon; for a 1 KT weapon the range is 0.22 km, whereas for a 20 KT weapon, the range is 0.76 km. Injuries will occur and casualties will be generated at greater ranges, but not consistently.

(2) The drag forces of the blast winds produced by a nuclear detonation are so great that almost any form of vegetation or structure will be broken up or fragmented into missiles. Thus, multiple, varied missile injuries will be common, increasing their overall severity and significance. Table 2-3 lists ranges at which significant missile injuries can be expected.

Table 2-3. Ranges for Probabilities of Injury from Small Missiles

YIELD (KT)	RANGES (KM) 1% PROBABILITY OF SERIOUS INJURY	50% PROBABILITY OF SERIOUS INJURY	99% PROBABILITY OF SERIOUS INJURY
1	0.28	0.22	0.17
10	0.73	0.57	0.44
20	0.98	0.76	0.58
50	1.4	1.1	0.84
100	1.9	1.5	1.1
200	2.5	1.9	1.5
500	3.6	2.7	2.1
1000	4.8	3.6	2.7

1 Incidence of injury based on incidence of perforation of skin and tissue.
2 Missiles used were 10 gram (gm) in weight.

(3) *The* velocity to which missiles are accelerated is the major factor in causing injury. The probability of a penetration injury increases with increasing velocity, particularly for small, sharp missiles such as glass fragments. Small, light objects are accelerated to speeds approaching the maximum (wind) velocity. Table 2-4 shows data for probability of penetration related to size and velocity of glass fragments.

Table 2-4. Probability of Penetration of Glass Fragments into Abdominal Cavity

MASS OF GLASS FRAGMENTS (GM)	1%	50%	99%
	IMPACT VELOCITY (METERS PER SECOND)		
0.1	78	136	243
0.6	53	91	161
1.0	46	82	143
10.0	38	60	118

(4) Heavy, blunt missiles may not penetrate, but can result in significant injury, particularly fractures. The threshold velocity for skull fractures from a 4.5 milligram (mg) missile is about 4.6 meters/second.

(5) The drag forces of the blast winds are strong enough to displace even large objects (such as vehicles), or to cause the collapse of large structures (such as buildings) resulting in serious crushing injuries. Man himself can become a missile. The resulting injuries sustained are called translational injuries. The velocity at which the body is displaced will determine the probability and the severity of injury. Assuming a displacement of 3.0 meters, the impact velocity associated with various degrees of injury is shown in Table 2-5. The velocities in Table 2-5 can be correlated against yield. The ranges at which such velocities would be found are given in Table 2-6.

Table 2-5. Translational Injuries

A. BLUNT INJURIES AND FRACTURES

PROBABILITY OF INJURY	VELOCITY (M/SEC)
1%	2.6
50%	6.6
99%	16.5

B. FATAL INJURIES

PROBABILITY OF FATALITY	VELOCITY (M/SEC)
1%	6.6
50%	17.0
99%	39.7

Table 2-6. Ranges for Selected Impact Velocities of a 70 Kilogram Human Body Displaced by Blast Wind Drag Forces for Different Yield Weapons

WEAPON YIELD (KT)	VELOCITIES (m/sec) 2.6	6.6	17.0
		RANGES (km)	
1	0.38	0.27	0.19
10	1.0	0.75	0.53
20	1.3	0.99	0.71
50	1.9	1.4	1.0
100	2.5	1.9	1.4
200	3.2	2.5	1.9
500	4.6	3.6	2.7
1000	5.9	4.8	3.6

2-4. Biological Effects of Thermal Radiation

The thermal radiation emitted by a nuclear detonation causes burns in two ways—by direct absorption of the thermal energy through exposed surfaces (flash burns); or by the indirect action of fires in the environment (flame burns). Indirect flame burns can easily outnumber all other types of injury.

a. Thermal radiation travels outward from the fireball in a straight line; therefore, the amount of energy available to cause flash burns decreases rapidly with distance. Close to the fireball all objects will be incinerated. The range for 100 percent lethality will vary with yield, height of burst, weather, environment, and immediacy of treatment. The critical factors determining the degree of burn injury are the flux (calories per square centimeter [cal/cm^2]) and the duration of the thermal pulse. The amount of thermal radiation needed to cause a flash second-degree burn on exposed skin will vary with the yield of the weapon and the nature of the pulse (Table 2-7).

NOTE

The battle-dress uniform, mission-oriented protective posture (MOPP) gear, or any other clothing will provide additional protection against flash burns. The airspaces between the clothing significantly impede heat transfer and may prevent or reduce the severity of burns, depending on the magnitude of the thermal flux.

Table 2-7. Factors for Determining the Probability of Second-Degree Burns

YIELD OF WEAPON	1 KT	10 KT	100 KT	1 MT	10 MT
Range (km) for production of second-degree burns on exposed skin	0.78	2.1	4.8	9.1	14.5
Duration of thermal pulse in seconds	0.12	0.32	0.9	2.4	6.4
Cal/cm² required to produce second-degree burns on exposed skin	4.0	4.5	5.3	6.3	7.0

b. Indirect (flame) burns result from exposure to fires caused by the thermal effects in the environment, particularly from ignition of clothing. The larger-yield weapons are more likely to cause fire storms over extensive areas. There are too many variables in the environment to predict either incidence or severity of casualties. Expect the burns to be far less uniform (in degree) and not limited to exposed surfaces. For example, the respiratory system may be exposed to the effects of hot gases produced by extensive fires. Respiratory system burns cause high morbidity and high mortality rates.

c. The initial thermal pulse can cause eye injuries in the forms of flash blindness and retinal scarring. Flash blindness is caused by the initial brilliant flash of light produced by the nuclear detonation. This flash swamps the retina, bleaching out the visual pigments and producing temporary blindness. During dayhght hours, this temporary effect may last for about 2 minutes. At night, with the pupil dilated for dark adaptation, flash blindness will affect personnel at greater ranges and for greater durations. Partial recovery can be expected in 3 to 10 minutes, though it may require 15 to 35 minutes for full night adaptation recovery. Retinal scarring is the permanent damage from a retinal burn. It will occur only when the fireball is actually in the individual's field of view and should be a relatively uncommon injury. The location of the scar will determine the degree of interference with vision. Figure 2-2 presents the threshold distance for minimal eye injuries.

2-5. Physiological Effects of Ionizing Radiation

A nuclear burst results in four types of ionizing radiation: neutrons, gamma rays, beta, and alpha radiation. The initial burst is characterized by neutrons and gamma rays while the residual radiation is primarily alpha, beta, and gamma rays. The effect of radiation on a living organism varies greatly by the type of radiation the organism is exposed to. See Table 2-8 for characteristics of nuclear radiation.

a. Alpha particles are extremely massive charged particles (four times the mass of a neutron); they are a fallout hazard. Because of their size, alpha particles cannot travel far and are fully stopped by the dead layers of the skin or by the uniform. Alpha particles area negligible external hazard, but if inhaled or ingested, can cause significant internal damage.