Chapter 1

The Dangers from Nuclear Weapons: Myths and Facts

An all-out nuclear war between Russia and the United States would be the worst catastrophe in history, a tragedy so huge it is difficult to comprehend. Even so, it would be far from the end of human life on earth. The dangers from nuclear weapons have been distorted and exaggerated, for varied reasons. These exaggerations have become demoralizing myths, believed by millions of Americans.

While working with hundreds of Americans building expedient shelters and life-support equipment, I have found that many people at first see no sense in talking about details of survival skills. Those who hold exaggerated beliefs about the dangers from nuclear weapons must first be convinced that nuclear war would not inevitably be the end of them and everything worthwhile. Only after they have begun to question the truth of these myths do they become interested, under normal peacetime conditions, in acquiring nuclear war survival skills. Therefore, before giving detailed instructions for making and using survival equipment, we will examine the most harmful of the myths about nuclear war dangers, along with some of the grim facts.

- **Myth**: Fallout radiation from a nuclear war would poison the air and all parts of the environment. It would kill everyone. (This is the demoralizing message of *On the Beach* and many similar pseudo-scientific books and articles.)

- **Facts**: When a nuclear weapon explodes near enough to the ground for its fireball to touch the ground, it forms a crater. (See Fig. 1.1.) Many

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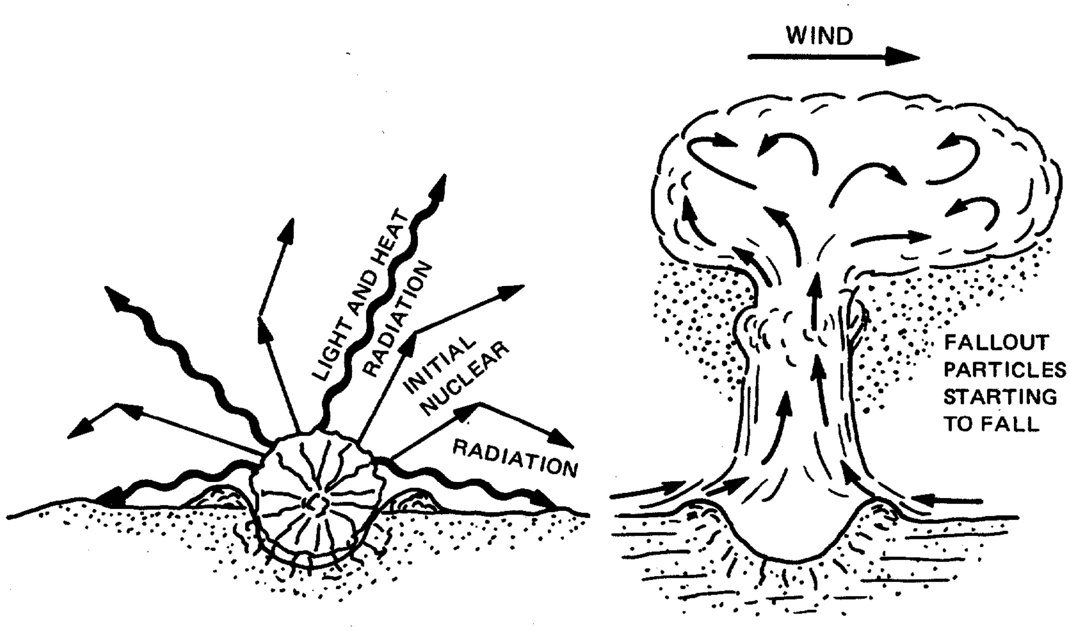

Fig. 1.1. A surface burst. In a surface burst, the fireball touches the ground and blasts a crater.

thousands of tons of earth from the crater of a large explosion are pulverized into trillions of particles. These particles are contaminated by radioactive atoms produced by the nuclear explosion. Thousands of tons of the particles are carried up into a mushroom-shaped cloud, miles above the earth. These radioactive particles then fall out of the mushroom cloud, or out of the dispersing cloud of particles blown by the winds—thus becoming fallout.

Each sand-like, contaminated particle continuously gives off invisible radiation, much like a tiny X-ray machine—while in the mushroom cloud, while descending, and after having fallen to earth. The descending radioactive particles are carried by the winds like the sand and dust particles of a miles-thick sandstorm cloud—except that they usually are blown at lower speeds and in many areas the particles are so far apart that no cloud is seen. The largest, heaviest fallout particles reach the ground first, in locations close to the explosion. Many smaller particles are carried by the winds for tens to hundreds of miles before falling to earth. At any one place where fallout from a single explosion is being deposited on the ground in concentrations high enough to require the use of shelters, deposition will be completed within a few hours.

The smallest fallout particles—those tiny enough to be inhaled into a person's lungs—are invisible to the naked eye. These tiny particles fall so slowly, from heights miles above the earth, that the winds carry them thousands of miles away from the site of the explosion before they reach the ground.

The air in properly designed fallout shelters, even those without air filters, is free of radioactive particles and safe to breathe except in a few rare environments—as will be explained later.

Fortunately for all living things, the danger from fallout radiation lessens with time. The radioactive decay, as this lessening is called, is rapid at first, then gets slower and slower. The dose rate (the amount of radiation received per hour) decreases accordingly. Figure 1.2 illustrates the rapidity of the decay of radiation from fallout during the first two days after the nuclear explosion that produced it. R stands for roentgen, a measurement unit often used to measure exposure to gamma rays and X rays. Fallout meters called dosimeters measure the *dose* received by recording the number of R. Fallout meters called survey meters, or dose-rate meters, measure the *dose rate* by recording the number of R being received per hour at the time of measurement. Notice that it takes about seven times as long for the dose rate to decay

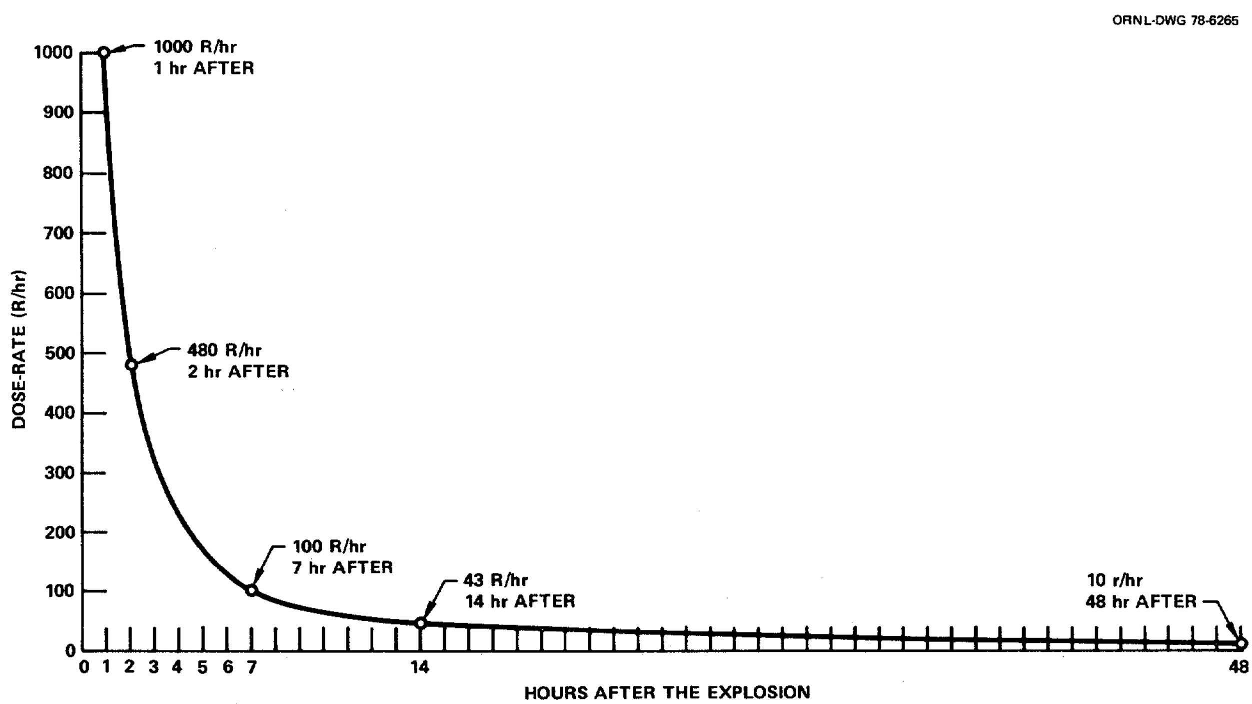

Fig. 1.2. Decay of the dose rate of radiation from fallout.

from 1000 roentgens per hour (1000 R/hr) to 10 R/hr (48 hours) as to decay from 1000 R/hr to 100 R/hr (7 hours). (Only in high-fallout areas would the dose rate 1 hour after the explosion be as high as 1000 roentgens per hour.)

If the dose rate 1 hour after an explosion is 1000 R/hr, it would take about 2 weeks for the dose rate to be reduced to 1 R/hr solely as a result of radioactive decay. Weathering effects will reduce the dose rate further; for example, rain can wash fallout particles from plants and houses to lower positions on or closer to the ground. Surrounding objects would reduce the radiation dose from these low-lying particles.

Figure 1.2 also illustrates the fact that at a typical location where a given amount of fallout from an explosion is deposited later than 1 hour after the explosion, the highest dose rate and the total dose received at that location are less than at a location where the same amount of fallout is deposited 1 hour after the explosion. The longer fallout particles have been airborne before reaching the ground, the less dangerous is their radiation.

Within two weeks after an attack the occupants of most shelters could safely stop using them, or could work outside the shelters for an increasing number of hours each day. Exceptions would be in areas of extremely heavy fallout such as might occur downwind from important targets attacked with many weapons, especially missile sites and very large cities. To know when to come out safely, occupants either would need a reliable fallout meter to measure the changing radiation dangers, or must receive information based on measurements made nearby with a reliable instrument.

The radiation dose that will kill a person varies considerably with different people. A dose of 450 R resulting from exposure of the whole body to fallout radiation is often said to be the dose that will kill about half the persons receiving it, although most studies indicate that it would take somewhat less.[1] *(Note: A number written after a statement refers the reader to a source listed in the Selected References that follow Appendix D.)* Almost all persons confined to expedient shelters after a nuclear attack would be under stress and without clean surroundings or antibiotics to fight infections. Many also would lack adequate water and food. Under these unprecedented conditions, perhaps half the persons who received a whole-body dose of 350 R within a few days would die.[2]

Fortunately, the human body can repair most radiation damage if the daily radiation doses are not too large. As will be explained in Appendix B, a person who is healthy and has not been exposed in the past two weeks to a total radiation dose of more than 100 R can receive a dose of 6 R each day for at least two months without being incapacitated.

Only a very small fraction of Hiroshima and Nagasaki citizens who survived radiation doses—some of which were nearly fatal—have suffered serious delayed effects. The reader should realize that to do essential work after a massive nuclear attack, many survivors must be willing to receive much larger radiation doses than are normally permissible. Otherwise, too many workers would stay inside shelter too much of the time, and work that would be vital to national recovery could not be done. For example, if the great majority of truckers were so fearful of receiving even non-incapacitating radiation doses that they would refuse to transport food, additional millions would die from starvation alone.

- **Myth**: Fallout radiation penetrates everything; there is no escaping its deadly effects.

- **Facts**: Some gamma radiation from fallout will penetrate the shielding materials of even an excellent shelter and reach its occupants. However, the radiation dose that the occupants of an excellent shelter would receive while inside this shelter can be reduced to a dose smaller than the average American receives during his lifetime from X rays and other radiation exposures normal in America today. The design features of such a shelter include the use of a sufficient thickness of earth or other heavy shielding material. Gamma rays are like X rays, but more penetrating. Figure 1.3 shows how rapidly gamma rays are reduced in number (but not in their ability to penetrate) by layers of packed earth. Each of the layers shown is one halving-thickness of packed earth—about 3.6 inches (9 centimeters).[3] A halving-thickness is the thickness of a material which reduces by half the dose of radiation that passes through it.

The actual paths of gamma rays passing through shielding materials are much more complicated, due to scattering, etc., than are the straight-line paths shown in Fig. 1.3. But when averaged out, the effectiveness of a halving-thickness of any material is approximately as shown. The denser a substance, the better it serves for shielding material. Thus, a halving-thickness of concrete is only about 2.4 inches (6.1 cm).

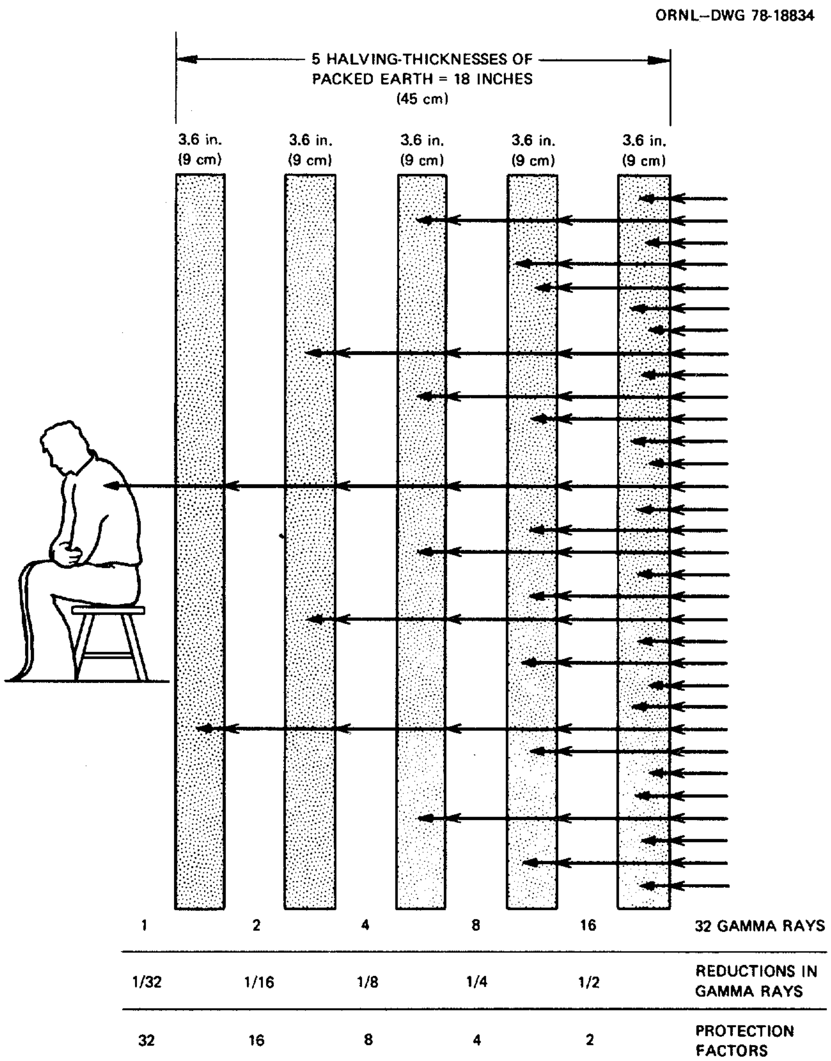

Fig. 1.3. Illustration of shielding against fallout radiation. Note the increasingly large improvements in the attenuation (reduction) factors that are attained as each additional halving-thickness of packed earth is added.

If additional halving-thicknesses of packed earth shielding are successively added to the five thicknesses shown in Fig. 1.3, the protection factor (PF) is successively increased from 32 to 64, to 128, to 256, to 512, to 1024, and so on.

- **Myth**: A heavy nuclear attack would set practically everything on fire, causing "firestorms" in cities that would exhaust the oxygen in the air. All shelter occupants would be killed by the intense heat.

- **Facts**: On a clear day, thermal pulses (heat radiation that travels at the speed of light) from an air burst can set fire to easily ignitable materials (such as window curtains, upholstery, dry newspaper, and dry grass) over about as large an area as is damaged by the blast. It can cause second-degree skin burns to exposed people who are as far as ten miles from a one-megaton (1 MT) explosion. (See Fig. 1.4.) (A 1-MT nuclear explosion is one that produces the same amount of energy as does one million tons of TNT.) If the weather is very clear and dry, the area of fire danger could be considerably larger. On a cloudy or smoggy day, however, particles in the air would absorb and scatter much of the heat radiation, and the area endangered by heat radiation from the fireball would be less than the area of severe blast damage.

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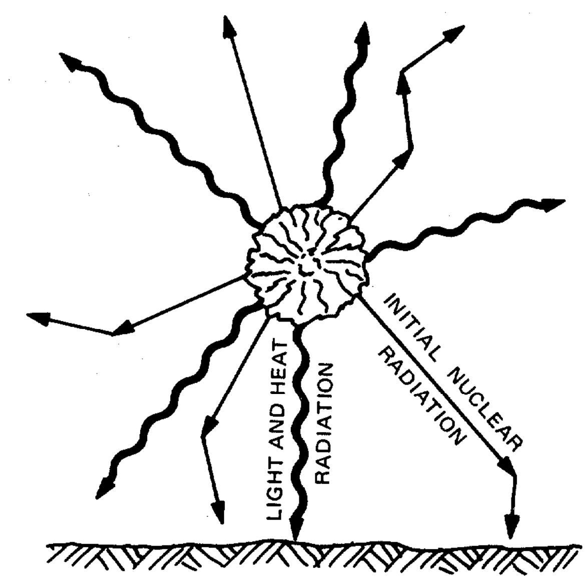

Fig. 1.4. An air burst. The fireball does not touch the ground. No crater, no deadly local fallout. The blast effects, the thermal pulses of intense light and heat radiation, and the very penetrating initial nuclear radiation are the main dangers.

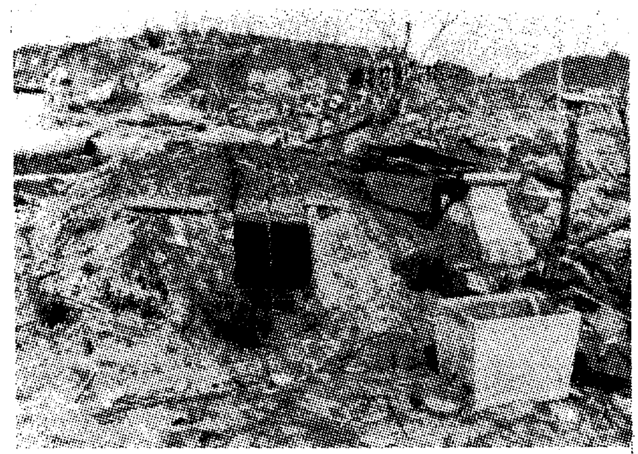

Fig. 1.5. Undamaged earth-covered family shelter in Nagasaki.

"Firestorms" could occur only when the concentration of combustible structures is very high, as in the very dense centers of a few old American cities. At rural and suburban building densities, most people in earth-covered fallout shelters would have nothing to fear from fire.

- **Myth:** In the worst-hit parts of Hiroshima and Nagasaki where all buildings were demolished, everyone was killed by blast, radiation, or fire.

- **Facts:** In Nagasaki, some people survived uninjured who were far inside tunnel shelters built for conventional air raids and located as close as one-third mile from ground zero (the point directly below the explosion). This was true even though these long, large shelters lacked blast doors and were deep inside the zone within which all buildings were destroyed. (People far inside long, large, open shelters are better protected than are those inside small, open shelters.)

Many earth-covered family shelters were essentially undamaged in areas where blast and fire destroyed all buildings. Figure 1.5 shows a typical earth-covered, backyard family shelter with a crude wooden frame. This shelter was essentially undamaged, although less than 100 yards from ground zero at Nagasaki.[4] The calculated maximum overpressure (pressure above the normal air pressure) was about 65 pounds per square inch (65 psi). Persons inside so small a shelter without a blast door would have been killed by blast pressure at this distance from the explosion. However, in a recent blast test,[5] an earth-covered, expedient Small-Pole Shelter equipped with blast doors was undamaged at 53 psi. The pressure rise inside was slight—not even enough to have damaged occupants' eardrums. If poles are available, field tests have indicated that many families can build such shelters in a few days.

The great life-saving potential of blast-protective shelters has been proven in war and confirmed by blast tests and calculations. For example, the area in which the surface-bursting of a 20-megaton weapon would wreck a 50-psi shelter with blast doors is about 17 square miles. Within this roughly circular area, practically all the occupants of wrecked shelters would be killed by blast, carbon monoxide from fires, or radiation. The same blast effects would kill most people who were using basements affording 5 psi protection, over an area of about 186 square miles.[6]

- **Myth:** Because some modern H-bombs are over 1000 times as powerful as the A-bomb that destroyed most of Hiroshima, these H-bombs are 1000 times as deadly and destructive.

- **Facts:** A nuclear weapon 1000 times as powerful as the one that blasted Hiroshima, if exploded under comparable conditions, produces equally serious blast damage to wood-frame houses over an area up to about 130 times as large, not 1000 times as large. However, the blast areas of multimegaton nuclear explosions are impressively large, and Americans concerned with survival should be aware of the destructive power of these huge weapons. For instance, a Soviet SS-9 missile reportedly can deliver a 20-megaton warhead. The explosion from such a weapon would release the same amount of energy as the explosion of 20 million tons of TNT. If a 20-megaton weapon were surface-burst (Fig. 1.1), the great majority of homes at least would be severely damaged to a distance of 10 to 11 miles from ground zero. Within a roughly circular area of about 350 square miles, homes would be severely damaged or completely destroyed.

In and close to the crater area of a large surface burst, even the best blast shelters would be obliterated or buried. In wet, hard rock, a 20-megaton contact surface burst would blast a crater about 550 feet deep. The ringlike, 200-foot-high hill of ejected rock around the crater would be almost a mile across.

If a weapon is air-burst (see Fig. 1.4) at the most advantageous height to produce on the maximum area overpressures that are at least as high as a desired overpressure, it will cover with the desired blast effect an area that is about twice as large as the same weapon would cover if it were surface-burst. A 20-megaton air burst over the center of a great city would cause severe damage to homes as far as 16 miles from ground zero. Nearer to ground zero, the blast damage would be worse. However, the air-bursting of weapons would not result in the often deadly fallout particles that reach the ground within 24 hours after a surface burst. Therefore, for Americans outside target areas, this would be a less dangerous attack than if weapons were surface-burst.

Although some strategists maintain that a limited attack is more probable than a massive one, the author believes it prudent to prepare for the worst possible attack. So let us suppose that an enemy strikes U.S. missile sites and other U.S. military targets with about 40% of its approximately 10,000 megatons of intercontinental nuclear weapons, with another 40% hitting American industries and cities with surface bursts. Most cities would be destroyed by warheads much smaller than 20 megatons. Such a massive attack could subject urban and suburban areas where some 140 million Americans live to blast effects sufficiently intense to destroy essentially all homes. Without well-supplied blast shelters, most urban Americans who would have remained in their cities would be killed by blast, fire, and very heavy fallout. Most Americans would greatly improve their chances of surviving a nuclear attack if they were to evacuate probable target areas before an attack and make or improve fallout shelters in dispersed locations outside these most threatened areas.

- **Myth:** So much food and water will be poisoned by fallout that people will starve and die even in fallout areas where there is enough food and water.

- **Facts:** If the fallout particles do not become mixed with the parts of food that are eaten, no harm is done. Food and water in dust-tight containers are not contaminated by fallout radiation. Peeling fruits and vegetables removes essentially all fallout, as does removing the uppermost several inches of stored grain onto which fallout particles have fallen. Water from many sources—such as deep wells and covered reservoirs, tanks, and containers—would not be contaminated. Even water containing dissolved radioactive elements and compounds can be made safe for drinking by simply filtering it through earth, as described later in this book.

- **Myth:** Most of the unborn children and grandchildren of people who have been exposed to radiation from nuclear explosions will be genetically damaged—will be malformed, delayed victims of nuclear war.

- **Facts:** The authoritative study by the National Academy of Sciences, *A Thirty Year Study of the Survivors of Hiroshima and Nagasaki,* was published in 1977. It concludes that the incidence of abnormalities is no higher among children later conceived by parents who were exposed to radiation during the attacks on Hiroshima and Nagasaki than is the incidence of abnormalities among Japanese children born to unexposed parents.

This is not to say that there would be no genetic damage, nor that some fetuses subjected to large radiation doses would not be damaged. But the overwhelming evidence does show that the exaggerated fears of radiation damage to future generations are not supported by scientific findings.

- **Myth:** Overkill would result if all the U.S. and U.S.S.R. nuclear weapons were used—meaning not only that the two superpowers have more than enough weapons to kill all of each other's people, but also that they have enough weapons to exterminate the human race.

● **Facts:** Statements that the U.S. and the Soviet Union have the power to kill the world's population several times over are based on misleading calculations. One such calculation is to multiply the deaths produced per kiloton exploded over Hiroshima or Nagasaki by an estimate of the number of kilotons in either side's arsenal. (A kiloton explosion is one that produces the same amount of energy as does 1000 tons of TNT.) The unstated assumption is that somehow the world's population could be gathered into circular crowds, each a few miles in diameter with a population density equal to downtown Hiroshima or Nagasaki, and then a small (Hiroshima-sized) weapon would be exploded over the center of each crowd. Other misleading calculations are based on exaggerations of the dangers from long-lasting radiation and other harmful effects of a nuclear war.