LEARN ABOUT NUCLEAR WEAPONS

The shock wave

A nuclear explosion creates an enormous shock/blast wave that reaches the speed of many hundreds of kilometres per hour. People close to ground zero will be instantly killed by the blast alone. At a distance, the blast causes internal injuries such as lung injuries, ear damage and internal bleeding. Above all, the blast wave will result in indirect damage. People will be buried under falling buildings or hurled against walls or objects. Debris such as glass splinters, bricks, concrete and wooden blocks will be hurled around and cause severe injuries. The shock wave and the thermal pulse are the factors causing the most immediate deaths and injuries in the event of a nuclear explosion.[1]

In Nagasaki, 9 percent of all deaths immediately after the atomic bombing are estimated to be the result of falling glass splinters. About as many were killed by other falling debris hitting people at a high speed. In Hiroshima, the proportion of deaths caused by falling and flying debris is estimated at 30 percent of the total death toll.[2]

The thermal pulse

Within a certain distance from the site of explosion, the heat is so intense that practically everything is vaporised. In Hiroshima, all that was left of some humans, sitting on stone benches near the centre of explosion, was their outlines. Outside the area where wounds are fatal, many people will suffer severe burns. Heat radiation on bare skin causes burns directly. The skin will also be indirectly damaged when their clothes catch fire.

The thermal radiation causes damage to the eyes so that many people will be blinded by the explosion. For most of them, sight will return within a few minutes, but some will suffer permanent damage to the eyes, due to retinal burns.

Many people will also be wounded or killed by the fires that result from the thermal radiation. These fires may combine together and become immense firestorms, spreading out from the site of explosion. Within these areas, even people in underground shelters will die because of heat, lack of oxygen or from carbon monoxide or -dioxide poisoning.

In Hiroshima, burns caused 60 percent of the immediate deaths, while the number of immediate deaths from burns in Nagasaki amounted to 95 percent.[3] The observant reader will notice that, counting together the number of deaths caused by falling debris and by burns, the sum will exceed 100 percent. The numbers are based on estimates by the Manhattan Engineer District, who point out that many of the victims suffered from a number of deadly injuries – hence a total sum of more than 100 percent.

Initial radiation

Initial radiation is the first radiation to appear after a nuclear weapon has detonated. It consists of gamma and neutron radiation emitted at the moment of explosion, lasting for at most a minute. This radiation causes damage to humans, animals, the environment, electronics etc. The intensity of the initial radiation decreases quickly with an increased distance from ground zero. Regarding larger nuclear weapons, with an explosive power larger than 50 kiloton, the effects of the blast and thermal wave are so grave that the health effects of the initial radiation is negligible.[4]

Radiation related injuries

One of the things that set nuclear weapons apart from conventional arms is that the former kills and wounds through radiation. This damage is caused by gamma and neutron radiation in both initial radiation as well as alpha and beta radiation in the delayed radioactive fallout. The cells of the body suffer the damage caused by radiation. If exposed to a deadly dose of radiation, death caused by radiation sickness can occur quickly or within a few months. The system for blood formation and infection defence in the bone marrow are particularly sensitive to radiation.

Ionising radiation also causes damage to DNA: the genetic material in living cells. A cell can repair certain levels of damage in its chromosomal DNA, especially at low levels of damage. However, faulty repairs can occur and may lead to proliferation of abnormal cells, which then form a cancer. Such cancers will generally take many cell generations to develop, and it may be several decades before the cancer is detected.

At higher levels of radiation exposure, cell death results. In parts of the body where cell turnover is normally high, such as the gastrointestinal tract and bone marrow, cells may not be replaced quickly enough, and tissues fail to function. This can be fatal.

The higher the dose of radiation, the sooner the symptoms will develop. Depending on the amount of radiation, three syndromes appear in human beings exposed to radioactivity:

The first syndrome concerns the blood-forming organs of the body. The bone marrow is damaged, decreasing its capacity to form white blood cells and blood platelets. Since the white blood cells defend the body against infections, the radiation victim becomes very sensitive to infection. The platelets bring about the coagulation of the blood, so a decrease in their number will increase bleeding. Thus, the risks are great that the victim will bleed to death. Depending on how much the bone marrow is damaged and how the victim is treated, he/she may return to health. Otherwise, death comes within a few months.

At a higher dose of radiation, the syndrome concerning the stomach and digestive system appears. It is characterised by nausea, vomiting, bleeding diarrhoea, dehydration and high fevers. The radiation victim dies within 1-2 weeks as a result of blood poisoning, intestinitis and disturbed water balance.

The third and gravest syndrome is the one that concerns the central nervous system (brain). The symptoms are headache, weariness, apathy, muscle tremors, coma, seizures and shock. This syndrome is an effect of high doses of radiation and inevitably ends in death within a few days.

The unit Gray indicates the absorbed radiation dose. In earlier writings, the unit Rad was often used, equalling 0,01 Gray. Since different types of radiation (alpha, beta and gamma) have different biological effects, in medical context the unit Sievert (Sv) is most commonly used to measure the biological effects of radiation. The unit is named after Rolf Sievert, a former radiophysicist at the Stockholm based Karolinska Institute. Sievert is a large unit – 1 Sv can cause acute radiation sickness. Hence, the dose is often expressed in millisievert: 1 mSv 0 0,001 Sv. When indicating the radiation dose, a full body dose is usually referred to – that is, when the whole body is exposed to radiation. Lethal full body dose for a human being is considered in the area 3-5 Sv.[5]

Dose (in Sievert)	Health effect	Time to onset (without heath care)
0,05-0,1 Sv	Changes in blood chemistry	
0,5 Sv	Nausea	Hours
0,55 Sv	Fatigue	
0,7 Sv	Vomiting	
0,75 Sv	Hair loss	2-3 weeks
0,9 Sv	Diarrhea	
1 Sv	Hemorrhage	
4 Sv	Possible death	Within 2 months
10 Sv	Destruction of intestinal lining	
	Internal bleeding	
	Death	1-2 weeks
20 Sv	Damage to central nervous system	
	Loss of consciousness	Minutes
	Death	Hours - days

Source: US Environmental Protection Agency: Radiation Protection[6]

Radioactive fallout

The radioactive material left behind by the nuclear weapon eventually falls to the ground as particles. This is called radioactive fallout and comes in three different categories: local, regional or global fallout.

In local fallout, the radioactive particles are spread downwind and fall to the earth within days. In some of the affected areas, the radioactive doses can be directly lethal to exposed humans.

The particles destined to become regional fallout go directly into the troposphere (the layer of air closest to the earth) after the explosion and then fall down during the span of some weeks. This fall-out can lead to damage in humans and, in the long run, to an increase in the numbers of cancer cases and genetic damage. People eating food, drinking water and breathing contaminated air suffer the effects of the fallout.

Some of the radioactive particles rise at the explosion to the stratosphere where they spread around the earth to slowly fall or rain down within months or even years as global fallout. This is caused mainly by larger nuclear weapons and when the explosion happens in the atmosphere rather than on the ground. The radioactivity decays somewhat before reaching the earth, but some radioactive substances have a half-life of thousands or millions of years – that is, the time it takes for the radioactivity to decrease by half. This means the global fallout can cause health effects for a very long time. Cesium-137 and radioactive Iodine are examples of radioactive substances that enter the food chain and hence affect people’s health.

1 http://www.afrri.usuhs.mil/www/outreach/pdf/chapter1/chapter1.pdf
2 http://www.atomicarchive.com/Docs/MED/med_chp10.shtml
3 Ibid.
4 http://www.fas.org/nuke/intro/nuke/radiation.htm
5 http://www.faktasamlingcbrn.foi.se/filer/n_sidor/1/3.html
6 http://www.epa.gov/radiation/understand/health_effects.html