1 Nuclear weapons

Nuclear history

Soon after nuclear fission was discovered by German physicist Otto Hahn in 1938, it was realized that the energy from fission could be used to produce a nuclear explosion. The fear that Germany and/or Japan might succeed in developing nuclear weapons stimulated the Americans to make a massive effort, known as the Manhattan Project, to develop them first. The effort led to the first nuclear explosion—a test carried out in the New Mexico desert in 1945.

Nuclear weapons have been used only twice in anger: Hiroshima was destroyed by a nuclear weapon on August 6, 1945 and Nagasaki was destroyed three days later. Together the two explosions killed a total of about 250,000 people. Many other nuclear weapons have been exploded in tests and to help designers develop new types, from the first nuclear test on July 16, 1945 in the desert near Alamogordo, New Mexico, to the most recent conducted in Pakistan on May 28, 1998.

Seven nuclear-weapon powers—China, France, India, Pakistan, Russia/the Soviet Union, the United Kingdom and the United States—have tested nuclear weapons. These countries are known to have carried out a total of at least 2,052 nuclear tests. Israel, the eighth known nuclear-weapon power, has not, so far as is publicly known, tested a nuclear weapon.

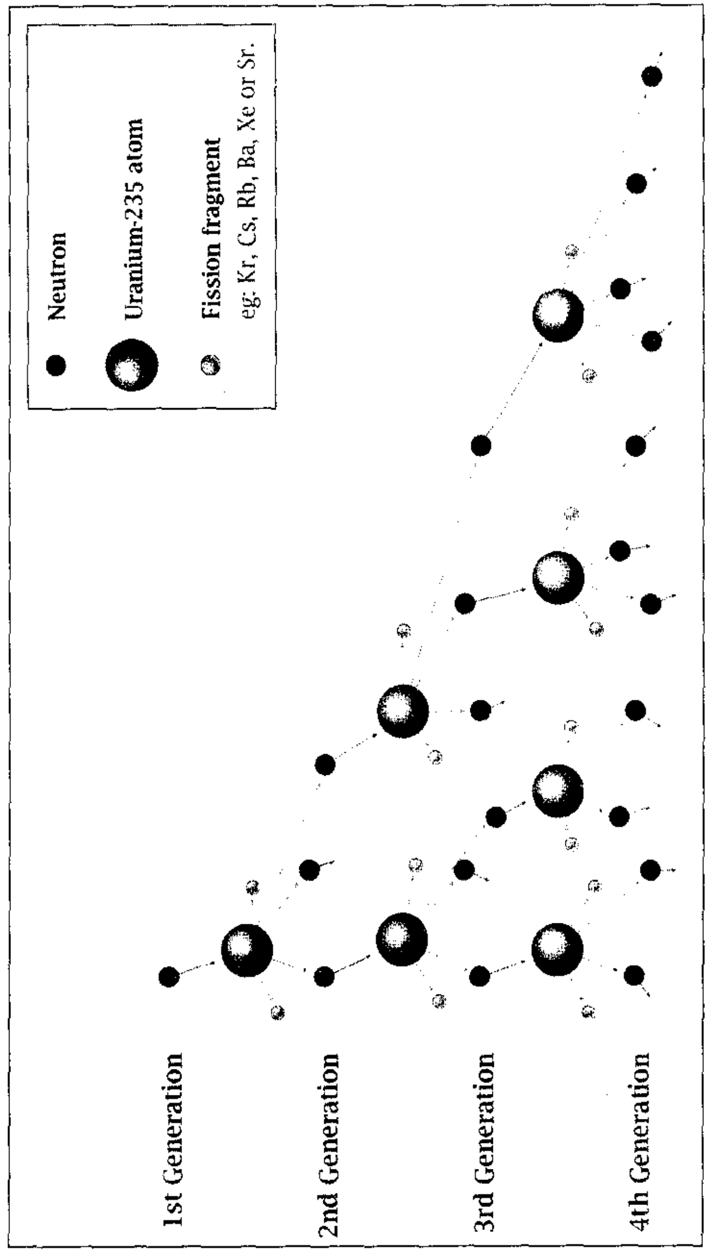
How a nuclear bomb works

A nuclear weapon produces a powerful explosion by releasing a very large amount of energy in a very short time. It works on the same principle as nuclear reactors which produce electricity; in each case, atoms of uranium or plutonium are split (undergo fission) in a chain reaction. The fission chain reaction in a nuclear reactor is controlled; in a nuclear weapon it is not.

Nuclear fission occurs in different forms of a heavy element—in practice, uranium or plutonium—when a neutron enters the nucleus of an atom of one of these isotopes. When fission occurs the original nucleus is split (fissioned) into two nuclei, called fission products. Two or three neutrons are released with the fission products. If at least one of these neutrons produces fission in a neighboring uranium or plutonium nucleus, a self-sustaining fission chain reaction can be produced. This process is best achieved if the isotopes uranium-235 or plutonium -239 are used. These two isotopes are the key materials in any nuclear-weapon program. Each fission event produces energy. A fission chain reaction, involving a very large number of fission events, can therefore release a very large amount of energy. A significant nuclear explosion will only occur if there is a sufficient amount of uranium-235 or plutonium-239 present to support a self-sustaining fission chain reaction. The minimum amount of the material required for this purpose is called the critical mass.

> *A nuclear weapon produces a powerful explosion by releasing a very large amount of energy in a very short time*

An amount somewhat larger than the critical mass, called a supercritical mass, is required to produce a fission chain reaction for a nuclear explosion. The larger the quantity of uranium-235 or plutonium-239 that is fissioned, the greater the explosive yield of the nuclear explosion. The nuclear-weapon designer's aim is to create a weapon that will not be blown apart until it has produced the size of explosion he requires. In other words, the aim is to

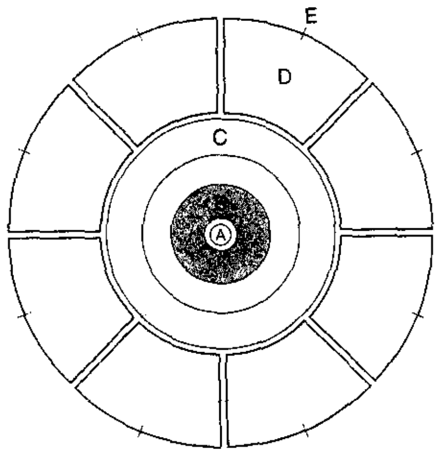


A fission chain reaction

keep the fission process going long enough to produce the required amount of energy. The most remarkable thing about nuclear weapons is the small amount of uranium-235 or plutonium -239 needed to produce a huge explosion: the critical mass of a sphere of plutonium-239 is about 11 kilograms; the radius of the sphere is only about 5 centimeters.

The plutonium sphere can be surrounded by a shell of a material like beryllium, the only function of which is to reflect back into the plutonium some of the neutrons that would otherwise have been lost to the fission chain reaction, increasing the number of fissions that take place. This trick reduces the critical mass considerably—typically, from 11 kilograms to about 4 kilograms, a sphere of a radius of approximately 3.6 centimeters, about the size of a small orange.

A fission nuclear weapon using just 4 kilograms of plutonium-239 would typically explode with a power of 20 kT, equivalent to that of the explosion of about 20,000 tons of TNT, the power of the



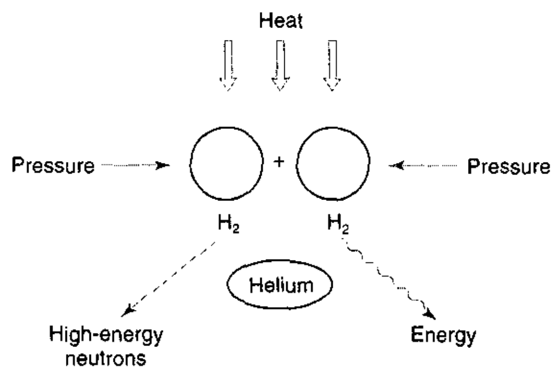
Ordinary nuclear fission weapon

Configuration of components of a fission bomb. A – initiator (neutron source or generator), B – fissile core (plutonium and U-235), C – tamper core reflector (uranium plus beryllium), D – high explosive lens (shaped plastic charge), E – detonator.

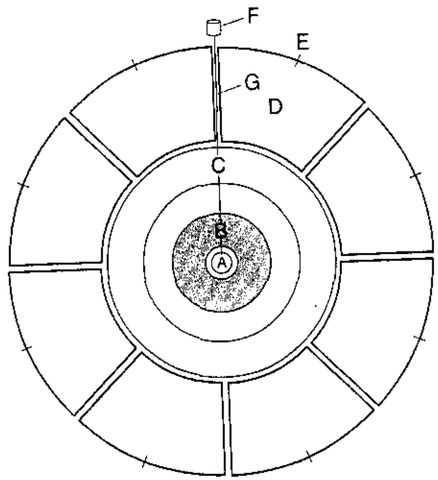
nuclear weapon that destroyed Nagasaki in August 1945. Such a nuclear weapon would therefore be about 5,000 times more effective, weight for weight, than a conventional bomb. The maximum explosive power of a militarily usable nuclear weapon using nuclear fission is about 50 kT because to obtain a bigger explosion a technique known as boosting is used. In a boosted weapon, some fusion material is injected into the centre of the plutonium mass as it is exploding with the result that the power of the explosion is boosted, typically tenfold.

Nuclear fusion occurs when nuclei of atoms of hydrogen isotopes fuse together to form nuclei of helium. Whereas fission involves the splitting of the nuclei of heavy isotopes like plutonium, fusion involves the joining together of light nuclei like hydrogen. Nuclear fusion takes place when the hydrogen nuclei are subject to very high temperatures and pressures, similar to those that occur in the sun, and exploding plutonium produces these conditions.

During fusion, neutrons are produced and energy is released. In a boosted weapon, these fusion neutrons are used to produce more fission in the plutonium-239. Boosted weapons are, therefore, sophisticated fission weapons. Tritium and deuterium, isotopes of hydrogen, are used as the fusion material in boosted weapons.



How nuclear fusion works



How a boosted weapon works

Configuration of components of a boosted fission bomb. A – initiator (neutron source or generator), B – fissile core (plutonium and U-235), C – tamper core reflector (uranium plus beryllium), D – high explosive lens (shaped plastic charge), E – detonator, F – tritium container, G – tritium feed into core of bomb.

Boosted weapons are very efficient, typically between five or ten times more than ordinary fission weapons. Much higher explosive powers can be obtained from a given amount of plutonium -239. Typically, explosive powers of up to 500 kT can be obtained from boosted fission weapons, ten times greater than the explosive powers that can be obtained from fission nuclear weapons that are not boosted. An explosion of this size would totally destroy a large city.

If even greater explosive powers than 500 kT are required, a large fraction of the energy must be obtained from nuclear fusion. Nuclear weapons that rely for their explosive power mainly on fusion are called thermonuclear weapons or H-bombs. In a thermonuclear weapon, a nuclear fission weapon acts as a trigger, providing the high temperature and pressure required for fusion. Typically, a cylinder of fusion material, in the form of lithium deuteride, is placed beneath the trigger. When the fission trigger explodes it generates fusion in the fusion stage.

There is no critical mass for the fusion process, and so in theory there is no limit to the explosive power that can be obtained from a thermonuclear weapon. In 1962, the former Soviet Union exploded a thermonuclear weapon at its Arctic test-site at Novaya Zemlya with an explosive yield equivalent to that of the explosion of nearly 60 million tons of TNT, or about 3,000 Nagasaki weapons. This is very much more explosive power than would be required to destroy totally the largest city on earth.

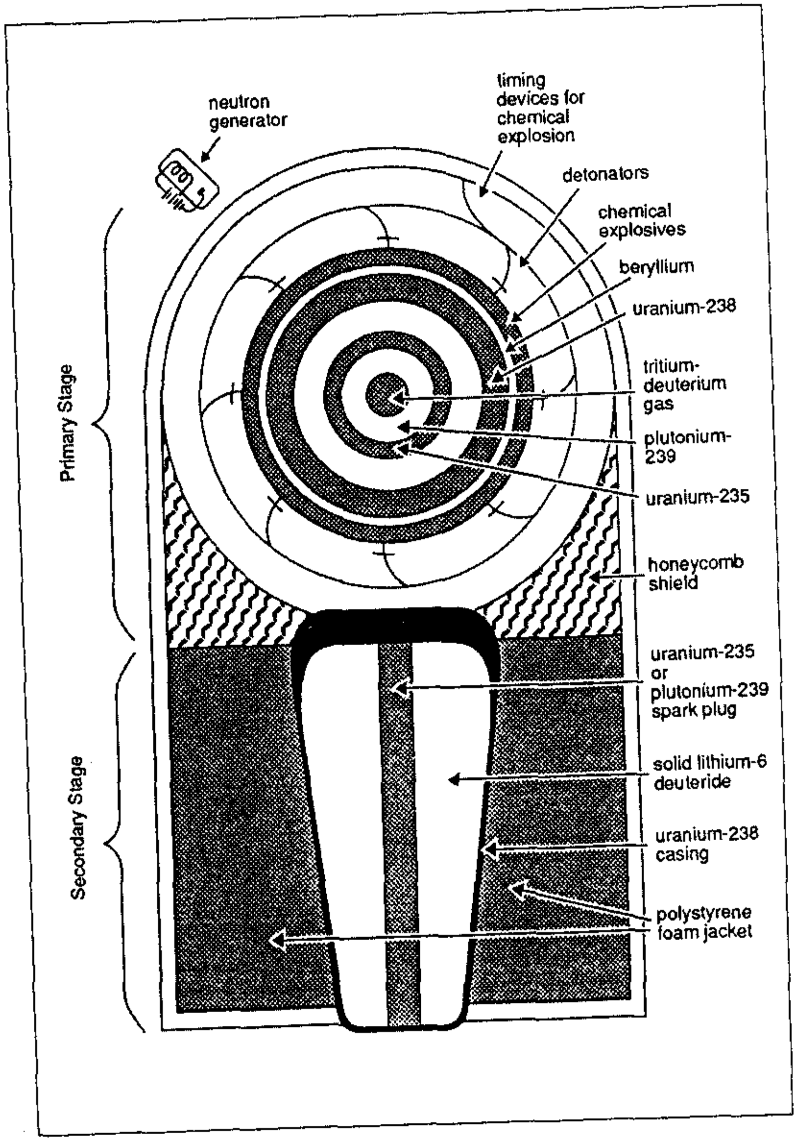
The nuclear powers

The Nuclear Non-Proliferation Treaty attempts to prevent the spread of nuclear weapons to countries other than China, France, Russia, the UK, and the USA (the five permanent members of the Security Council of the UN). The development, production, stockpiling, and use of both biological and chemical weapons are prohibited under international treaties. But these treaties have not prevented the proliferation of biological, chemical or nuclear weapons.

Nuclear weapons are the WMDs of choice of the five major powers mentioned above, and of three regional powers—India, Israel, and Pakistan. Iran and Iraq are strongly suspected of developing nuclear weapons and North Korea probably already has one or two.

There are about 30,000 nuclear weapons in today's world. Some are deployed in operational weapons; some are kept in reserve for possible future deployment; and some are waiting to be dismantled. The majority are American or Russian; the United States and Russia each deploy about 9,000 nuclear weapons. The other countries with nuclear weapons—China, France, the UK, India, Israel, and Pakistan—have a total of about 1,200 in their operational nuclear arsenals. China has deployed about 400 nuclear weapons, France about 350, and the UK about 200. Israel is estimated to have about 200, India about 60, and Pakistan about 35.

There are about 30,000 nuclear weapons in today's world



Schematic cross-section of a thermonuclear weapon

Nuclear weapons are far more destructive than conventional bombs. During the Second World War it took a number of raids, each involving 1,000 or more bombers, to destroy, for example, the German city of Dresden with high explosive and incendiary bombs, killing at least 50,000 people. Several times more people were killed in 1945 in each of the Japanese cities of Hiroshima and Nagasaki using a single nuclear weapon.

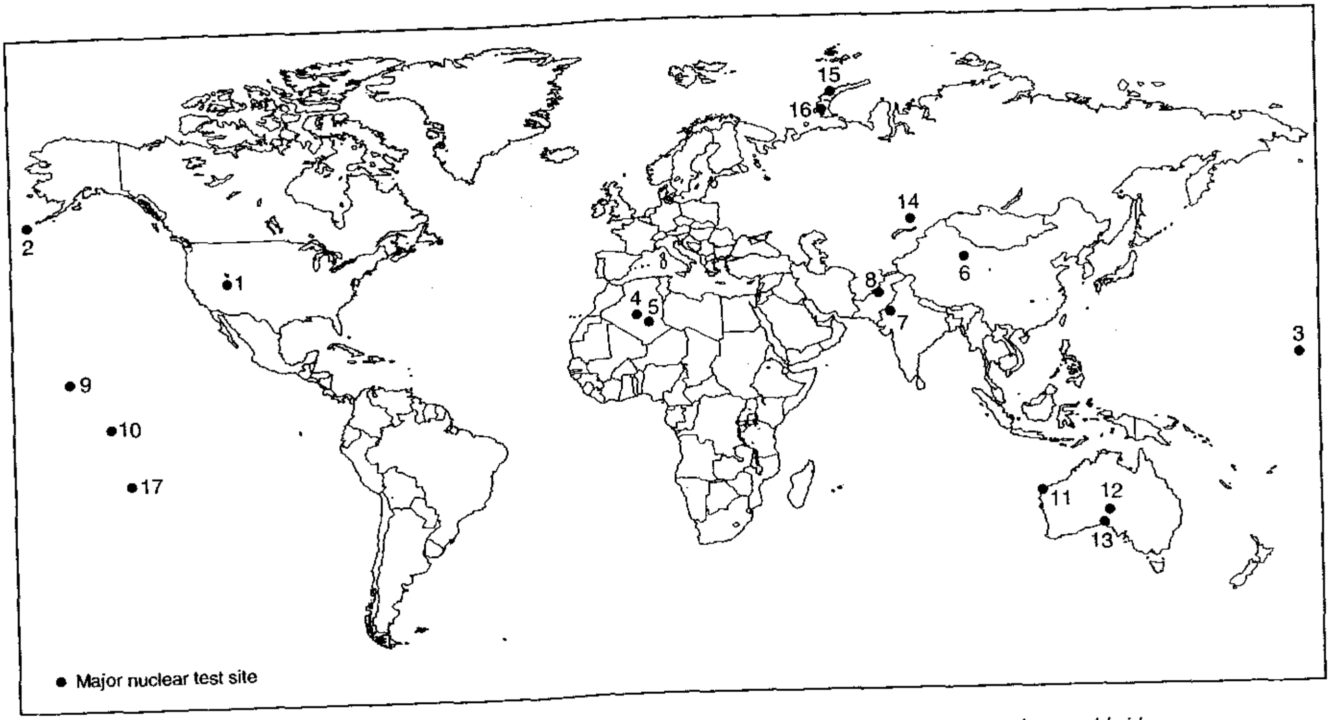
There are many types of nuclear weapons—aircraft bombs, artillery shells, depth charges, torpedoes, land mines, cruise missiles, and a variety of ballistic and other missiles. They may be deployed for tactical or strategic use. Tactical ones generally have a lower explosive yield and shorter range than strategic ones. The effect of the explosion of a nuclear weapon depends mainly on the explosive yield of the weapon and the altitude at which it explodes.

The explosive yields of the nuclear weapons currently deployed by the nuclear-weapon powers vary considerably. Some artillery shells, aircraft bombs, and land mines have low yields, some of less than 1 kT; strategic intercontinental and submarine-launched ballistic missiles have the highest yields. Some Chinese strategic nuclear weapons have yields as high as 5 megatons. All other deployed strategic nuclear weapons have yields of less than 750 kT.

What a nuclear explosion does

The author was present when British nuclear weapons were tested at Maralinga, in the South Australian desert, in 1953. Seeing a nuclear explosion is an awesome experience: the observer at first stands with his back to the explosion to avoid being blinded by the initial flash of light and ultraviolet radiation. After the flash, he can turn towards the nuclear explosion to watch the fireball grow.

The initial flash of light is followed by a weird, very short period of silence. Any exposed skin then feels a wave of heat. Just



World map showing civil nuclear powers, date of first civil nuclear power reactor and major nuclear test sites worldwide

Major Nuclear Test Sites

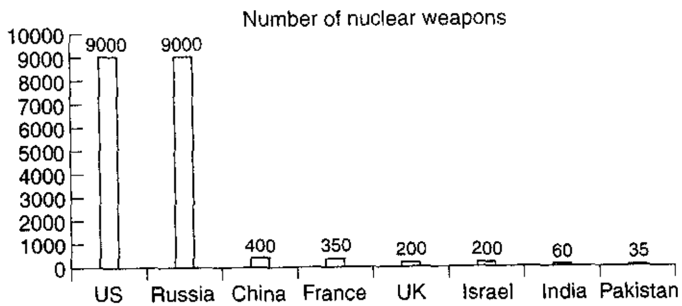
1.	USA	Nevada test site (u and a)
2.	USA	Amchitca, Alaska (u)
3.	France	French Polynesia at Mororoa Atoll and Fangatuafa (u and a)
4.	France	Reggan, Sahara desert (a)
5.	France	Sahara desert (u)
6.	China	Lop Nor, Sinkiang Province (u and a)
7.	India	Thar desert, Jaisalmer district (u)
8.	Pakistan	Chagai Hills (u)
9.	UK	Pacific at Johnston Atoll (a)
10.	UK	Pacific at Christmas Island (a)
11.	UK	Monte Bello Islands (a)
12.	UK	Emu Field, South Australia (a)
13.	UK	Maralinga, South Australia (a)
14.	USSR	Novaya Zemlya, South Site (u and a)
15.	USSR	Semipalatinsk, Kazakhstan (u and a)
16.	USSR	Novaya Zemlya, North Site (u and a)
17.	USA	Pacific tests at Johnston Atoll, Enewetak, Bikini, Christmas Island (a)

u = nuclear tests performed underground
a = nuclear tests performed in the atmosphere

Year when countries commissioned their first nuclear-power reactors

Country	*year of operation of first nuclear-power reactor*	*Country*	*year of operation of first nuclear-power reactor*
Argentina	1974	Lithuania	1985
Armenia	1979	Mexico	1990
Belgium	1962	Netherlands	1969
Brazil	1985	Pakistan	1972
Bulgaria	1974	Romania	1996
Canada	1971	Russia	1954
China	1994	Slovakia	1973
Czeck Republic	1985	Slovenia	1983
Finland	1977	South Africa	1984
France	1964	Spain	1971
Germany	1966	Sweden	1972
Hungary	1983	Switzerland	1969
India	1969	Taiwan	1978
Italy	1964	UK	1956
Japan	1965	Ukraine	1978
Kazakhstan	1973	USA	1957
South Korea	1978		

Italy and Kazakhstan no longer have nuclear-power reactors.



Nuclear arsenals by country

as one gets over the surprise of the heat wave, one is shaken by the blast wave, accompanied by a loud noise. The body is shaken again by a wind travelling away from the explosion, raising a cloud of dust. A short time later, one is shaken yet again by another wind blowing in the opposite direction.

Experiencing the heat, blast, noise, and the winds, seeing the brilliantly colored fireball growing to a tremendous size, and watching the mushroom cloud rise to a high altitude, combine to give a sense of the immense power of a single nuclear explosion. It is an experience that one does not forget. The most awesome thing is that this huge explosion, powerful enough to destroy a city, is produced by a piece of plutonium about the size of a tennis ball.

The initial flash of light is followed by a weird, very short period of silence

Nuclear weapons are quantitatively and qualitatively different from conventional weapons. Professor Sir Joseph Rotblat, in his book *Nuclear Radiation in Warfare*, explains:

> A single nuclear bomb can have an explosive yield greater than that of the total of all the explosives ever used in wars since gunpowder was invented. The qualitative difference which makes nuclear weapons unique is that, in addition to causing

Nuclear weapon exploding

> loss of life by mechanical blast, or by burns from the heat of the fireball, nuclear weapons have a third killer—radiation. Moreover, and unlike the other two agents of death, the lethal action of radiation can stretch well beyond the war theatre and continue long after the war has ended, into future generations.

At the instant of the detonation of a typical nuclear weapon, the temperature shoots up to tens of millions of degrees and pressure to millions of atmospheres. As the fireball, a luminous mass of air, starts to expand, conditions are like those in the sun. The energy of the explosion is carried off by heat, blast and radiation. When a typical nuclear-fission weapon explodes, roughly half of the energy goes in blast, about a third in heat and the rest in radiation.

With a bomb of the size of the Hiroshima one, heat will kill people over a larger area than either blast or radiation. The lethal areas for blast and radiation are about the same; each is about half of the lethal area for heat. For weapons with much larger explosive yields, heat is by far the biggest killer, several times more lethal than either blast or radiation.

Heat, blast and radiation

In the first few thousandths of a second after the explosion begins there is a burst of ultraviolet radiation from the fireball as it rises in the atmosphere. This is followed by a second burst of radiation—thermal radiation—lasting for a few seconds. After a minute or so, the temperature of the fireball has fallen sufficiently for it to stop emitting visible light. The second burst of thermal radiation is responsible for the heat effects of the weapon. Exposed people will be killed or severely burned and fires will be started over a large area. The area affected will depend on the explosive yield of the weapon and the weather. If the weather is fine, the heat wave can kill and injure people at much greater distances than can blast and radiation.

About half of the people caught by the heat wave at a distance of 2 kilometers from the explosion of a nuclear weapon with a yield of 12 kT (similar to the atomic bomb that destroyed Hiroshima) at low altitude in fine weather will suffer third-degree burns. For a nuclear explosion of 300 kT, the distance would be about 7.5 kilometers. People will also be killed and injured by fires set alight by the thermal radiation.

If a nuclear weapon is exploded over a town or city, most immediate death and injury will be caused by blast. Blast will also be the main cause of damage to buildings. In fact, most blast deaths occur from indirect effects—falling buildings and debris, being hurled into objects by the blast wave, and so on. For a 12 kT bomb exploded at a height of 300 meters, the lethal blast area is about 5 square kilometers.

During the first minute following a nuclear explosion, ionizing radiation, called initial radiation, is given off. Ionizing radiation emitted after a minute is called residual radiation, most of which comes from the fallout of radioactive fission products. Much of the radioactivity in the fallout will be in the mushroom cloud produced by the explosion.

As the cloud is blown downwind, radioactive particles will fall to the ground. People in the contaminated area may then be exposed to the radiation given off by the radioactive particles.

They can be irradiated by radiation given off by radioactive fallout; they can also inhale or swallow radioactivity from fallout and then be irradiated by the radioactivity in their bodies.

Radiation causes atoms to become electrically charged, a process called ionization. Cells in the body consist of atoms, and if one of the atoms in a cell is ionized it can be dangerous. When a person is exposed to low levels of radiation, cells will be damaged but the body can repair this damage, but when the body is exposed to higher doses of radiation so many cells are damaged that the body's repair mechanisms cannot cope.

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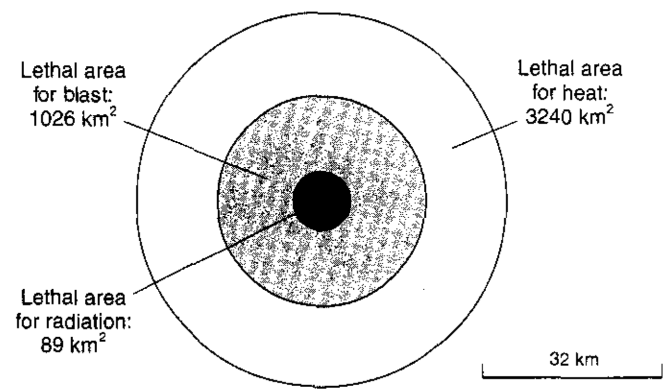
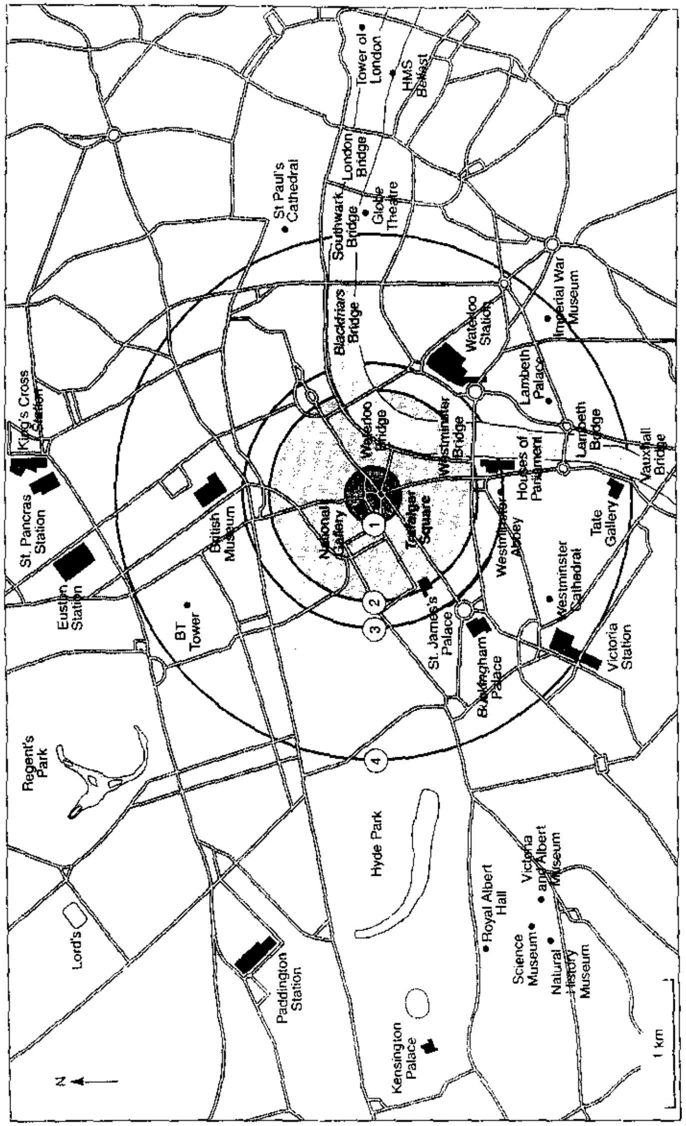
Some cells are more easily damaged by radiation than others. The most sensitive cells are those that line the intestines, white



Lethal area of a 60mT bomb

("Lethal area" is defined as the area in which the number of survivors equals the number of fatalities outside the area)



Map of central London showing effect of 1 kT explosion

Within Circle 1 (200 meters), almost 100 percent fatality in those directly exposed to thermal radiation; within Circle 2 (800 metres), almost 100 percent fatality in those directly exposed to blast; within Circle 3 (one kilometer), almost 100 percent fatality in those directly exposed to prompt nuclear radiation; within Circle 4 (two kilometers), almost all directly exposed suffer immediate injuries from burns and blast. (Map by Antony Smith with additional graphics by Richard Prime.)

blood cells that combat infection, and cells that produce red and white blood cells. The effects of radiation on these types of cells lead to the first symptoms of radiation sickness, including nausea, diarrhea, vomiting and fatigue. These symptoms may be followed by, among others, headache, hair loss, dehydration, breathlessness, hemorhage, anemia, permanent darkening of the skin, loss of weight, fever, fatigue and sweating. All of these symptoms occur only at high doses of radiation; with lower doses only some of them may occur.

Very high doses of ionizing radiation can produce symptoms within minutes. Death may occur from short-term (acute) effects within about two months. Death from long-term effects, particularly leukemia, may occur several years later and other cancers may occur after very long times, of thirty or more years.

The reality of nuclear attack—eyewitness accounts

> 8:15 a.m.—atomic bomb released—43 seconds later, a flash—shock wave, craft careens—huge atomic cloud
>
> 9:00 a.m.—cloud in sight—altitude more than 12,000 meters
>
> Part of the flight log of the *Enola Gay*, the American B-29 bomber that atom-bombed Hiroshima, August 6, 1945.

The pilot's story

The *Enola Gay* dropped the bomb that destroyed Hiroshima from an altitude of about 7,900 meters; the bomb exploded at an altitude of 570 meters. Paul Tibbets, the pilot of the *Enola Gay*, explained that he told his air crew that he would say, as the *Enola Gay* approached Hiroshima,

> "One minute out," "Thirty seconds out," "Twenty seconds," and "Ten" and then I'd count, "Nine, eight, seven, six, five,

four seconds," which would give them time to drop their cargo (the atomic bomb). They knew what was going on because they knew where we were. And that's exactly the way it worked, it was absolutely perfect. We get to that point where I say "one second" and by the time I'd got that second out of my mouth the airplane had lurched, because 10,000 l.b.s. (the weight of the bomb) had come out of the front. I'm in this turn now, tight as I can get it, that helps me hold my altitude and helps me hold my airspeed and everything else all the way round. When I level out, the nose is a little bit high and as I look up there the whole sky is lit up in the prettiest blues and pinks I've ever seen in my life. It was just great.

the whole sky is lit up in the prettiest blues and pinks I've ever seen in my life

I tell people I tasted it. "Well," they say, "what do you mean?" When I was a child, if you had a cavity in your tooth the dentist put some mixture of some cotton or whatever it was and lead into your teeth and pounded them in with a hammer. I learned that if I had a spoon of ice-cream and touched one of those teeth I got this electrolysis and I got the taste of lead out of it. And I knew right away what it was. OK, we're all going. We had been briefed to stay off the radios: "Don't say a damn word, what we do is we make this turn, we're going to get out of here as fast as we can." I want to get out over the sea of Japan because I know they can't find me over there. With that done we're home free.

The shockwave was coming up at us after we turned. And the tailgunner said, "Here it comes." About the time he said that, we got this kick in the ass. I had accelerometers installed in all airplanes to record the magnitude of the bomb. Next day, when we got figures from the scientists on what they had learned from all the things, they said, "When that bomb exploded, your airplane was ten and a half miles away from it."

You see all kinds of mushroom clouds, but they were made with different types of bombs. The Hiroshima bomb did not make a mushroom. It was what I call a stringer. It just came up. It was black as hell, and it had light and colors and white in it and grey color in it and the top was like a folded-up Christmas tree.

A survivor's story

Scientific descriptions of the effects of the explosion of a nuclear weapon over a city cannot convey the awesome power of a nuclear explosion nearly as well as eyewitness accounts. The difference is dramatically brought home by the eloquence of the accounts of survivors of the nuclear destruction of Hiroshima and Nagasaki.

Kataoka Osamu was a teenage schoolboy in Hiroshima when the bomb exploded. His moving account of his experience is in stark contrast to the detached, matter-of-fact account of the pilot.

"I looked out of the window at the branch of a willow tree," he remembers.

> Just at the moment I turned my eyes back into the old and dark classroom, there was a flash. It was as if a monstrous piece of celluloid had flared up all at once. Even as my eyes were being pierced by the sharp vermilion flash, the school building was already crumbling. I felt plaster and roof tiles and lumber come crashing down on my head, shoulders and back. The dusty smell of the plaster and other strange smells mixed up with it penetrated my nostrils.
>
> I wondered how much time had passed. It had gradually become harder and harder for me to breathe. The smell had become intense. It was the smell that made it so hard to breathe.
>
> I was trapped under the wreckage of the school building . . . I finally managed to get out from under the wreckage and stepped out into the schoolyard. It was just as dark outside as it had been under the wreckage and the sharp odor was everywhere. I took my handkerchief, wet it, and covered my mouth with it.
>
> Four of my classmates came crawling out from beneath the wreckage just as I had done. In a daze we gathered around the willow tree, which was now leaning over. Then we began singing the school song. Our voices were low and rasping, with a tone of deep sadness. But our singing was drowned out by the roar of the swirling smoke and dust and the sound of the crumbling buildings.
>
> We went to the swimming pool, helping a classmate whose leg had been injured and who had lost his eyesight. You cannot imagine what I saw there. One of our classmates had fallen into the pool; he was already dead, his entire body burned and

Hiroshima bomb damage

tattered. Another was trying to extinguish the flames rising from his friend's clothes with the blood which spurted out of his own wounds. Some jumped into the swimming pool to extinguish their burning clothes, only to drown because their terribly burned limbs were useless. There were others with burns all over their bodies whose faces were swollen to two or three times their normal size so they were no longer recognizable. I cannot forget the sight of those who could not move at all, who simply looked up at the sky, saying over and over, "Damn you! Damn you!"

I cannot forget the sight of those who could not move at all, who simply looked up at the sky, saying over and over, "Damn you! Damn you!"

Hiroshima victims

Nuclear terrorism

Terrorists would have to obtain suitable uranium or plutonium to fabricate a crude nuclear explosive. They are more likely to acquire plutonium than uranium because it is becoming increasingly available (see Chapter 7). Civil plutonium is separated from spent civil nuclear-power reactor fuel in reprocessing plants, such as those operated at Sellafield, England; La Hague, France; and Chelyabinsk, Russia. Another is being constructed at Rokkashomura, Japan.

A group of two or three people with appropriate skills could design and fabricate a crude nuclear explosive. It is a sobering fact that the fabrication of a primitive nuclear explosive using plutonium or suitable uranium would require no greater skill than that required for the production and use of the nerve agent produced by the AUM group and released in the Tokyo underground.

A crude nuclear explosive designed and built by terrorists could well explode with a power equivalent to that of 100 tons of TNT. For comparison, the largest conventional bombs used in warfare so far had explosive powers equivalent to about 10 tons of TNT. The terrorist bomb set off at the World Trade Center in 1993 had an explosive power equivalent to that of about a ton of TNT, the one that destroyed the Murrah building in Oklahoma in 1995 that of about 2 tons of TNT, and the one that destroyed the Al Khobar Towers building near Dhahran, Saudi Arabia, in 1996 that of about 4 tons of TNT. The size of the Dhahran bomb surprised and shocked American security officials.

A nuclear explosion equivalent to that of 100 tons of TNT in an urban area would be a catastrophic event, with which the emergency services would be unable to cope effectively. Exploded on or near the ground, it would produce a crater, in dry soil or dry soft rock, about 30 meters across. The area of lethal damage from the blast would be roughly 0.4 square kilometers; the lethal area for heat would be about 0.1 square kilometers.

The direct effects of radiation, blast or heat would very probably kill people in the open within 600 meters of the explosion. Many other deaths would occur, particularly from indirect blast effects such as the collapse of buildings.

Heat and blast will cause fires, from broken gas pipes, gasoline in cars, and so on. The area and extent of damage from fires may well exceed those from the direct effects of heat.

The area significantly contaminated with radioactive fallout will be uninhabitable until decontaminated. It may be many square kilometers and it is likely to take a long time to decontaminate it to a level sufficiently free of radioactivity to be acceptable to the public.

An explosion of this size, involving many hundreds of deaths and injuries, would paralyze the emergency services. They would find it difficult even to deal effectively with the dead. Many, if not most, of the seriously injured would die from lack of medical care. In the UK, for example, there are only a few hundred burn beds in the whole country.

There would be considerable delays in releasing injured people trapped in buildings. And, even for those not trapped, it would take a significant time to get ambulances through to them and then to transport them to the hospital. A high proportion of the seriously injured would not get medical attention in time to save them. This scenario of a nuclear terrorist attack would put a far greater strain on the emergency services than did the attack on New York on September 11, 2001.

There are literally millions of radioactive sources used worldwide in medicine, industry and agriculture; many of them could be used to fabricate a dirty bomb

The simplest and most primitive terrorist nuclear device would be a radiological weapon or radiological dispersal device, commonly called a "dirty bomb". It is not strictly speaking a nuclear weapon, as it does not involve a nuclear explosion. A dirty bomb would consist of a conventional high explosive—for example, Semtex, dynamite or TNT—and a quantity of a radioactive material. Incendiary material, such as thermite, is likely to be put into a dirty bomb to produce a fierce fire when the bomb is set off. The radioactivity would be taken up into the atmosphere by the fireball and would then be blown downwind.

There are literally millions of radioactive sources used worldwide in medicine, industry, and agriculture; few of them are kept securely and many of them could be used to fabricate a dirty bomb. The most likely to be used are those that are relatively easily available, have a relatively long half-life, of several months or years, and emit energetic gamma radiation; suitable candidates include caesium-137, cobalt-60, and strontium-90.

Clearly, the lack of security on radioactive materials around the world is a major cause for concern; even in the United States and Europe, where security is comparatively strong, there are thousands of instances of radioactive sources that have been lost or stolen over the years. Their present whereabouts are unknown.

Effects of a radiological weapon

The detonation of a dirty bomb is unlikely to cause a large number of casualties. Generally, any immediate deaths or serious injuries would most likely be caused by the detonation of the conventional explosive. The radioactive material in the bomb would be dispersed into the air but would soon be diluted to relatively low concentrations.

If the bomb were exploded in a city, as it almost certainly would be, some people would probably be exposed to a dose of radiation. But in most cases the dose would probably be relatively small. A low-level exposure to radiation would slightly increase the long-term risk of cancer.

The main potential impact of a dirty bomb is psychological—it would cause considerable fear, panic, and social disruption, exactly the effects terrorists wish to achieve. The public fear of radiation is very great indeed, some say irrationally or disproportionately so.

The radioactive area would have to be evacuated as quickly as possible, to prevent people becoming contaminated, and would then have to be decontaminated. The degree of contamination would depend on the amounts of high explosive and incendiary material used, the amount and type of radioisotope in the bomb, whether it was exploded inside a building or outside, and the weather conditions. Decontamination is likely to be very costly (costing millions of dollars) and take weeks or, most likely, many months to complete. Radioactive contamination is the most threatening aspect of a dirty bomb.