What Does a nuclear bomb do?

Hiroshima Day, 2002

1. How does a nuclear bomb destroy things?

2. How powerful is the bomb?

3. Are there large and small bombs?

4. Does it kill immediately, or slowly?

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9. Can we protect ourselves from the bomb?

How does the bomb destroy things?

1. immediate radiation (flash)

2. a heat wave

3. a blast

4. a firestorm

5. delayed radiation (fallout)

How powerful is the bomb?

A nuclear bomb's yield is measured by the amount of TNT which would be required to do the same damage. TNT has about the same effect as an equal weight of dynamite.

The yield of nuclear bombs ranges from a kiloton (1000 tons of TNT) to a hundred megatons (100 million tons of TNT). The actual weight of such a bomb is nowadays much less than a ton.

The bomb used on Hiroshima on August 6, 1945, had an yield of 16 kilotons of TNT. The bomb used on Nagasaki on August 9, 1945, has an yield of 20 kilotons of TNT.

Are there large and small bombs?

Modern day atomic weapons available with the USA and the constituent countries of the former USSR (Russia, Ukraine, etc) can be very large, very small, and any size in between. The smallest known are somewhat over 100 tons. The largest tested bomb had an yield of about 200 megatons. In addition, there are bombs which have reduced blast but enhanced radiation.

There are two classes of bombs— fission bombs were used in Hiroshima and Nagasaki. In the 1950's higher yield fusion bombs were developed. Fusion bombs are also called hydrogen bombs or thermonuclear bombs.

India's test in 1974 had an yield of about 10–20 kilotons. The tests in May 1998 have been in the range of under 1 kiloton to about 50 kilotons and are supposed to have tested battlefield weapons and fusion bombs.

Pakistan's tests in May 1998 had yields of a few 10s of kilotons.

Does it kill immediately, or slowly?

The blast, the heat wave, and the firestorm can kill immediately. The radiation kills slowly. The bomb is unique amongst all weapons which have been used in that it can kill people who are not yet born.

It is estimated that the Hiroshima bomb killed 70,000 people immediately, 130,000 by the end of 1945, and 200,000 people by 1950. The Nagasaki bomb killed 60,000 people immeidately, and 140,000 people by 1950.

In comparison, the firebombing of Dresden killed 135,000 people over two days of bombing by 1300 planes.

The total number of British civilians killed by the Luftwaffe bombings during WWII is estimated by Britian to be 51,509.

How much does it destroy? (1)

A lot ...

Consider a one Megaton bomb exploded 2500 meters above ground.

These effects travel at the speed of light

The first flash of light can burn people's flesh deeply out to 10 kms away. Superficial burning and blisters can be caused almost 15 kms away. It can melt people's retinas upto 8 kms away.

The first pulse of X-rays can kill within a radius of 3 kms.

The flash of heat can set fire to light combustible material 14 kms away.

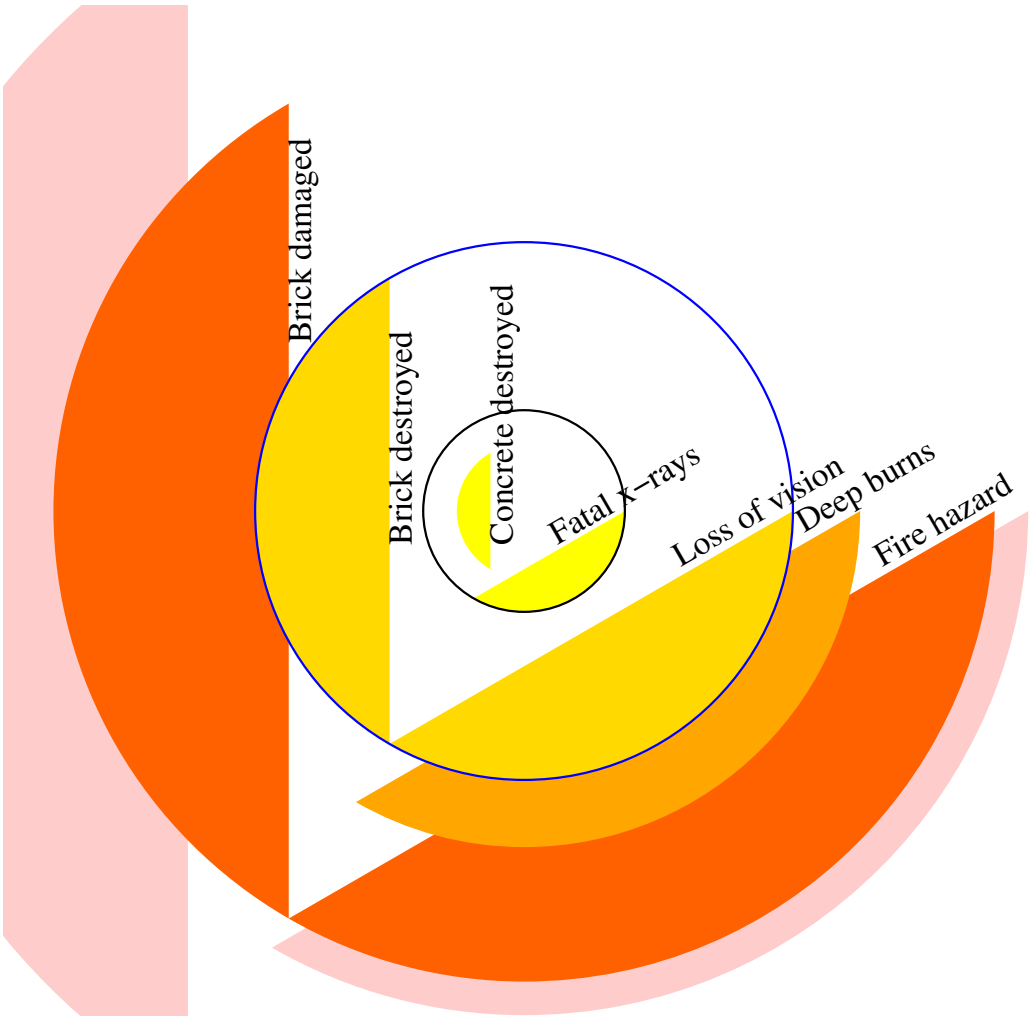
How much does it destroy? (2)

These effects travel at the speed of sound

The blast would destroy even reinforced concrete structures within a radius of 2 km. It can destroy brick houses upto about 8 kms, and severely damage buildings upto 14 kms away. Windows and doors can be destoryed 20–30 kms away.

Within 3 kms radius every person will be killed. At 8 kms there is a 50% chance of being killed immediately (however major injuries can are still expected).

How much does it destroy? (3)



How much does it destroy? (4)

Even slower ...

Immediately after the flash a fireball would form at a temperature of over 1000 degrees and rise, forming the mushroom cloud. It would draw in air from the surroundings to feed the fires kindled by the flash and start a firestorm. This would raise the temperature and use up all the oxygen in the air.

Long term

Everything within 2 kms of the burst will be radioactive. There could be a radioactive "black rain" (this happened in Hiroshima). Around 1/3 of the original radiactive material is widely dispersed, possibly upto several 100 kms, depending on winds and weather. This would increase risks of cancer and birth defects over 20 years or more.

How much does it destroy? (5)

Bombay has an area of 436 sq km. It has a population of 15 million. The average population density is 34400 people per sq km.

For a 1 megaton air burst

The area in the radius of full annihilation is $\pi(3\text{ km})^2 = 28.3\text{ km}^2$. This is expected to contain about 97300 people.

The area in the radius of 50% survival rate is $\pi(8^2 - 3^2)\text{ km}^2 = 172.8\text{ km}^2$. This is expected to contain about 59 lakhs of people. Half of them are expected to survive, but with large injuries.

What can happen to survivors?

In any bombing, injured survivors need first aid and medical attention. In the first few days after the bombing this will be the main concern.

Unlike other bombs, the survivors of nuclear bombs also face long term health risks. In Japan, these risks have slowly come to light over the years. They include—

1. Early effects on survivors (from several months to several years after the atomic bombings): acute radiation syndrome, radiation cataract (lens opacity), death.

2. Effects on the in utero exposed: growth impairment and mental retardation, mortality among survivors with in utero exposure

3. Late effects on the survivors (from several years after the atomic bombings to the present day): cancer risks among the atomic-bomb survivors, site-specific cancer deaths, leukemia risks among atomic-bomb survivors, benign tumors: uterus, parathyroid, deaths due to noncancer disease, effect on cholesterol levels, fertility, growth, chromosome aberrations in white blood cells, mutation in blood cells, effects upon the immune system, psychological effects, effects upon the aging process,

4. Genetic effects (many hereditary endpoints have been studied): no increase in birth defects among the children of atomic-bomb survivors; no chage in sex ratio in children born to survivors; some chromosome mutations; some changes in blood proteins; through age 20, risk of death is not higher among children of atomic-bomb survivors

How does radiactivity harm people?

In daily life we are exposed to many sources of natural radioactivity. The dosage per person per year is 1–2 mSv.

In Hiroshima and Nagasaki the radioactivity now (more than 50 years after the bombings) is below the level of naturally occurring radioactivity.

Radiation harms people by breaking up by creating free radicals inside cells which can then destroy proteins, lipids and DNA. Chemicals can also create free radicals.

Can you save people injured by the bomb?

We should try.

The first problem to be faced is first aid to so many people. The next problem is to find sufficient hospital beds. Finally, the problem is to have sufficient trained medical personnel.

For long term survivors, the question of help may be more subtle.

Can we protect ourselves from the bomb?

The best protection is to make sure, through diplomacy, that we never face a nuclear war.

In the immediate vicinity of a blast, there is very little chance of protection. More than 30 kms away, the protection needed will be from fallout.

Global nuclear war can bring about a “nuclear winter”, lowering temperatures below freezing all over the world, disrupting civilisation and even agriculture, wiping out whole ecosystems. It seems hard to protect ourselves from this except through prevention.