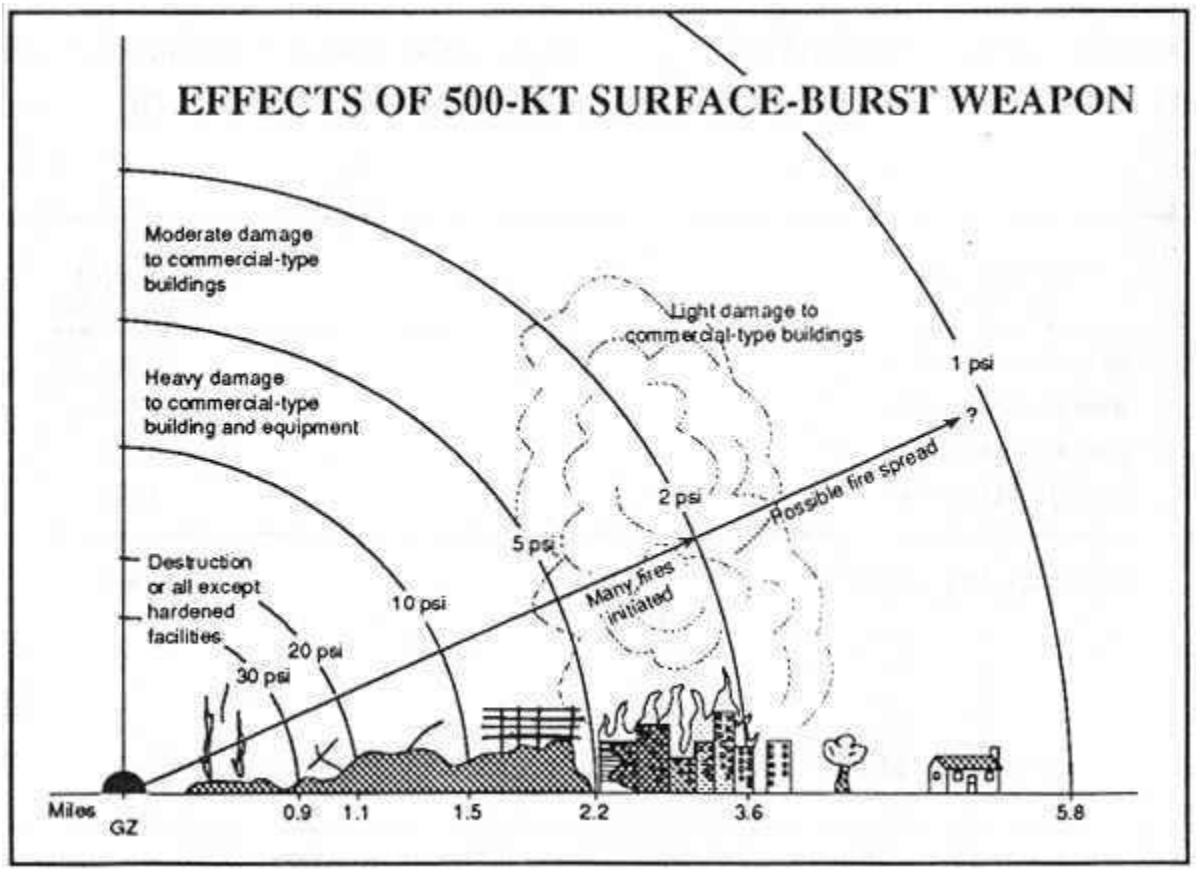
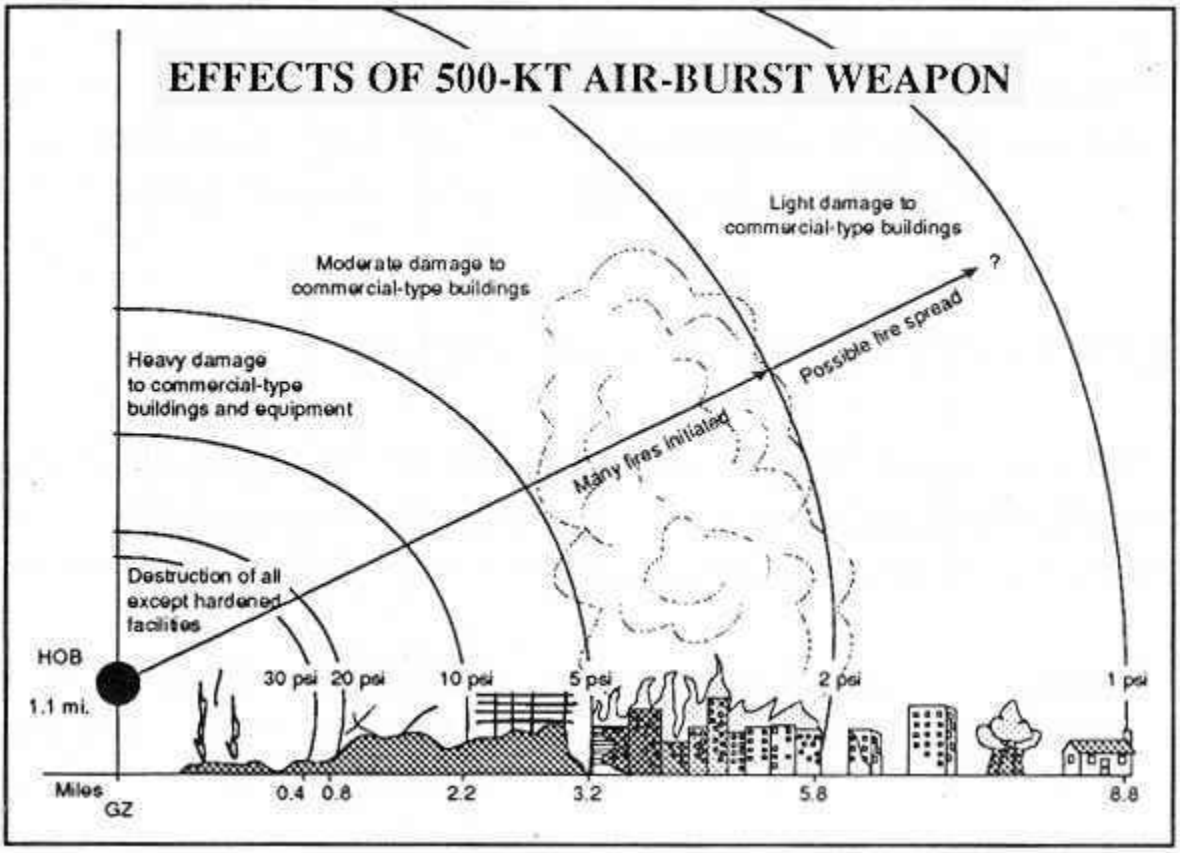
THE EFFECTS OF A NUCLEAR BLAST

A nuclear explosion releases vast amounts of energy in three forms:

1) light and heat
2) blast
3) radiation

The amount of energy released depends upon the size and design of the weapon. The effects of the blast depend upon whether the weapon is exploded high in the air, or on, or near the ground. An air burst produces more fire and blast damage than a ground burst which results in a big crater and more radioactive fallout.



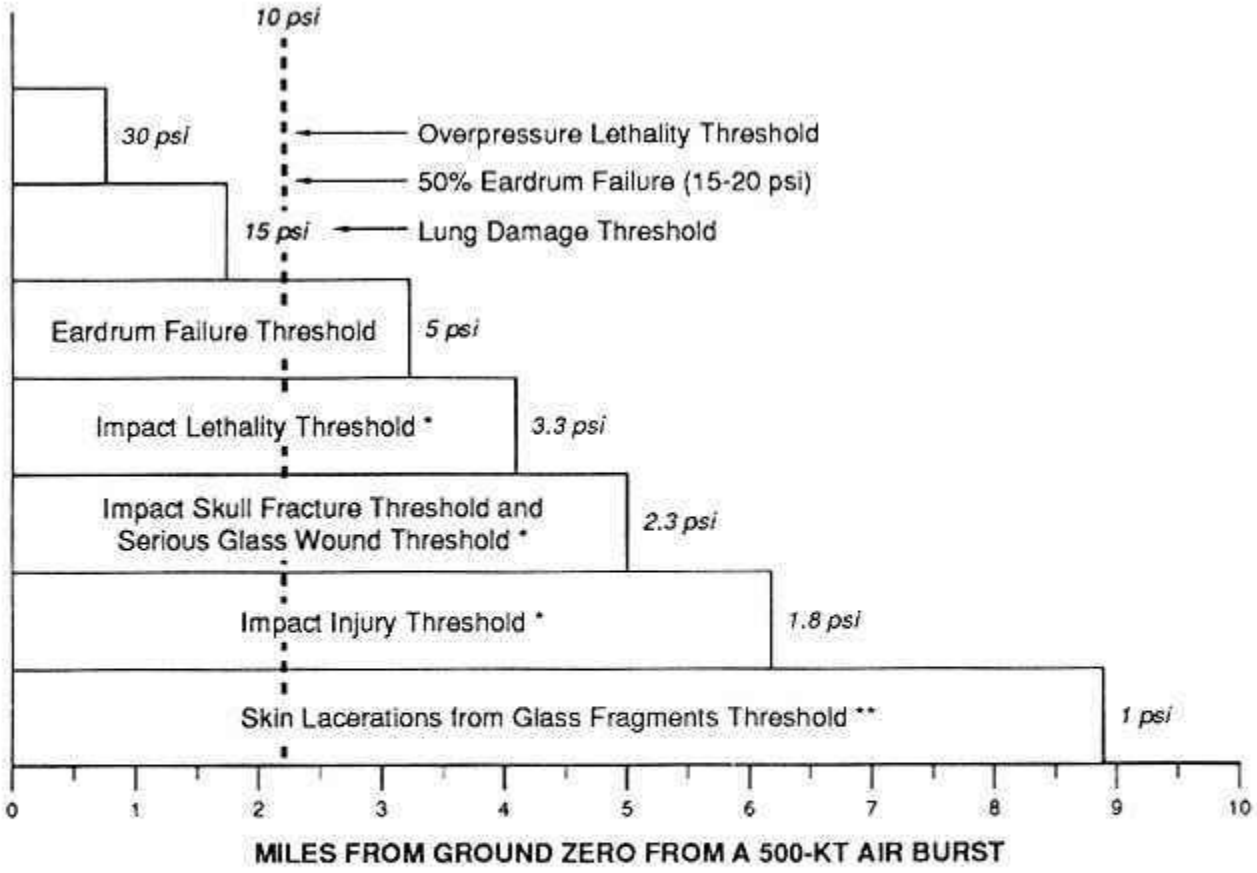


The very high temperatures attained in a nuclear explosion result in the formation of an extremely hot incandescent mass of gas called a **fireball**. Immediately upon formation, the fireball begins to grow rapidly and rise like a hot air balloon. Within a millisecond after detonation, the diameter of the fireball from a 1 megaton (Mt) air burst is 150 m. This increases to a maximum of 2200 m within 10 seconds, at which time the fireball is also rising at the rate of 100 m/sec. The initial rapid expansion of the fireball severely compresses the surrounding atmosphere, producing a powerful blast wave. There is an instant vapourization of all matter with the fireball. As it expands toward its maximum diameter, the fireball cools, and after about a minute its temperature has decreased to such an extent that it no longer emits significant amounts of thermal radiation. The combination of the upward movement and the cooling of the fireball gives rise to the formation of the characteristic mushroom-shaped cloud. A flash of thermal (heat) radiation is emitted from the fireball and spreads out over a large distance but with steadily decreasing intensity. The amount of heat energy received a certain distance away from ground zero depends on the power of the weapon, the terrain and the weather.

People can receive flash burns, burns caused by fire, retinal burn and flash blindness. With a 500 KT nuclear detonation, 3rd degree burns can be seen up to 10 km away; 2nd degree burns for people 10-12 km away; 1st degree burns for people up to 15 km away from ground zero. In most places however, fog, smog, haze, clouds, buildings, trees and hills would block and reduce some of this thermal radiation.

The very rapid expansion of the bomb materials produces a high pressure shock wave, that moves rapidly outward from the exploding bomb. In air, this **shock wave** is called a **blast wave** because it is equivalent to and is accompanied by powerful winds of much greater magnitude than hurricanes. Much of the damage inflicted by a nuclear explosion is the result of its shock wave. There are two components to a blast's shock wave. First, there's the wall of pressure that expands outward from the explosion. It is this pressure, measured in psi (pounds per square inch), that blows away the walls from buildings. A typical two-story house subjected to 5 psi would feel the force of 180 tons on the side facing the blast. Additionally, the blast creates a 160 mile-an-hour wind. And that's only at 5 psi. The wind speed following a 20 psi blast would be 500 mph! Obviously, the bigger the weapon yield, the larger the area of damage from the blast wave. The blast wave travels more slowly than the heat flash. The damage is caused both by high overpressure of air at the front of the blast wave and by the extremely powerful winds that persist after the wave front has passed. Once again, the amount of damage caused by the blast wave is dependent on the size of the weapon, the altitude at which the bomb is detonated and the distance from ground zero (point directly under the bomb). Complete destruction of all buildings occur up to 5 km away, damage beyond repair can be seen anywhere from 5 to 8 km away; major damage to structures before they can be occupied can occur from 8 km to 17 km away; light damage to buildings (they can be occupied while being repaired) can be see from 17 km to 25 km away.

Injury to humans from the blast wave can include crushed lungs, ruptured ear-drums and ruptured hollow viscera. Due to the very powerful winds, people and other objects (wood, glass, metal) will be lunched into the air. People may be crushed by fallen buildings and/or receive penetrating trauma, blunt trauma, broken bones, severe head injuries and burns.



* *For impact injury or death to occur at stated overpressure, the body must be thrown at least 10 feet before impact. Otherwise, a higher overpressure is required to achieve necessary velocity.*

** *Glass fragments must also travel at least 10 feet.*

The exploding nuclear device has a unique effect – it releases penetrating radiation, which is quite different from thermal radiation. When absorbed by the body, nuclear radiation can cause severe injury/death. Nuclear radiation from an explosion can be divided into 2 categories: **immediate/prompt radiation** and **residual radiation**.

Prompt radiation is given off at the time of the explosion. It is dangerous only within 3-5 km. If you were near the explosion without adequate protection and managed to survive the effects of the blast and fire, you could still be seriously affected by this radiation. The nuclear fission and nuclear that occur to produce the explosion release, either directly or indirectly, neutrons, gamma rays, beta particles, and alpha particles. Neutrons are heavy particles that are released from atoms' nuclei. These tiny "missiles" can easily penetrate solid objects. Another penetrating form of radiation is gamma rays, which are energetic photons. Both of these types of radiation can be deadly.

Residual radiation is given off by the radioactive particles left as “fallout” after the explosion. If a nuclear weapon is exploded on or near the ground, danger from radioactive fallout is the greatest. Millions of tones of pulverized earth, stones, buildings, people and other material are drawn up into the fireball and become radioactive. This radioactive material is then carred by winds until it settles to earth. The heaviest particles fall closest to ground zero and at the other extreme, the smallest particles, invisible to the naked eye can travel thousands of miles on the winds and some of it will stay suspended for decades. The radioactivity it gives off cannot be seen, felt or smelt. It can best be described as fine to coarse sand carried by winds.

There are four things which determine the amount of radiation reaching your body from fallout:

1) the time that has passed since the explosion
2) the length of time you are exposed to fallout
3) the distance you are from the fallout
4) the shielding between you and the fallout.

Listed below are the effects of a 1 MT nuclear blast:

1 Megaton Surface Blast: Pressure Damage

Radius of destructive circle: 1.7 miles
12 pounds per square inch

At the center lies a crater 200 feet deep and 1000 feet in diameter. The rim of this crater is 1,000 feet wide and is composed of highly radioactive soil and debris. Nothing recognizable remains within about 3,200 feet (0.6 miles) from the center, except, perhaps, the remains of some buildings’ foundations. At 1.7 miles, only some of the strongest buildings — those made of reinforced, poured concrete — are still standing. Ninety-eight percent of the population in this area are dead.

Radius: 2.7 miles
5 psi

Virtually everything is destroyed between the 12 and 5 psi rings. The walls of typical multi-story buildings, including apartment buildings, have been completely blown out. The bare, structural skeletons of more and more buildings rise above the debris as you approach the 5 psi ring. Single-family residences within this this area have been completely blown away — only their foundations remain. Fifty percent of the population between the 12 and 5 psi rings are dead. Forty percent are injured.

Radius: 4.7 miles
2 psi

Any single-family residences that have not been completely destroyed are heavily damaged. The windows of office buildings have been blown away, as have some of

their walls. The contents of these buildings' upper floors, including the people who were working there, are scattered on the street. A substantial amount of debris clutters the entire area. Five percent of the population between the 5 and 2 psi rings are dead. Forty-five percent are injured.

Radius: 7.4 miles
1 psi

Residences are moderately damaged. Commercial buildings have sustained minimal damage. Twenty-five percent of the population between the 2 and 1 psi rings have been injured, mainly by flying glass and debris. Many others have been injured from thermal radiation — the heat generated by the blast. The remaining seventy-five percent are unhurt.

1 Megaton Surface Blast: Fallout

Assumptions
Wind speed: 15 mph
Wind direction: due east
Time frame: 7 days

3,000 Rem*
Distance: 30 miles
Much more than a lethal dose of radiation. Death can occur within hours of exposure. About 10 years will need to pass before levels of radioactivity in this area drop low enough to be considered safe, by U.S. peacetime standards.

900 Rem
Distance: 90 miles
A lethal dose of radiation. Death occurs from two to fourteen days.

300 Rem
Distance: 160 miles
Causes extensive internal damage, including harm to nerve cells and the cells that line the digestive tract, and results in a loss of white blood cells. Temporary hair loss is another result.

90 Rem
Distance: 250 miles
Causes a temporary decrease in white blood cells, although there are no immediate harmful effects. Two to three years will need to pass before radioactivity levels in this area drop low enough to be considered safe, by U.S. peacetime standards.

*Rem: Stands for "roentgen equivalent man." This is a measurement used to quantify the amount of radiation that will produce certain biological effects.

Besides the blast and radiation damage from individual bombs, a large scale nuclear war could conceivably have a catastrophic global effect on the climate. The nuclear winter theory states that numerous nuclear weapons being detonated would throw up enormous quantities of dust and smoke into the atmosphere. The amount could be sufficient enough to block off sunlight for several months, particularly in the northern hemisphere. This would destroy plant life and create a sub-freezing climate until the dust settled. The ozone layer might also be affected, permitting further damage. If the results were sufficiently prolonged, they could spell the virtual end of human civilization.