NUCLEAR FISSION BOMB

Introduction

A nuclear bomb detonation is a very difficult subject for this writer to discuss because of the many deaths and suffering in two Japanese cities in 1945. Many of the survivors in Hiroshima and Nagasaki suffered from cancer many years later. This must never happen again.

The treat of a nuclear attack was considered very real during the Cold War. During the 1950's, newspapers carried articles on what would happen if a nuclear bomb were dropped in the center of the city covered by the newspaper, with damage and radiation expected at various distances from "ground zero". Some people built fallout shelters. Schools held drills where children were sent to the center of the building on a lower floor where radiation would be expected to be less. The United States came close to a nuclear war during the Cuban missile crisis in 1963. There was another incident in the early 1980's when the Soviet military mistook some "ghosts" or "natural phenomena" on their systems for a U.S. missile attack and almost launched an all-out counter attack (aired on a TV news documentary).

Today, the threat seems less real, at least from a nation-state. But there is still concern that a nuclear missile site might be taken over by a terrorist group, or a small nuclear device might be carried in a suitcase by a terrorist.

AristaTek carried an article on nuclear weapons in November 2002. The article can be obtained from the AristaTek website.

Nuclear weapons may take different forms. We will limit the discussion here to smaller nuclear fission weapons, which might be carried in a suitcase and detonated at ground level or near ground level by a terrorist.

Fox News carried a story (see http://www.foxnews.com/story/0,2933,76990,00.html) that Russian National Security Adviser Alexandr Lebed in 1997 alleged that up to 100 nuclear 1 KT potable bombs that looked like suitcases were unaccounted for since the 1991 breakup of the Soviet Union. Usama Bin Laden allegedly has purchased a number of suitcase or backpack nuclear bombs from Chechen organized crime groups. Former FBI Director Louis Freeh told Congress, "We have not seen any hard evidence of suitcase-sized nuclear devices unaccounted for or falling into the hands of terrorists or rogue states". See also National Fire and Rescue reprint article (2002), http://www.nfrmag.com/library/HD-Rad.pdf and http://www.ki4u.com/loose_nukes.htm.

What Does A Small Nuclear Fission Bomb Look Like?

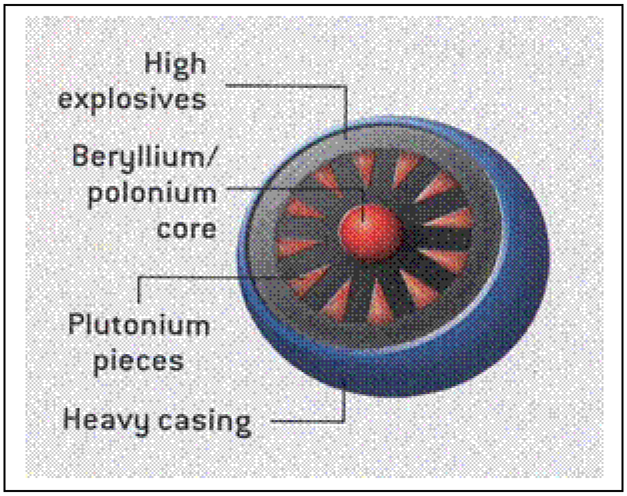
The essential starting material is fissionable material such as uranium 233, uranium 235, plutonium 239, or plutonium 241. Perhaps plutonium 239 produced from nuclear power plants using uranium 238 as fuel may be the most common fissionable material available.

Detonation of a nuclear device occurs when a critical mass of fissionable material is achieved. The amount required to produce a critical mass depends on what the fissionable material is and the arrangement of material such that enough neutrons are reflected back to the material to result in detonation.

The detonation of a nuclear device requires a method of quickly converting a subcritical system to a critical one. Two methods are generally used:

- One or more subcritical mass fragments are brought together very quickly in order to achieve a supercritical mass, for example, a high explosive device blows one subcritical mass in some gun-barrel device into another subcritical mass firmly held at the muzzle end.
- Another method is to rapidly compress a subcritical quantity such that the density increases and the mass becomes critical. This is done by using a spherically-fabricated shape of a high explosive with a subcritical sphere of fissionable material in the center. When the explosive detonates, an inwardly-directed implosion wave is produced causing the uranium or plutonium to be compressed.

Conventional explosives are required to set off a nuclear device.



Illustrated at the left is a cut of a possible nuclear fission bomb arrangement using plutonium 239 or uranium 235. This cut was also used in an article in the Scientific American for Nov. 2002 (page 78) on weapons of mass destruction. This illustration is of interest because it shows an arrangement whereby many subcritical plutonium pieces are arranged and brought together to form one large critical mass. A more simple fission bomb can be created by bringing say two subcritical pieces together, but the bomb yield (kiloton TNT equivalent) will be less. The subcritical plutonium 241 is in the shape of inwardly pointing pyramids surrounded by a shell of high explosives. When the high explosives detonate, the plutonium pieces are driven together into a sphere containing a core pellet of beryllium/polonium creating a critical mass. The core pellet controls the neutron flux from the plutonium allowing a critical mass to be achieved with a smaller amount of fissionable material (e.g. a few pounds of plutonium 239). Plutonium 239 has a mass density of 19.5 grams/cc; a 5 kg critical mass would be equivalent to a cube 2.5 inches on the side. The time between the high explosive detonation to the detonation of the nuclear device is a small fraction of a second.

The Soviet nuclear backpack system consists of three "coffee can-sized" aluminum canisters with a 6-inch detonator and powered by a battery. The canisters are interconnected as a single unit; the contents are brought together by setting off an explosive remotely. [http://www.foxnews.com/story/0,2933,76990,00.html]

More on nuclear weapons design can be found at the website, http://www.fas.org/nuke/intro/nuke/design.htm.

Other Nuclear Weapons

- Thermonuclear weapon. If heavy isotopes of hydrogen (deuterium or tritium) are heated to very high temperatures (over one million degrees), they will fuse forming helium and heat energy. This process is called fusion. In order to reach the million plus temperatures, detonation a fission-type nuclear bomb is required. The combination of the fission and fusion bomb releases tremendous amounts of energy mostly in the form of heat. The TNT energy equivalent usually is in excess of one million tons. This is sometimes called the "hydrogen bomb". In one variation, the fusion core of the bomb is wrapped in a blanket of uranium 238 atoms. The uranium 238 atoms are then split by the searing energy released from the fusion core initiating a very powerful secondary fission explosion.
- Neutron bomb, or Enhanced Radiation Warheads. These are small nuclear devices with limited blast and heat effects when detonated but are designed to release a sudden and deadly flux of neutrons which can penetrate tank armor in the battlefield or disrupt trajectories of an incoming missile attack. They can be a small fission-type bomb which are constructed of materials (chromium and/or nickel) which allow for maximum escape of neutrons rather than be absorbed by the bomb material producing radioactive isotopes. They can be a fusion type bomb or a thermal nuclear weapon. According to the neutron bomb inventor [Sam Cohen, see http://www.manuelsweb.com/sam_cohen.htm] irradiated red mercury can be exploded resulting in temperatures high enough to trigger a fusion device using hydrogen isotopes without the need of plutonium or uranium 235. The neutron bomb could be packaged in a container the size of a baseball. The initial blast and heat effects would be limited to a few hundred yards, but lethal neutron and gamma radiation distance would extend much further. The neutron bomb can be

designed to produce minimal residual radiation. Countries believed to possess neutron bombs include the U.S., China, Russia, Israel, and France, and possibly India.

Energy Released From Detonation of a Fission Nuclear Bomb

At the instant of detonation of a nuclear device there will be a blinding flash of light, much brighter than the sun. The light will be so intense that permanent retinal damage will occur even though the person is many miles away unless typography or structures block his/her vision of the fireball. In the worst case of a detonation of a very large nuclear device at say 10,000 feet elevation at night, retinal damage can occur even 150 miles away from ground zero.

The maximum light intensity may occur within 0.1 second of the detonation (a blink of the eye takes about 0.25 seconds). Persons within several miles of ground zero (depending upon the size of the device) may also receive a lethal dose of gamma and neutron radiation and fatal third degree burns in the first few seconds, unless protected by buildings or underground shelters.

After the first few seconds or minutes (depending upon the distance from ground zero) there will be a blast wave and accompanying wind, sufficient to level buildings.

The photo to the left is taken of a daytime aerial detonation taken right after detonation, with the camera lens darkened to blot out all light except for the flash itself. Notice the separation between the initial nuclear flash and the debris from the ground which will form part of the nuclear cloud, and the blast wave spreading out from ground zero.

Following the events of the first hour, responders may make decisions whether it is “safe” to enter the stricken area. There will be residual radiation from the radioactive isotopes formed and dispersed over the area. This residual radiation should decay at a predictable rate. Complicating this picture will be radioactive fallout from the sky which may be carried long distances from the source. There will also be many secondary fires endangering people.

As a rough rule of thumb, about 200 MeV of energy is released per atom undergoing fission. Of this 200 MeV, about 185 MeV energy is released instantaneously in the form of blast and shock waves, heat, and radiation, and 15 MeV in the form of radioactive decay. It is customary to rate the energy released in terms of TNT equivalents. The complete fission of one pound of uranium 233 or plutonium 239 releases as much energy as 8,000 tons of TNT. The atomic bomb dropped on Japan in 1945 was rated at 20 kilotons of TNT. Theoretically a 20-kiloton weapon would require 2.5 pounds of uranium 233 or plutonium 239, but the actual amount used was probably more because the fission process is not 100% efficient.

In a ground level burst, about 1% of the energy released would vaporize the ground at the site. An one-megaton TNT equivalent weapon would vaporize about 4000 tons of soil material which would be sucked up into the fireball Large amounts of dirt and water would be sucked up as the fireball rises. Neutrons emitted during the first second of the detonation will interact with the ground producing radioactive isotopes. The dirt sucked up would be dispersed as radioactive fallout some distance away from the explosion. In an air burst, less energy would be absorbed by the ground. More blast and heat energy will affect locations further away from ground zero. Less dirt will be sucked up into the fireball, and less fallout overall might be expected.

Detonation of a nuclear bomb results in the following:

- Blast waves and accompanying wind
- Heat and blinding light
- Initial nuclear radiation (within first minute of blast)
- Residual nuclear radiation (after first minute of blast)
- Radioactive fallout

<u>PEAC Tool (Version 5.2)</u>

Information on Nuclear Fission Detonation in the PEAC tool is accessed at any time by clicking on the red “mushroom” icon at the top center of the PEAC tool, regardless of anything else that might be displayed, see figure below.

The Nuclear Detonation Calculator icon

The PEAC tool used information in the public domain from the fission bomb tests at the Nevada Test Site and other locations and the 1945 detonations at Hiroshima and Nagasaki. The information in the PEAC tool is intended for training exercises as in (1) estimating evacuation distances or shelter in place in case a suspicious package is located and must be disarmed or (2) a nuclear device has exploded and rescue operations begin.

When the user opens the “red mushroom” icon, a descriptor/disclaimer statement is displayed:
“Detonation of a nuclear fission-type device will result in an initial blinding flash of light, heat, gamma and neutron radiation with the first second or two of detonation, followed quickly by a blast wave. These calculations consider only initial damage. The calculations do not consider radioactive fallout, secondary fires, additional radiation exposure from use of dirty starting materials, use of enhanced radiation warheads, or detonation of a thermal nuclear device. Calculations apply to a ground level fission device on fairly level terrain. An aerial detonation or detonation on a hilltop may result in greater damage at distances further from ground zero.”

A screen pops up titled “Nuclear Device Yield”. The user must estimate the Yield in units of kilotons (KT) of TNT energy equivalents. By convention, the energy released by nuclear bombs is rated in terms of TNT equivalents, even though no TNT explosives are actually used. If the nuclear device has been detonated, the KT yield may be estimated by either specifying (1) the mushroom cloud height, (2) the crater diameter if detonated at ground level, or (3) a blast damage estimate at some distance away from ground zero. The cloud height can be calculated knowing the distance from ground zero and the angle from the horizontal (best 10 to 30 minutes after detonation).

The display of the following examples are in metric units The PEAC user can chose “English units” if desired.

Nuclear Device Yield

Yield 1.0 KT

Use any one of the following visual indicators to ESTIMATE the yield of the nuclear device.

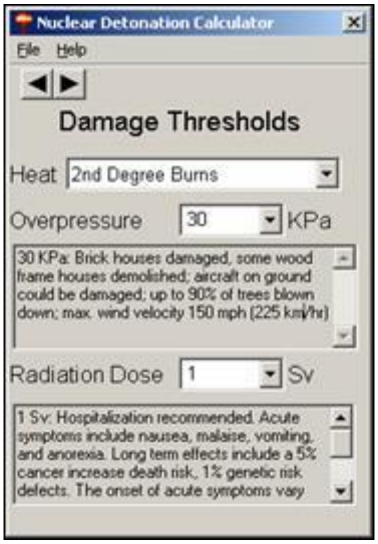
Cloud Height 4.5 km

Crater Diameter 40 m

Moderate Damage 1200 m

Cloud height measured 10-15 minutes after detonation of nuclear device at ground level. Moderate Damage for wood frame buildings includes wall framing cracked, roofs badly damaged, and interior partitions blown down. For steel frame buildings, damage would include some to major distortion of frame.

Estimate Yield



Damage Thresholds

Heat 2nd Degree Burns

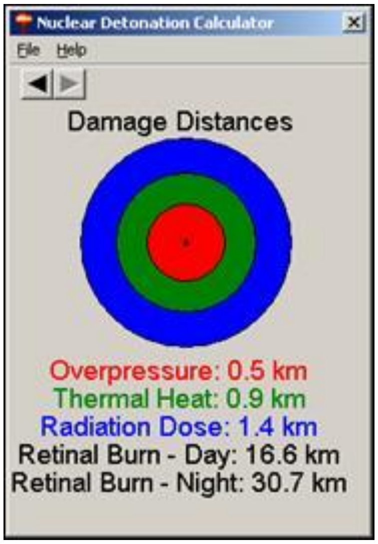
Overpressure 30 KPa

30 KPa: Brick houses damaged, some wood frame houses demolished; aircraft on ground could be damaged; up to 90% of trees blown down; max. wind velocity 150 mph (225 km/hr)

Radiation Dose 1 Sv

1 Sv: Hospitalization recommended. Acute symptoms include nausea, malaise, vomiting, and anorexia. Long term effects include a 5% cancer increase death risk, 1% genetic risk defects. The onset of acute symptoms vary

Specify Damage Thresholds



Damage Distances

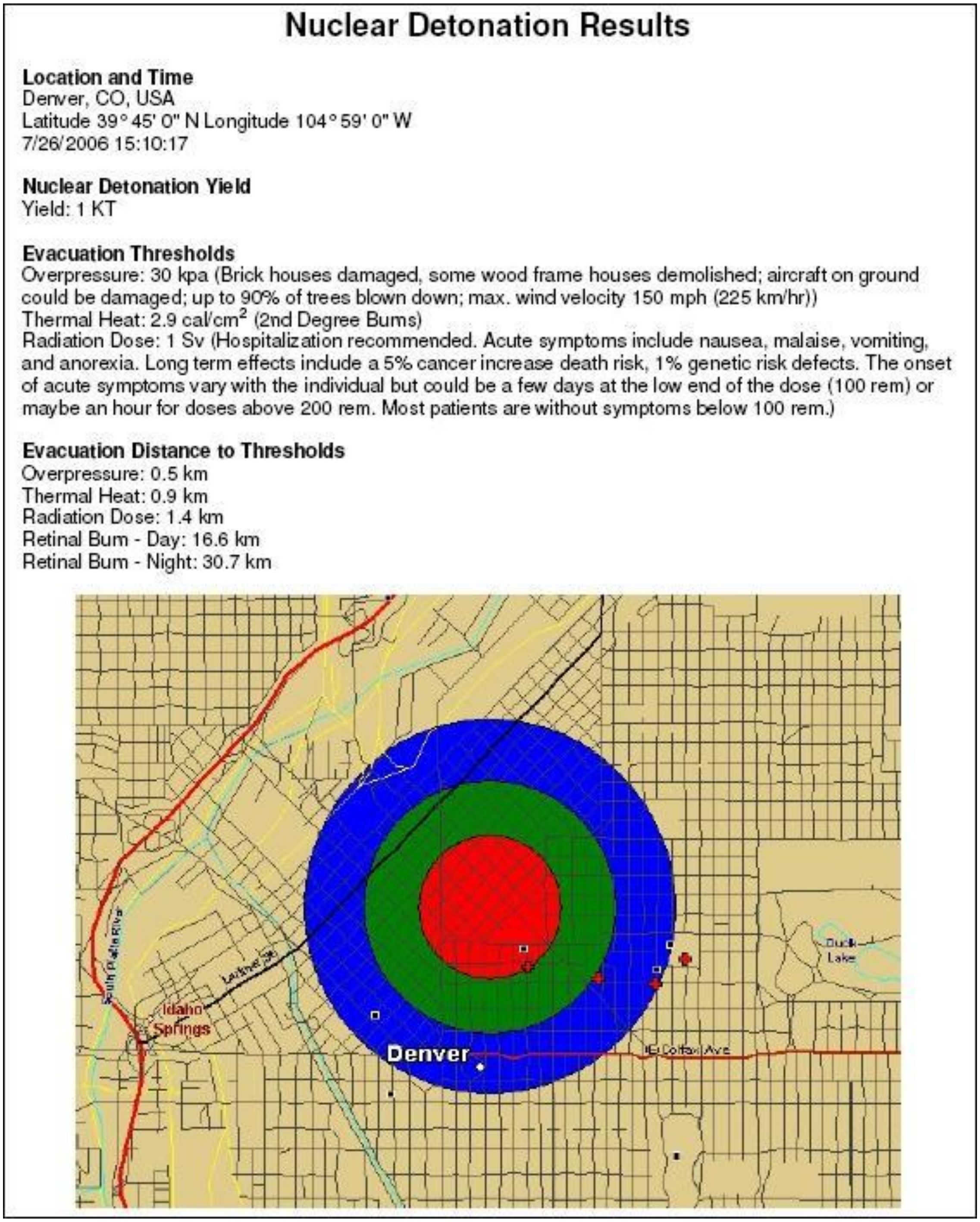
Overpressure: 0.5 km
Thermal Heat: 0.9 km
Radiation Dose: 1.4 km
Retinal Burn - Day: 16.6 km
Retinal Burn - Night: 30.7 km

Damage Distances

In the next screen, the user specifies damage thresholds. Overpressure refers to blast damage; the number specified is linked to a physical description of the blast damage, which the PEAC user can display (not shown). There will also be an initial burst of heat (thermal) energy; the user can specify “second degree burns” or 3rd degree burns (at different fatality levels). The user also specifies a radiation dose from the initial pulse of gamma and neutron radiation, which occurs during the first few minutes of the nuclear blast. An estimate for the daytime and nighttime distance for retinal burns is also displayed on the results screen.

The last screen Damage Distance estimates for the kiloton yield, blast overpressure, thermal heat, and radiation dose specified. The retinal burns distances are not displayed on the map.

The PEAC Map Tool will automatically display the resulting distances as polygons on a street map for the specified location. When finished, all of this information is displayed on one screen, which can be printed or copied or recalled for later viewing. A portion of a Nuclear Detonation Results Report is shown in the figure below. Additional information on the distances to damage of different types infrastructure is provided in a table (not shown) below the map display of the results.



Nuclear Detonation Results

Location and Time
Denver, CO, USA
Latitude 39° 45' 0" N Longitude 104° 59' 0" W
7/26/2006 15:10:17

Nuclear Detonation Yield
Yield: 1 KT

Evacuation Thresholds
Overpressure: 30 kpa (Brick houses damaged, some wood frame houses demolished; aircraft on ground could be damaged; up to 90% of trees blown down; max. wind velocity 150 mph (225 km/hr))
Thermal Heat: 2.9 cal/cm^2 (2nd Degree Burns)
Radiation Dose: 1 Sv (Hospitalization recommended. Acute symptoms include nausea, malaise, vomiting, and anorexia. Long term effects include a 5% cancer increase death risk, 1% genetic risk defects. The onset of acute symptoms vary with the individual but could be a few days at the low end of the dose (100 rem) or maybe an hour for doses above 200 rem. Most patients are without symptoms below 100 rem.)

Evacuation Distance to Thresholds
Overpressure: 0.5 km
Thermal Heat: 0.9 km
Radiation Dose: 1.4 km
Retinal Burn - Day: 16.6 km
Retinal Burn - Night: 30.7 km

Example of a Nuclear Detonation Results Report

The calculations apply to someone caught out in the open when a nuclear detonation occurs. The retinal burn distances apply for a clear day for a person who happens to be facing the direction of ground zero at the instant of detonation, and there is no terrain or structures blocking his/her line of sight. The distances are greater at night because it is assumed that the pupils are more open. The retinal damage occurs in the first second of detonation.

In contrast, the blast damage occurs later. The arrival time of the blast front depends on a number of factors including the height of the nuclear burst. For a 1 kiloton burst at ground level, the blast front will take 0.5 seconds to travel 1,100 feet, 2 seconds to travel 2,000 feet, and 4.5 seconds to travel 5,850 feet. The actual analysis of the blast is fairly complicated. The blast wave can undergo multiple reflections. There is also a strong wind component moving from the blast. At 5 psi overpressure, the accompanying wind may be 160 mph.

Neutron radiation exposure occurs within the first second of detonation. Almost all of the gamma radiation exposure (excluding gamma radiation from radioactive isotopes and from fallout) also occurs in the first minute. The exposure distances are for someone caught out in the open. Because gamma and neutron radiation scatters, a barricade between a person and the detonation will offer little additional protection, unless the person is completely surrounded by the barricade. The shielding must be provided in all directions. The damp earth tenth-value thickness for gamma rays is 18 inches; for neutrons, it is about 24 inches. Twelve inches of concrete (on all sides) should reduce gamma radiation intensity by a factor of 10; twenty four inches by a factor of 100. The interior lower floors of reinforced buildings may provide a 50 to 300-fold protection from radiation compared with someone outside. A basement in a one-story house might offer a 15-fold protection factor. The subbasement of multistory buildings might offer a 1,000 protection factor.

Shielding for neutrons is more complex; the neutrons must first be slowed down (an elastic scattering material such as one containing barium or iron best) and then adsorbed (water good for this purpose). Therefore the protection factors for neutrons offered by a given thickness of shielding are different compared with gamma radiation.

Delayed Radiation and Radiation Fallout

The above discussion considers only initial effects. The neutrons emitted during fission will interact with everything nearby producing radioactive isotopes. The radioactive isotopes will continue to emit alpha, beta, and gamma radiation over the lifetime of the isotopes which may be for several decades. The mushroom cloud formed will carry the radioactive isotopes high into the atmosphere. Some will fall to the ground as radioactive fallout. Some will be dispersed with the wind that accompanies the blast. Some of the radioactive isotopes will be dispersed worldwide and enter the food chain, resulting in an increased risk of cancer.

The PEAC-WMD application currently doesn’t predict radioactive fallout patterns because of the many variables involved.

The radiation dose as a function of distance from ground zero depends how the radioactive isotopes are distributed; they can be absorbed into or onto the ground or carried by the wind to some distance from the site. However, if the dose rate (Roentgens per hour) is known at a location at particular time since detonation, the dose rate can be estimated for a later time. Fission tests conducted at the Nevada Test Site and elsewhere roughly 50 years ago have produced a mixture of isotopes such that the dose rate falls off in a predictable way, for example, if the dose rate at a particular location is 1,000 Roentgens/hour at one hour after the detonation, after 1,000 hours, the dose rate is 0.24 Roentgens/hour. About 55% of the “infinity residual radiation dose” (e.g. the radiation dose if the person remained there for many years) is received between the first minute and hour since detonation. About 80% of the infinity dosage is received between the first minute and 24 hours since detonation. This kind of information is of use to responders who may venture into an area devastated by a nuclear explosion, or when people in shelters might come out. The PEAC tool contains a calculator for estimating the radiation dose rate at a future time if a measurement is taken at an earlier time, providing that additional fallout has not occurred.

This methodology for radioactive decay should hold true for ordinary fission-type devices including a fission device used to initiate a thermonuclear device (the “hydrogen” bomb). It does not hold true for fission bombs with additional material is added to produce long-lived radioactive isotopes. An example is where the warhead is incased in a cobalt shell (the “cobalt bomb”); the radioactive isotope decay will be enriched in the cobalt 60 radioactive isotope formed during the nuclear blast. The cobalt 60 radioactive isotope would decay much slower rate. After about 20 or so years, the radiation level might decay by a factor of ten or fifteen.

In a rainy situation, practically all of the radioactive fallout might occur within the rain location, especially in the case of a lower yield detonation near or at the ground.

Building structures offer some protection against delayed radiation including fallout. A one-story frame house in the center of the house might offer a 2.3 protection factor for radiation. A basement of a one-story house might offer a 15 protection factor. A two-story frame house basement might offer a 37 protection factor. The protection factor in subbasements of multistory buildings or in underground shelters (at least 3 feet of dirt on top) could be 1,000.

Certain isotopes from fission explosions are of particular concern because they get into the food chain. The two major ones are strontium 90 (half life 27.7 years) and cesium 137 (half life 30.5 years). Moreover these two isotopes have gaseous precursors as part of the radioactive decay chain allowing for dispersal over a large area, even worldwide. For every 1,000 atoms undergoing fission, about 30 to 40 atoms of strontium 90 and 50 to 60 atoms of cesium 137 are eventually formed.

Effect of Radiation on Health

Table 1: Whole Body Radiation Exposure Levels and Resulting Effects for a Single Dose

Dose, Rem	Effects
5	No observable effects
10	Difficult to demonstrate a higher incidence in fetal abnormalities or cancer effects below 10 rem dose. A 10 rem dose results in a 0.8% lifetime increase in developing cancer.
15	Threshold, blood and sperm abnormalities seen
25	Threshold, genetic effects demonstrated
70	A decrease in lymphocytes in peripheral blood chemistry profile after 24 hours indicating some bone marrow depression.
100	Hospitalization recommended
100	Acute symptoms include nausea, malaise, vomiting, and anorexia. Long term effects include a 5% cancer increase death risk, 1% genetic risk defects. The onset of acute symptoms vary with the individual but could be a few days at the low end of the dose (100 rem) or maybe an hour for doses above 200 rem. Most patients are without symptoms below 100 rem.
120	Abrupt decreases in sperm count, but recovery of natural fertility usually occurs after several months or a year
200	Bone marrow depression symptoms apparent. The onset of symptoms associated with bone marrow depression can vary with the individual and dose; but can be several weeks or even months after radiation exposure. These symptoms may occur weeks after the person has recovered from the initial onset of nausea and anorexia. Changes in the peripheral blood profile may occur as early as 24 hours after radiation exposure. Lymphocytes will be depressed most rapidly, and other leukocytes and thrombocytes will be depressed less rapidly. A 50% drop in lymphocytes in 24 hours indicates significant radiation injury. Symptoms include bleeding (hemorrhage) and anemia, diarrhea, fluid loss, and decreased resistance to infection, which become apparent several weeks after radiation exposure. Minimal treatment includes fluid

	replacement, antibiotics, and prevention of infection. More aggressive treatment includes bone marrow resuscitation therapy.
250	10% of people develop cataracts within several months
300	Epilation (hair loss)
350	Median lethal dose of radiation that will kill 50% of the exposed persons within 60 days without appropriate medical treatment. Mortality is low with aggressive therapy.
400	Continued loss of epithelial cells of the intestinal mucosa results in hemorrhage and marked fluid loss contributing to shock; these symptoms occur within 1 or 2 weeks after irradiation.
600	Almost 100% fatal within 60 days if untreated. Erythema occurs. Lymphocyte count decreases from normal level of about 2,000 or 2,500 to about 500 in 24 hours. Cognitive impairment.
800+	Rapid incapacitation. Symptoms may occur within an hour after exposure. Diarrhea, fever, electrolyte imbalance. Mortality rate high even with treatment.
2,000	Onset of symptoms within minutes. Neurovascular symptoms occur within several hours to about 3 days after exposure. These include a steady deteriorating state of conscience with eventual coma and death.

To convert “rems” to “Sieverts” multiply by 0.01

Individual Protection Against a Nuclear Blast

The U.S. Center for Disease Control and Prevention has issued the following advice for individuals and families in case of a nuclear blast:
[Information from: http://www.bt.cdc.gov/radiation/nuclearfaq.asp].

How can I protect my family and myself during a nuclear blast?
In the event of a nuclear blast, a national emergency response plan would be activated and would include federal, state, and local agencies. Following are some steps recommended by the World Health Organization if a nuclear blast occurs:

If you are near the blast when it occurs:

- Turn away and close and cover your eyes to prevent damage to your sight.
- Drop to the ground face down and place your hands under your body.
- Remain flat until the heat and two shock waves have passed.

If you are outside when the blast occurs:

- Find something to cover your mouth and nose, such as a scarf, handkerchief, or other cloth.
- Remove any dust from your clothes by brushing, shaking, and wiping in a ventilated area—however, cover your mouth and nose while you do this.
- Move to a shelter, basement, or other underground area, preferably located away from the direction that the wind is blowing.
- Remove clothing since it may be contaminated; if possible, take a shower, wash your hair, and change clothes before you enter the shelter.

If you are already in a shelter or basement:

- Cover your mouth and nose with a face mask or other material (such as a scarf or handkerchief) until the fallout cloud has passed.
- Shut off ventilation systems and seal doors or windows until the fallout cloud has passed. However, after the fallout cloud has passed, unseal the doors and windows to allow some air circulation.
- Stay inside until authorities say it is safe to come out.
- Listen to the local radio or television for information and advice. Authorities may direct you to stay in your shelter or evacuate to a safer place away from the area.
- If you must go out, cover your mouth and nose with a damp towel.
- Use stored food and drinking water. Do not eat local fresh food or drink water from open water supplies.
- Clean and cover any open wounds on your body.

If you are advised to evacuate:

- Listen to the radio or television for information about evacuation routes, temporary shelters, and procedures to follow.
- Before you leave, close and lock windows and doors and turn off air conditioning, vents, fans, and furnace. Close fireplace dampers.
- Take disaster supplies with you (such as a flashlight and extra batteries, battery-operated radio, first aid kit and manual, emergency food and water, nonelectric can opener, essential medicines, cash and credit cards, and sturdy shoes).
- Remember your neighbors may require special assistance, especially infants, elderly people, and people with disabilities.

Treatment for Radiation Exposure

- If exposure occurs because of radioactive fallout or contact with dust containing the radioactive isotopes, about 95% of the external radioactive material can be removed by taking off the victim's clothing and shoes and washing with water. Further decontamination may require the uses of bleaches and/or mild abrasives.
- It is essential to protect against inhalation of radioactive-contaminated dust by using appropriate air-purifying respirators or SCBA.
- Victims should be treated for hemorrhage and shock. Open wounds are usually irrigated to cleanse them of any radioactive traces.

- If radioactive material is ingested, treatment is given to reduce absorption and enhance excretion and elimination. This may include stomach pumping, laxatives, and use of aluminum antacids.
- If radioactive isotopes are in the victim's internal organs and tissues, treatment may include various blocking and diluting agents. The treatment may include where appropriate mobilizing agents such as ammonium chloride, diuretics, expectorants, and inhalants to force tissues to release the materials. Other treatments may include chelating agents and use of potassium iodide.
- Advanced treatments exist (see table 1) to increase survival if a person receives a radiation dose in the 100 to 600+ Rem range. The condition where a person is exposed to high levels of radiation is called Acute Radiation Syndrome (ARS) and is characterized by damage to the production of major blood elements in the blood marrow. Minimal treatment includes fluid replacement, antibiotics, and prevention of infection. More aggressive treatment includes bone marrow resuscitation therapy. Hollis-Eden Pharmaceuticals with the U.S. Armed Forces Radiobiology Research Institute have developed a drug (NEUMINE, or HE2100) for bone marrow treatment. The drug was demonstrated in non-human primates to be very effective in treating the bleeding and infections (neutropenia and thrombocytopenia) resulting from radiation exposure. CBS 60 Minutes aired a program on this drug on 29 January 2006, acknowledged its success, but questioned whether it would be available on a mass basis in the event of a nuclear attack. More details are at the drug company website, http://www.holliseden.com/content/?page_id=79.