NUCLEAR EXPLOSIONS 101

Why Think About Nuclear Attacks? Most of us would rather not think about a nuclear attack on our country and imagine it would be a catastrophic event. However, the area affected by a blast can be much smaller than you might imagine and dealing with radioactive fallout is not as complicated as you might think. With nine countries believed to currently have nuclear weapons, it is worth taking some time to think about what you can do to protect yourself and your loved ones, should the unthinkable happen.



<u>NINE COUNTRIES WITH NUCLEAR WEAPONS</u>: At present Russia, the USA, China, France and the UK (permanent members of the UN Security Council) along with Pakistan, India, Israel and reportedly North Korea have nuclear arsenals. Russia and the USA between them own 90% of the world's nuclear weapons. There are currently approximately 13,000 nuclear weapons in existence. Though high, those totals are lower than in the post-WWII arms race era, thanks to the INF Treaty of 1987 and the more recent Strategic Arms Reduction Talks. Also, the fact that the weapons exist does not mean they are ready to be used.

Cuban Missile Crisis: The prospect of nuclear weapons being used has arisen in a way not seen since the Cold War era of the 20th Century. In October 1962, the 13-day Cuban Missile Crisis saw a stand-off between the USA and the Soviet Union. The crisis ended when President JF Kennedy and Soviet leader Nikita Khrushchev agreed that the USSR would remove its weapons in return for the USA agreeing not to attack Cuba.



The cover of the New York Times from 23rd October 1962. The photo shows President Kennedy addressing the nation.

What Happens in a Nuclear Explosion?

 The danger from nuclear explosions arises not only from the blast itself but from the radioactive fallout that follows. Nuclear explosions produce greater heatwaves and stronger blast waves than other types of explosions. They scatter hazardous particles over a considerable area resulting in the threat of being exposed to dangerous levels of radioactivity; however, the danger subsides quite quickly.



- **Mushroom Cloud**: The distinctive **mushroom cloud** associated with atomic bombs is formed by dirt and liquid materials carried into the upper atmosphere by the wind. The material in the mushroom cloud interacts with radioactive particles from the nuclear weapon, with the liquid matter freezing.
- Radioactive Fallout: The radioactive material in the mushroom cloud condenses and falls back to earth, resulting in radioactive fallout. The particles from the initial fallout might be the size of sand or salt granules and they are visible to the eye. Fallout pollutes everything it connects with, including food and supplies. The wind direction influences its direction and area of coverage. A <u>10 kiloton</u> explosion, for example, could cause hazardous fallout to travel up to <u>20 miles</u> downwind.
- A nuclear explosion is an exothermic (heat-producing) explosion caused by nuclear fission or nuclear fusion.
 - Nuclear fission involves using an atom to split a heavy nucleus into lighter ones and explosives of this type are known as atomic bombs.
 - Nuclear fusion is the opposite, as two nuclei are fused to become one. This process creates a thermonuclear
 or hydrogen explosion.
 - Both processes release a tremendous amount of energy compared to the traditional explosive TNT. Thus, nuclear bombs are often described in terms of how much TNT would be required to create a similar blast. A kiloton bomb would have a similar effect to 1,000 tons of TNT.
- A nuclear explosion over the sea.

• On detonation, a **nuclear device** creates an intense fireball along with shock waves/blasts, intense heat, blinding light and radiation. Apart from forming the distinctive mushroom cloud, the explosion also causes radioactive debris to fly into the atmosphere before it returns as radioactive fallout (this is called delayed ionising radiation).

<u>What Can You Do</u>? There is no need to fret about something that may never happen; however, there are also simple steps that you could take that could someday make a difference in your life and the lives of your family:



1.) Do a safety audit now and then. Consider where you could shelter if an attack was announced when you are at work or on your commute.

2) Evaluate where you can keep safe in or around your home.

- 3) Have provisions set aside that would be useful should you need to remain inside for some days.
- 4) Find out what injuries are most likely to occur and refresh your First Aid training.

This course will cover these topics as well as explain a little more about nuclear explosions and their impacts on communities and the places they live. Remember, any incident is unlikely to happen in a vacuum. There would be government action to protect civilians. You may be evacuated, or if you live in the vicinity of a likely military target, you could make your own plans to relocate.

<u>Get as Far as Possible from the Explosion</u>: It may seem obvious, but the immediate danger to life and property from both the blast and heat generation depends on your proximity to the explosion, so the more distance you can create, the better. However, <u>don't decide to move once an attack is imminent</u>, as you are much safer indoors than outside or in a vehicle.



The Atomic Bomb Dome in Hiroshima survived the attack and is now a Unesco World Heritage site

In the case of the American bombing of Hiroshima in Japan on 6 August 1945, the bomb contained the equivalent of 15,000 tons of TNT and destroyed a 13km² area, approximately 5miles².

The attack, from the B-29 bomber plane Enola Gay, was the first time an atomic weapon had been used in war. The bomb was dubbed 'Little Boy'.

Damage Zone Limited: While the world hopes that such weapons will never again be deployed, understanding what happens in a nuclear blast and what steps you can take to protect yourself and your loved ones is prudent.

First off, today's nuclear missiles are more precise weapons than the atomic bombs of the last century. Depending on the size and location of the explosion, <u>it is possible that the severe damage zone where most fatalities occur, is not large</u> - think of Manhattan rather than all of New York. Unfortunately, no one would survive in this zone.

A couple of miles from the blast area, the moderate damage zone offers the possibility of survival. In the light damage zone, which is further out, injuries will be less severe.

It's impossible to give precise measurements as those distances depend on a number of factors which we will cover later. As you move away from the blast zone, the danger is from radioactive fallout, which can be blown downwind.

Light, Moderate and Severe Damage Zones



All approximated distances from center of detonation site

Figure 1.1: Representative damage zones for 10 KT nuclear explosion (not to scale; circles are idealized here for planning purposes)

What to Do in an Attack:

STEP 1: The following describes the steps you can take in the event of an attack. If a nuclear blast is imminent and you cannot put significant distance between yourself and the explosion, you should seek cover inside a solid building, preferably made of stone, concrete or brick. Go to a basement, the lowest floor of a large building or the lowest centre point of your home, staying as far as possible from exterior walls, windows and the roof. Expect to remain there for 24 hours unless it becomes unsafe through damage to the structure and you need to find an alternative.

STEP 2: DUCK AND COVER. You should lie face down, preferably beneath a solid table, and cover your eyes. This can help you to avoid some of the impact of the explosion as well as the blinding flare and heat. People blinded by the flare generally find their eyesight returns to normal in a matter of hours although the damage can be longer-lasting. Research indicates that if you are lying down your body can withstand twice as much atmospheric pressure as if you are standing up.

STEP 3: STAY INDOORS. <u>Remain inside for at least 24 hours</u>. Government officials or your local authority will advise if it is safe to emerge out of your shelter before that. While digital communications are likely to be affected in the event of a blast, a battery-operated or hand-cranked radio would still work and is worth having.

IN A VEHICLE: If you are driving or are the passenger in a vehicle and you realise an explosion is imminent, pull off the road safely to be out of the way of other traffic and crouch as low as possible. Close the windows and air vents and turn off the air conditioning to prevent contaminated air from entering the vehicle. Cover your eyes. Other drivers may be blinded by the light and there are likely to be collisions if you are on a busy road.

<u>CAUGHT OUTSIDE</u>: Should you be outdoors and a nuclear explosion is about to occur, run for cover behind a wall or something similar that might shield you from the blast. Lie face down to protect your skin from the heat and flying debris. Cover your eyes, nose and mouth with a scarf or fabric if possible.

<u>10 MINUTES TILL FALLOUT</u>: An explosion is accompanied by a shockwave. Wait until it has passed before moving. Then, you have approximately 10 minutes to find shelter before the fallout begins to arrive. It's important to make the most of this time as the radioactivity in the fallout is at its worst in the early stages and decreases with time.

Radioactive Fallout Safeguards

• To prevent contamination from radioactive fallout, you need to keep it off your skin and out of your body. It is important to try to prevent it from entering your mouth and nose: If caution is issued or fallout begins to descend, go to a safe place with the best available insulation. Cellars or basements, roadway conduits or subways, and other places fall under this category.

DEBRIS: Fallout consists of bits of earth, fissile materials such as uranium and plutonium, and other components that have descended to the ground. If debris granules are seen in the air or on structures, treat them as a potential radiation source.

<u>CLOTHING</u>: If you don't reach shelter before the fallout hits, conceal as much of your body as you can to prevent contaminants from settling on your skin. Use full sleeve shirts, headgear, and accessories to cover your body and head.

<u>ACCESSIBLE ITEMS</u>: If you don't reach shelter before the fallout hits, conceal as much of your body as you can to prevent contaminants from settling on your skin. Use full sleeve shirts, headgear, and accessories to cover your body and head.

FALLOUT GRANULES: It's worth noting that radioactive fallout on an area **does not** render that surface radioactive. Instead, the granules themselves, not the surface with which they come into contact, are radioactive. Remove any outer layers that may be contaminated and place them in a bag, if possible, and out of the way. Brush off any fallout granules that appear on your clothing. Limiting the volume of fallout carried inside is a great strategy.

FILTER: It's doubtful that sufficient fallout particulates will reach the bloodstream to cause serious injury. However, a face mask or wrapped fabric over the nostrils acts as a filter if the atmosphere is too gritty.

Don't Panic! It is easy to become fearful when discussing nuclear wars or accidents; however, it is better to keep things in perspective. The damage, while severe at the seat of a blast, may not be widespread. Knowing to 'duck and cover' means you are less likely to be injured and the most dangerous radioactive material, in the immediate aftermath of an explosion, is visible to the eye.

Before you become over-anxious about all types of radiation, remember that we are exposed to sunlight, radio waves and more all the time. Not all radiation is dangerous in small doses, like the ionising radiation caused by nuclear reactions.

Even internal contamination is not hopeless. It may be treated with a range of medicines to speed up the process of excreting the material from the body and help the body heal. However, there is no magic pill to provide an instant cure.

If you are exposed to fallout, you will not be 'radioactive' or contagious to others.

Radioactive Fallout

• The radioactive elements that reach earth due to a nuclear detonation are known as delayed ionising radiation or **fallout**. This is made up of artillery wreckage, fissionable materials, and irradiated soil in the event of an explosion at ground level. There is a risk of being harmed by the **radioactive fallout** even if you are not close enough to the site of a blast to be affected by the **energy generation**. The fallout caused by detonation at or near ground level is substantially larger than that released by blasts at higher elevations.

Radioactive particles fall to Earth

Exposure to Radiation

• One side-effect of exposure to fallout is the risk from radioactive materials. An explosion releases <u>various types of</u> <u>radiation</u> - primarily <u>alpha</u> and <u>beta</u> particles and <u>gamma</u> rays. Not all are equally perilous.

<u>Alpha radiation</u> cannot penetrate the skin and is kept at bay by clothing.

Particles emitting **<u>beta radiation</u>** can travel farther and may penetrate the skin, causing <u>burns</u>. Both alpha and betaemitting particles are hazardous if they enter the body through wounds or through being <u>inhaled</u> or consumed - a face mask is generally effective at keeping those at bay.

<u>Gamma radiation</u> is most dangerous as, <u>like x-rays</u>, gamma rays can travel some distance and penetrate the body, causing damage to tissue and DNA, which is why it is associated with cancer. Unfortunately, gamma rays are not halted by PPE, although a substantial barrier such as a thick wall or a body of water offers some protection.

A simple method to help you visualise radioactive contamination is to compare it with compost: If you remain next to new manure, you can smell it strongly. However, the stench leaves you once you stroll away from the area. Similarly, you will be susceptible to radiation if you stand near contaminated materials. However, you can leave the radiation dose behind if you keep the contamination off your person or clothing.

Clothing: If you walk over compost, you will get compost on your footwear. When you leave the area, you will be able to notice the compost until you have scrubbed your shoes.

Radiation: If your skin or clothing becomes contaminated, you will be vulnerable to the radiation until you rinse it off. Although the radioactive substance continues to generate radiation, you will no longer be contaminated.

Forecasting Fallout: Fallout's size, nature, and timestamp are hard to forecast perfectly because of factors such as: The more powerful and destructive the explosive, the further the fallout is likely to travel.

THE ALTITUDE OF THE EXPLOSION: A bomb that occurs at the earth's surface yields more fallout than one that occurs at a higher elevation.

SURFACE NATURE UNDERNEATH THE EXPLOSION: A few substances have a higher probability of being more radioactive and becoming supersonic.



WEATHER CONDITIONS: The landing duration of fallout is affected by wind conditions. While a strong wind may carry the material some distance, on the positive side, rainfall may wash the fallout from the atmosphere quickly.



Take Cover:

• The priority in the event of fallout is to seek refuge. You may be advised to **'shelter in place'** which means stay where you are if you are indoors. The rate of contamination outdoors will be far higher than any inside a shelter. Therefore, getting indoors should not be postponed to remove fallout from garments.

• The following are measures that are recommended within the hideout: At first, when securely within a safe place, close any external openings or entry points to prevent fallout debris from entering.

<u>KEEP PEOPLE AND PETS INSIDE</u>: Make sure no one goes in or out and keep your pets indoors with you. If you are with other families, maintain social distancing. Don't go looking for other family members or for pets.

ACT QUICKLY: Fallout contamination decays rapidly and can lose more than 80% of its energy in the first 24 hours. It is more important to get rid of contaminated clothing quickly and brush or rinse any fallout off the skin and hair than to wait until you can have a shower. Don't forget to brush any fallout off pets too.

<u>Safety Measures</u> After a nuclear attack, people should remain indoors for 24 hours or until they have been advised that the vulnerability factor from fallout has levelled out enough to allow them to leave the shelter safely for exercise and other purposes. Food and Water Safety

Food and Nutrition: Food that has been stored in tightly sealed containers, such as jars, tins and lunch boxes is safe to eat, along with any food in your refrigerator or freezer. Food stored in a pantry or drawer away from radioactive material is safe to consume. Once safe food has finished, it is preferable to eat contaminated food than to go without any. Before using counters, plates, pots, and utensils, wipe them down with a damp cloth or clean towel.

Water Safety: Heating tap water will not remove radioactive particles. Drinking water should be included in your essential supplies. Water, soft drinks and other beverages are safe to drink if they have been kept in an airtight bag. Drinks kept in the fridge are also safe to consume.

Limiting Fallout Exposure

Ascertaining the Rate of Exposure. The proportion of ionising radiation per hour in your immediate vicinity is referred to as the <u>exposure rate</u>, whereas the physiological impact of that irradiance on the body is known as the <u>dose rate</u>. Limit your exposure to fallout by using the same measures that would protect you from sun damage due to solar radiation.

Duration: Restricting the exposure period shrinks the dosage from the source for individuals exposed to radiation.

Proximity: As the temperature from fire becomes less intense as you move away from it, so the severity and dose of irradiation drops substantially as you move away from the source.

Cloaking: Cement or a body of water can offer some protection against radioactive hazards such as gamma rays and neutrons.

<u>**Unpredictability of Fallout**</u>. The illustration below depicts the fallout trends of two different Nevada weapon tests, demonstrating the unpredictability of the distribution of fallout.

Governments' contingency planning includes warning the public of the estimated arrival time through an official notice. However, should you notice a higher than usual surface accumulation of dust and dirt in the wake of an explosion, you should take precautions and treat it as though it was fallout. It is worth noting that while radioactive

contamination may be detected across a broader area in the wake of fallout, as it decays rapidly, the dosage may not be dangerous.

What Happens to Fallout

• You could buy a portable **Geiger Counter** to measure radiation; however, you may be alarmed by detectable radiation when in fact the levels are so low as to be harmless. The authorities where you live will be monitoring the situation and most likely organising testing and decontamination centres for the public once the initial emergency has passed.

• The **7:10 Rule** is used to forecast future exposure rates based on the data from a survey tool. Basically, it means that for every 7-fold increment after the explosion, the exposure rate drops 10 fold. If the exposure rate is 500 rads per hour two hours after the detonation, it will have dropped to 50 rads per hour after 14 hou

• **Tsar Bomba,** also known as Big Ivan, (Russian: 'King of Bombs'), was a Soviet nuclear weapon tested over the Arctic Ocean's Novaya Zemlya island on October 30, 1961. It was the most powerful nuclear bomb ever launched.



The bomb was developed in 1961 by a team of Soviet scientists led by Andrey Sakharov. The Cold War between the USSR and the US had become extremely serious at the time. The multiple stages bomb, which was intended to be a demonstration of Soviet dominance, was unrivalled in terms of power.

MEGATIONS: It had a range of 100 megatons, but the shrapnel from such an explosion was deemed too hazardous for a test environment. As a result, it was altered to produce 50 megatons, which is roughly 3,800 fold the intensity of the US bomb unleashed on Hiroshima during WWII. Even then, the plane from which it was parachute-dropped only just escaped.



<u>CONSEQUENCES</u>: A remote effect was that there were enhanced radiation deposits found in the glaciers of Novaya Zemlya. This impact was more than 50 times more hazardous than the environment in nearby locations. The

international outcry over the incident was such that the Soviet Union, the USA and Great Britain signed the Partial Nuclear Test Ban Treaty in August 1963.

Different Kinds of Explosions. As we have seen, not all nuclear explosions are equal. The force of a nuclear blast and the potential for devastation vary greatly, depending on the position of the surge in relation to the ground as well as the size of the device. The least harmful ones are carried out at high altitudes.

WIND EXPLOSION: The flame does not come into contact with the surface. The blast takes place at a depth of lower than 100,000 feet. This is known as an <u>Air Burst</u>.

LAND EXPLOSION: The nuclear explosion takes place around or marginally over the land surface and is called a <u>Ground Burst</u>. The explosion creates a lot of radioactive material.

SUBTERRANEAN EXPLOSION: Destruction might take place on land or in water. The impacts on the ground are influenced by depth.

Consequences of a Nuclear Explosion

The repercussions of a nuclear explosion vary based on the following:

- o The magnitude of the device
- The proximity of the person to the explosion
- While people in the severe damage zone, within about 0.5 miles of a 10 kiloton explosion would not be expected to survive, many of those in the moderate damage zone would have treatable injuries. Those in the light damage zones would have lighter injuries. Burns or skin damage are among the most common injuries along with those caused by shrapnel and broken glass, as windows will shatter within a wide area.
- Some skin damage may show up in minutes, however, other complications could take several weeks to manifest. These injuries may range from mild to severe, depending on the volume of radioactive material assimilated by the body, the form of irradiance, the mode of transmission, and the exposure period.

Effects of Radiant Heat

• There are three types of energy produced by a nuclear explosion that causes injury and destruction. The main one is **radiant heat or thermal radiation.**

FLASH BLINDNESS: The illumination flash can cause 'flash blindness' and even skin burns. A six kiloton nuclear detonation might induce flash blindness half a mile away or twenty miles away on a clear day. It normally begins to fade within 10 minutes unless the retina has been damaged. If you are warned there may be a blast, ignore the temptation to look out the window. You don't need to be looking in the direction of the blast to be affected by flash blindness. Pullover safely if you are driving and cover your eyes.

<u>FIRST DEGREE BURNS</u>: A ten kiloton attack could induce first-degree burns two miles away on a clear day. These are superficial burns, equivalent to a bad sunburn on the skin's surface.

SECOND DEGREE BURNS: The same blast can cause second-degree burns within a 1.5 miles radius. Here, the second layer of skin, the dermis, is also damaged. Without healthcare attention, second-degree burns that encompass more than 30% of the body can be dangerous. If left untreated, blisters from second-degree burns may become infected. Remove jewellery and clothing touching the damaged area in case of swelling. Avoid pulling away any fabric that is stuck to the burn in case you damage the skin further. Soak it in cool water but don't use ice, creams or any greasy substance on burns. Use gauze or something that won't stick to the skin to keep the burn clean. Painkillers may help, and if the person gets a fever, you may need antibiotics.



Land

THIRD DEGREE BURNS: Third-degree burns penetrate the skin to the tissue. Although these are most lifethreatening, they can be less painful than the other types of burn as the nerves may be damaged. However, even if the patient has no pain, they need medical attention urgently. The skin may turn black and charred or white. While waiting for medical assistance, you should **not** soak the burn in water or apply anything to it. Don't remove any clothing stuck to the burn but simply cover the area loosely with a clean cloth or sterile bandage.

Dangers of a Blast Wave

A **nuclear bomb's blast wave**, the second form of energy released, can decimate large structures for miles around. For instance, the airflow from a ten kiloton detonation could create a deadly force of more than 5 psi up to 25 miles away. This is comparable to the impact from a 180-ton object smashing into the side of a typical two-storey house or a windspeed of 160 miles per hour. Even though your body can resist tensile stress of up to 30 psi, wind speeds of two to three psi can throw belongings out of a building. (Take a First Aid course for comprehensive training in supporting someone who has been struck by falling masonry, shrapnel or glass.)

Initial Ionising Radiation. The third type of energy released in a nuclear explosion is the initial ionising radiation; this is different from fallout which is delayed ionising radiation. Gamma radiation and alpha and beta neutrons constitute the majority of the early radiation. The impact of the massive gamma radiation is to create electromagnetic waves or an electromagnetic pulse (EMP), especially if the detonation is above the ground.

An EMP does not pose a direct hazard to humans; however, it may disrupt communications and cell phones, TVs and internet services, and even car computers may be affected. This is why having a battery or hand-cranked radio is advisable. Walkie-talkie radios are also useful. It is possible that communication devices in the wider region may not be affected, depending on the damage to the infrastructure.

Acute Radiation Sickness

• Anyone whose body has received a hefty dose of radiation in a short time may end up with Acute Radiation Sickness (ARS) if the radiation has penetrated the organs. The symptoms may include vomiting, diarrhoea, nausea and headache, and they may have skin damage in the form of burns, blisters, redness or itching. The ARS symptoms may start at once or after some time and may come and go. Often the person will appear well for a time before falling ill again with symptoms that might include the earlier symptoms along with fever and fatigue. This phase may last a short time or go on for months and may be accompanied by temporary hair loss. Recovery time can take weeks to two years. The treatment involves treating infections and burns or injuries, keeping the patient hydrated, and possibly treating the bone marrow.

• Pregnant women would be strongly advised to seek medical attention if they think they had been exposed to radiation as it can have a detrimental impact on the fetus. Children, too, are more at risk than adults from the effects of radiation.

Wellerstein's Maps. It is easy to become fearful about the extent of the damage caused by a nuclear bomb; however, the geographical area impacted may be much smaller than you might expect. Nuclear historian Alex Wellerstein, of the Stevens Institute of Technology, has created a map with which you can visualise the impact of an explosion in your area. You can select the yield of a weapon, whether it explodes in the air or on the ground and estimate the radius of the fireball, blast damage, radiation and casualties. Visit https://nuclearsecrecy.com/nukemap/



Useful Map Tool: The Fat Man bomb which destroyed Nagasaki in 1945 had a yield of 20 kilotons. The map indicates what might happen if a similar bomb exploded at surface level in London.

Fireball and Heavy Blast Damage: The map indicates that the **fireball radius**, the small yellow ring in the circle, would be 260 metres (0.22 km²), and there would be **heavy blast damage** within 0.9km of the detonation which would inflict severe damage on buildings (red circle).

Radiation Radius: The grey circle indicates **moderate blast damage** (5 psi) to a radius of 1.24km. This would cause residential buildings to collapse and there would be widespread injury and loss of life. There would be a risk of fires starting.

The radiation radius (500 rem) is estimated at 1.41km and is indicated by the green circle.

<u>Burns and Light Blast Damage</u>: The orange circle indicates the area where people may suffer **third degree burns** which penetrate the skin. The outer grey circle shows the **light blast damage radius** (1 psi) at 3.19 km (32 km²). This would cause windows to break.

Fallout Blown in the Wind This

wider view of the same map shows the potential reach of fallout, assuming a south-easterly wind at 15mph. The intensity of the dose of radiation absorbed by the body is measured in 'rads'. The longest yellow ellipse shows the area where people might experience 1 rad per hour and it covers 1,470 km². This dose would not be harmful unless it was sustained for a number of weeks.

<u>Be Shelter Aware.</u> Should you find that your region is threatened with a nuclear attack or any other explosion, it's worth being mindful of your



surroundings along routes you normally travel. If a warning came and you were not within a mile of the blast, having already identified a subway or a substantial building where you can take sanctuary means you will react more quickly. Look for buildings made of brick or concrete and have a basement or an inner part with no windows. An underground rail station or an underground car park are both useful options. Take note of useful places to shelter as you go about your business. Depending on where you live, there may be caves, underground passages or mines that offer excellent shelter.



Bunker Vs Fallout Shelter? The tunnel entrance to the North American Air Defense (NORAD) Space Command Cheyenne Mountain Complex

A bunker, like the NORAD Space Command Cheyenne Mountain Complex in Colorado, USA, is built to withstand substantial force but few people have the funds or ability to create something on this scale. While some buildings could survive being directly below a nuclear bomb detonated above ground level, in general one could expect a nuclear strike to be targeted and not impact a very wide area and for most people, a bunker is

not feasible. If your country has air raid or fallout shelters from previous times, find out where your nearest one is and work out your route and how long it takes to get there.

Building a Shelter. Wellerstein's interactive map demonstrates how the impact of a nuclear explosion varies greatly depending on the size of the blast and its proximity to you. While tragically, any such attack would be devastating or highly dangerous for those nearest the blast zone, there are many precautions people in the wider area can take against fallout. If you don't live in an area with public fallout shelters, it is possible to create your own. If you are fortunate enough to have a basement in your house, the most straightforward and effective way is to add reinforcements to it, specifically the ceiling, to keep gamma radiation out. Concrete or lead are ideal, but any additional layers are likely to be helpful, including mud, so long as you can add the support for the extra weight. It is also essential to be able to filter the air to keep the fallout out. Some fabric over vents should catch fallout particles if you can't install an air filtration system.

• **Kearney's Shelters** Cresson Kearny showed families how to create shelters by digging a trench and covering it with logs covered with earth. He calculated that 30 inches of earth on the roof offers a protection factor of over 300; that is, persons inside would receive less than 1 300th of the gamma-ray dose of fallout radiation that they would receive if they were standing outside in the open.

Side Elevation of Kearney's Trench The side elevation shows how an angled opening allows fallout to be absorbed before travelling into the trench.





<u>What to Have In Your Shelter</u>: If you plan to move into your own shelter or a shared one, consider taking enough supplies to last you a fortnight. Items might include a kit you would pack for a camping trip:

o Plenty of water

- o Rubbish bags
- o Foodstuffs
- o A camping stove and matches
- o Plates, cutlery and cups
- o Saucepans
- o Sleeping bags
- o Battery radio and batteries
- o Torches and batteries
- o Basic toiletries
- If you won't have access to a toilet, consider getting a portable toilet and liners as the health hazards from having untreated waste in your vicinity are genuine.

Pack an Emergency Bag. While in ordinary times, there is no need to be concerned, should the threat of nuclear war arise, you may wish to put your own emergency pack together so that you can easily stay indoors. Take it with you if you are going away or keep a duplicate in your car. Your emergency pack would contain whatever you need over the course of 24 hours:

- Bottled water
- Packaged foods they must be airtight. Have enough for a couple of days if possible
- First Aid kit and painkillers
- If someone needs medication, have two days' doses.
- A battery-operated radio and extra batteries
- A flashlight and extra batteries
- If you have pets, include pet food
- A spare phone charger
- Face masks
- Sanitary products if applicable
- Wet wipes

There are many other items that you may deem essential - a child's favourite toy for instance. Bear in mind that your bag needs to be ready to lift in an emergency, manageable and not too bulky.

Non-urgent Supplies. While your emergency bag is all about the kit you need if you have to evacuate in a hurry, you may find you are confined to your house for some days or weeks. If possible, while you are doing your normal shop, stock up on other items that would help you stay inside until the coast is clear. Items might include:

- Cleaning products
- Bathroom supplies
- Tinned food
- A can of fuel for your car
- A camping stove for cooking on in case your power is off
- Plenty of candles, matches and torches
- Large containers of water

Don't panic buy and deprive others of essentials. Spare a thought for those who can only buy little and often. Aim to have about three weeks' worth of items.

<u>After the Event</u> When thinking about the aftermath of a nuclear strike, whether accidental or deliberate, it is easy to imagine having to fend for oneself, however, governments and their emergency services as well as charities and humanitarian relief agencies, have contingency plans in place for these sort of catastrophic events and there would be information and support available and regular updates about the extent of fallout contamination. Don't forget that for an airburst, there is almost no fallout impacting the ground.

Factors Affecting Fallout: As you have already heard, rain could impact the amount of fallout in the atmosphere. **Other atmospheric features also affect the contamination**, including the presence of smoke, what season it is and whether you are in the northern or southern hemisphere. According to America's Defense Civil Preparedness Agency [DCPA] the area that would realistically be covered by fallout is approximately a factor of 40 times less than a simple model would suggest, partly because the radioactivity is airborne for longer than an hour, allowing substantial decay to occur before reaching the ground and because the heaviest fallout is closest to the detonation point.

<u>GLOBAL FALLOUT</u>: The remaining radioactive particles and gases are so small that they remain airborne for years and are known as **global fallout**. Global fallout consists of the radioactivity carried by fine particles and gases in the atmosphere. Some of this (the Intermediate time scale global fallout) will be removed by rain within the first month whereas the long term global fallout remains in the atmosphere for years.

<u>Unsafe Water:</u> You may find that a month passes before it is safe to resume life where you are. When trying to get back to normal, the other hazard looking forward relates to drinking water. In built-up areas, there would probably be a failure of the **water supply** which would be heavily contaminated. Between dust, smoke and radioactivity, **surface water** would be unsafe to use in areas downwind of an explosion for a number of months.

<u>New Life in Hiroshima and Nagasaki</u> The earth is more resilient than one might expect and we can draw hope from Japan's experience. Studies of the after-affects of the nuclear bombings of Nagasaki and Hiroshima found that while the death tolls were enormous (up to 166,000 in Hiroshima and 80,000 in Nagasaki), the communities and their land have recovered.

The deaths are attributed to both blasts and acute radiation exposure. There was an increase in cases of leukaemia, particularly among children, from two years after the attacks until about five years later. The rate of other cancers for people who survived a whole-body radiation dose is believed to be just five times greater than normal, according to research by Dale L. Preston of Hirosoft International Corporation.

These figures are recorded by Dan Listwa of the Center for Nuclear Studies at Columbia University, New York. He also notes that there have been **no radiation-related excess of disease in the children of survivors** so far. The cities themselves have radiation levels on a par with any other part of the world. Preston records that the local population was amazed to see the oleander flower begin to bloom again in the spring of 1946, just months after the attacks. The flower has become a symbol of Hiroshima. He concludes: "The healthfulness of the new generations in Hiroshima and Nagasaki provide confidence that, like the oleander flower, the cities will continue to rise from their past destruction."

Modern Nagasaki. Glover garden is a Park founded by Scottish entrepreneur Thomas Blake Glover in Nagasaki, Japan, now an openair Museum. From the Dutch hill you can enjoy wonderful views of the city and the port.

Lesson Summary

• THE COLD WAR AND ARMS TREATIES



- Nine countries have nuclear arsenals: Russia, the USA, China, France and the UK (permanent members of the UN Security Council), along with Pakistan, India, Israel and reportedly North Korea. Ukraine, Belarus, Kazakhstan and South Africa have had nuclear weapons in the past.
- Russia and the USA between them own 90% of the world's nuclear weapons. The total number has fallen since the post-WWII arms race era, thanks to the INF Treaty of 1987 and the more recent Strategic Arms Reduction Talks. There is a bilateral non-proliferation treaty between Russia and the USA.
- In October 1962, the 13-day Cuban Missile Crisis ended when President JF Kennedy and Soviet leader Nikita Khrushchev agreed that the USSR would remove its weapons in return for the USA deciding not to attack Cuba.
- The accelerated **exothermic reaction** from a spontaneous nuclear reactivity causes a **nuclear explosion**.

- Nuclear fission involves using an atom to split a heavy nucleus into lighter ones, and explosives of this type are known as atomic bombs.
- **Nuclear fusion** is the opposite, as two nuclei are fused to become one. This process creates a thermonuclear or hydrogen explosion.
- Nuclear bombs are often described in terms of how much TNT would be required to create a similar blast. A kiloton bomb would have a similar effect to 1,000 tons of TNT.
- The detonation of a nuclear weapon results in a large flare comprising dirt and liquid material and is transported upwards by the wind. Subsequently, this leads to the formation of the **mushroom cloud**.
- The radioactive material condenses and falls back to earth, resulting in **fallout**. It pollutes everything it connects with, including food and supplies.
- The repercussions of a nuclear explosion vary based on the magnitude of the grenades and the **person's proximity** to the outburst.

HAZARDS OF NUCLEAR EXPLOSION

- Bomb or shockwave consequences, radiation heat influences, and nuclear exposure pose intense risks from the **energy** generated by an explosion.
- The device's energy produced is the amount of energy emitted in a nuclear blast. There are three categories of energy generation: Radiant heat, Explosion Impact and Ionising radiation.
- The energy produced by a nuclear explosion also contains substantial quantities of **radiant heat**.
- Nuclear detonations are blasts with instant destructive responses determined by a blow.
- The radiation released during the first minute after a nuclear detonation is the **initial ionising** radiation.
- The radioactive substances created during the blast are primarily responsible for**residual ionising** radiation.
- Finer particles that remain in the atmosphere are known as **global radiation**. Some (Intermediate) are washed to earth by rain within the first month while the rest stays in the atmosphere permanently.

MEASURES OF PROTECTION

- Extended fatalities may happen due to massive initial neutron and gamma radiation hazards.
- Protective measures are taken quickly, such as **lying face down beneath a massive object and covering one's eyes,** which help to avoid explosive impacts and radiant heat. Flash blindness is generally temporary. You do not need to be looking towards the flare to experience flash blindness.
- **Duration, proximity, and cloaking** deeds reduce your radiation exposure in the same way that safeguards you from sun damage to solar radiation.
- Understand that fallout consists of earthy elements, fissionable materials, and other components that have descended to the ground. If debris granules are seen in the atmosphere or on structures, they are treated as potential radiation sources.
- When you are in a shelter, **first use the non-tainted food rations**. Following that, make use of the contaminated supplies. Do not deprive anyone of nourishment because of infected resources.
- Once you invest the effort to recognise the primary preventative considerations *duration, proximity, and cloaking* **rational thinking** will be your most valuable resource.

• HOW TO RESPOND TO A WARNING

In **Hiroshima in Japan on 6 August 1945**, a bomb dubbed 'Little Boy' contained the equivalent of 15,000 tons of TNT and destroyed a 13km2 area, approximately 5miles2. The attack, from the American B-29 bomber plane Enola Gay, was the first time an atomic weapon had been used in war.

• There are three zones of damage in a nuclear blast - **severe, moderate, and light**. The area they cover is determined by the size of the explosion and where it has happened in relation to the earth's surface.

- In the event of a warning, find shelter in a basement, or the lowest point of a building, staying as far as possible from exterior walls, windows and the roof. Expect to remain there for **24 hours** unless it becomes unsafe through damage to the structure and you need to find an alternative.
- If you are in a **vehicle** and you realise an explosion is imminent, pull off the road safely to be out of the way of other traffic and crouch as low as possible. Close the windows and air vents and turn off the air conditioning to prevent contaminated air from entering the vehicle. Cover your eyes.
- A shockwave accompanies an explosion. Wait until it has passed before moving. Then, you have approximately 10 minutes to find shelter before the fallout arrives.
- If you are exposed to fallout, you will not be 'radioactive' or contagious to others.

• TYPES OF BURNS AND TREATMENTS

- First-degree burns are equivalent to a bad sunburn on the surface of the skin. Run cool water over it, if available.
- In second-degree burns, the second layer of skin, the dermis, is also damaged. Blisters may become infected. There could be swelling. **Do** soak the damaged skin in *cool water*, but **don't***use ice, creams, or any greasy substance* on burns.
- Third degree burns penetrate the skin to the tissue and can cause nerve damage and need medical attention urgently. The skin may turn black and charred or white. **Do not soak the burn** in water or apply anything to it. Instead, cover the area loosely with a clean cloth or sterile bandage.
- Acute Radiation Sickness (ARS) can be caused if the radiation has penetrated the organs. Symptoms include vomiting, diarrhoea, nausea and headache, and skin damage may include burns, blisters, redness or itching. Recovery involves treating infections, burns or injuries and possibly treating the bone marrow.
- Pregnant women are strongly advised to seek medical attention for exposure to radiation as it can have a detrimental impact on the fetus. Children, too, are more at risk than adults from the effects of radiation.

• ESSENTIALS FOR SHELTER

Tsar Bomba, also known as Big Ivan, (Russian: 'King of Bombs'), was a Soviet nuclear weapon tested over the Arctic Ocean's Novaya Zemlya island on October 30, 1961. At 50 kilotons, it was the most powerful nuclear bomb ever launched.

- If your country has **air raid or fallout shelters**, work out your route and how long it takes to get there.
- It is possible to keep gamma radiation out by reinforcing your basement ceiling with lead, concrete or mud, so long as you can support the extra weight. It is also essential to be able to filter the air to keep the fallout out.
- Cresson Kearny was a US government advisor who wrote a Survival Manual, which includes instructions for trench fallout shelters that can be built in days. He calculated that 30 inches of soil on the roof gives 300 times more protection against gamma radiation than being in the open.
- An emergency pack contains essential items needed for **24 hours**, the initial lockdown period for fallout.
- It's advised to stock up on basic provisions that would last 3-4 weeks if instructed to stay at home.
- The items required for staying in a **fallout shelter** are similar to those for a <u>camping</u> trip.
- Water from open sources is likely to remain contaminated for months.