OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

Nuclear Anthropogenic Hazards Causes, Protection, Control and Prevention

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ABSTRACT: *Anthropogenic hazards are major adverse events resulting from Nuclear radiation, Chemical warfare, Electronic waste, Pollution, Solid Waste etc.*
Anthropogenic hazards can cause loss of life or damage to properties and typically leaves some economic damage in its wake, the severity of which depends on the affected population's resilience or ability to recover and also on the infrastructure available.
Hence it is necessary to study the causes of anthropogenic hazards in detail and plan for control, prevent the disaster and improve resilience among people to face challenge for effective mitigation process. Here the study of Nuclear Anthropogenic hazards in detail and various method of prevention is taken up for study and benefit
the people

I. INTRODUCTION

Nuclear and radiation accidents and incidents

A **nuclear and radiation accident** is defined by the International Atomic Energy Agency (IAEA) as "an event that has led to significant consequences to people, the environment or the facility." Examples include lethal effects to individuals, large radioactivity release to the environment, or reactor core melt." The prime example of a "major nuclear accident" is one in which a reactor core is damaged and significant amounts of radioactivity are released, such as in the Chernobyl disaster in 1986.

The impact of nuclear accidents has been a topic of debate practically since the first nuclear reactors were constructed in 1954. It has also been a key factor in public concern about nuclear facilities. Some technical measures to reduce the risk of accidents or to minimize the amount of radioactivity released to the environment have been adopted. Despite the use of such measures, human error remains, and "there have been many accidents with varying impacts as well near misses and incidents". As of 2014, there have been more than 100 serious nuclear accidents and incidents from the use of nuclear power. Fifty-seven accidents have occurred since the Chernobyl disaster, and about 60% of all nuclear-related accidents have occurred in the USA. Nuclear power accidents can involve loss of life and very large monetary costs for remediation work.

Fukushima nuclear disaster, authorities shut down the nation's 54 nuclear power plants. As of 2013, the Fukushima site remains highly radioactive, with some 160,000 evacuees still living in temporary housing, and some land will be un-farmable for centuries. The difficult cleanup job will take 40 or more years, and cost tens of billions of dollars.

II. FACTORS CONTRIBUTING NUCLEAR DISASTERS

Nuclear reactor attacks

The vulnerability of nuclear plants to deliberate attack is of concern in the area of nuclear safety and security. Nuclear power plants, civilian research reactors, certain naval fuel facilities, uranium enrichment plants, fuel fabrication plants, and even potentially uranium mines are vulnerable to attacks which could lead to widespread radioactive contamination. The attack threat is of several general types: commando-like ground-based attacks on equipment which if disabled could lead to a reactor core meltdown or widespread dispersal of radioactivity; and external attacks such as an aircraft crash into a reactor complex, or cyber attacks.

The United States 9/11 Commission has said that nuclear power plants were potential targets originally considered for the September 11, 2001 attacks. If terrorist groups could sufficiently damage safety systems to cause a core meltdown at a nuclear power plant, and/or sufficiently damage spent fuel pools, such an attack could lead to widespread radioactive contamination. The Federation of American Scientists have said that if nuclear power use is to expand significantly, nuclear facilities will have to be made extremely safe from attacks that could release massive quantities of radioactivity into the community. New reactor designs have features of passive nuclear safety, which may help.

Nuclear reactors become preferred targets during military conflict and, over the past three decades, have been repeatedly attacked during military air strikes, occupations, invasions and campaigns. Various acts of civil disobedience since 1980 by the peace group Plowshares have shown how nuclear weapons facilities can be penetrated, and the group's actions represent extraordinary breaches of security at nuclear weapons plants. Non-proliferation policy experts have questioned "the use of private contractors to provide security at facilities that manufacture and store the government's most dangerous military material".

Nuclear weapons materials on the black market are a global concern, and there is concern about the possible detonation of a small, crude nuclear weapon by a militant group in a major city, with significant loss of life and property.

Radiation and other accidents and incidents

The red background is intended to convey urgent danger, and the sign is intended to be used in places or on equipment where exceptionally intense radiation fields could be encountered or created through misuse or tampering. The intention is that a normal user will never see such a sign, however after partly dismantling the equipment the sign will be exposed warning that the person should stop work and leave the scene

Over 2,000 nuclear tests have been conducted, in over a dozen different sites around the world. Red Russia/Soviet Union, blue France, light blue United States, violet Britain, black Israel, orange China, yellow India, brown Pakistan, green North Korea and light green (territories exposed to nuclear bombs)

Nuclear Accident categories

Nuclear meltdown

A nuclear meltdown is a severe nuclear reactor accident that results in reactor core damage from overheating. It has been defined as the accidental melting of the core of a nuclear reactor, and refers to the core's either complete or partial collapse. A core melt accident occurs when the heat generated by a nuclear reactor exceeds the heat removed by the cooling systems to the point where at least one nuclear fuel element exceeds its melting point. This differs from a fuel element failure, which is not caused by high temperatures. A meltdown may be caused by a loss of coolant, loss of coolant pressure, or low coolant flow rate or be the result of a as the RBMK-1000, an external fire may endanger the core, leading to a meltdown.

Large-scale nuclear meltdowns at civilian nuclear power plants include:

- The Lucens reactor, Switzerland, in 1969.
- The Three Mile Island accident in Pennsylvania, United States, in 1979.
- The Chernobyl disaster at Chernobyl Nuclear Power Plant, Ukraine, USSR, in 1986.
- The Fukushima Daiichi nuclear disaster following the earthquake and tsunami in Japan, March 2011.

Criticality accidents

A criticality accident (also sometimes referred to as an "excursion" or "power excursion") occurs when a nuclear chain reaction is accidentally allowed to occur in fissile material, such as enriched uranium or plutonium. The Chernobyl accident is an example of a criticality accident.

Decay heat

Decay heat accidents are where the heat generated by the radioactive decay causes harm. In a large nuclear reactor, a loss of coolant accident can damage the core: for example, at Three Mile Island a recently shutdown PWR reactor was left for a length of time without cooling water. As a result, the nuclear fuel was damaged, and the core partially melted. The removal of the decay heat is a significant reactor safety concern, especially shortly after shutdown. Failure to remove decay heat may cause the reactor core temperature to rise to dangerous levels and has caused nuclear accidents. The heat removal is usually achieved through several redundant and diverse systems, and the heat is often dissipated to an 'ultimate heat sink' which has a large capacity and requires no active power, though this method is typically used after decay heat has reduced to a very small value. The main cause of release of radioactivity in the Three Mile Island accident was a pilot-operated relief valve on the primary loop which stuck in the open position. This caused the overflow tank into which it drained to rupture and release large amounts of radioactive cooling water into the containment building. In 2011, an earthquake and tsunami caused a loss of power to two plants in Fukushima, Japan, crippling the reactor as decay heat caused 90% of the fuel rods in the core of the Daiichi Unit 3 reactor to become uncovered. As of May 30, 2011, the removal of decay heat is still a cause for concern.

Equipment failure

Equipment failure is one possible type of accident. In Białystok, Poland, in 2001 the electronics associated with a particle accelerator used for the treatment of cancer suffered a malfunction. This then led to the overexposure of at least one patient. While the initial failure was the simple failure of a semiconductor diode, it set in motion a series of events which led to a radiation injury.

A related cause of accidents is failure of control software, as in the cases involving the Therac-25 medical radiotherapy equipment: the elimination of a hardware safety interlock in a new design model exposed a previously undetected bug in the control software, which could have led to patients receiving massive overdoses under a specific set of conditions.

Human error

Many of the major nuclear accidents have been directly attributable to operator or human error. This was obviously the case in the analysis of both the Chernobyl and TMI-2 accidents. At Chernobyl, a test procedure was being conducted prior to the accident. The leaders of the test permitted operators to disable and ignore key protection circuits and warnings that would have normally shut the reactor down. At TMI-2, operators permitted thousands of gallons of water to escape from the reactor plant before observing that the coolant pumps were behaving abnormally. The coolant pumps were thus turned off to protect the pumps, which in turn led to the destruction of the reactor itself as cooling was completely lost within the core.

III. STUDY AREA

A nuclear accident is still possible even though the construction and operation of nuclear power plants are closely monitored and regulated by the Nuclear Regulatory Commission (NRC).

Nuclear power plants use the heat generated from nuclear fission in a contained environment to convert water to steam, which powers generators to produce electricity. It is the by-product of this activity that creates the biggest hazard.

Nuclear Accidents

March 11, 2011 Fukushima Daiichi nuclear power plant in Japan confirmed a nuclear accident with resulting in an explosion and radiation leak in the waked of the 9.0 earthquake and major Tsunami that swept 6 miles inland.Japan declared states of emergency for five nuclear reactors at two power plants after the units lost cooling ability. The nuclear safety agency reported an emergency at second reactor and have evacuated as many as 170,000 people from the areas around two nuclear power plants and the prime minister has warned residents living within 19 miles to stay inside or risk getting radiation sickness.

After the recent blast radiation detectors showed 11,900 microsieverts of radiation three hours after the blast, up from just 73 microsieverts beforehand. However, health risks are at levels **exceeding 100,000 microsieverts**.

Radiation Exposure

The potential danger from a nuclear accident is exposure to radiation. Exposure could result from the release of radioactive material from a nuclear plant into the environment, usually characterized by a plume (cloud-like formation) of radioactive gases and particles. If a complete reactor meltdown, where the uranium core melts through the outer containment shell, were to occur, a wave of radiation would be released, resulting in major, widespread health problems. The major hazards to people in the vicinity of the plume are radiation exposure to the body from the cloud and particles deposited on the ground, inhalation of radioactive materials, and ingestion of radioactive materials.

Radioactive materials are composed of atoms that are unstable. An unstable atom gives off its excess energy until it becomes stable.

The energy emitted is radiation.

The longer a person is exposed to radiation, the greater the effect. A high exposure to radiation can cause serious illness or death.

A nuclear blast has an incredibly destructive pressure wave. In fact, this is what creates the most damage initially. Second to that is the radioactive material that contaminates the air, water, and ground. This is one kind of radiation associated with a nuclear bomb. The other is thermal radiation. Thermal radiation is "heat" radiation. It is what causes the first, second and third degree burns on skin (depending upon distance to the explosion site).**A nuclear device** can be anything from a weapon on a missile to a small portable nuclear device transported by an individual.

All nuclear devices cause deadly effects when exploded, including blinding light, intense heat (thermal radiation), and secondary fires caused by the destruction.

Hazards of a Nuclear Accident

The extent, nature, and arrival time of these hazards are difficult to predict.The geographical dispersion of hazard effects will be defined by the following:

- Size of the device. A more powerful bomb will produce more distant effects.
- Height above the ground the device was detonated. This will determine the extent of blast effects.
- Nature of the surface beneath the explosion. Some materials are more likely to become radioactive and airborne than others. Flat areas are more susceptible to blast effects.
- Existing meteorological conditions. Wind speed and direction will affect arrival time of fallout; precipitation may wash fallout from the atmosphere.

Radioactive Fallout from Nuclear Accident or Blast

Even if individuals are not close enough to the nuclear blast to be affected by the direct impacts, they may be affected by radioactive fallout.

Any nuclear blast results in some fallout.

Blasts that occur near the earth's surface create much greater amounts of fallout than blasts that occur at higher altitudes. This is because the tremendous heat produced from a nuclear blast causes an up-draft of air that forms the familiar mushroom cloud. Fallout from a nuclear explosion may be carried by wind currents for hundreds of miles if the right conditions exist. Effects from even a small portable device exploded at ground level can be potentially deadly.

Nuclear radiation cannot be seen, smelled, or otherwise detected by normal senses.

IV. METHODOLOGY

Radiation can only be detected by radiation monitoring devices. This makes radiological emergencies different from other types of emergencies, such as floods or hurricanes.
Monitoring can project the fallout arrival times, which will be announced through official warning channels. However, any increase in surface build-up of gritty dust and dirt should be a warning for taking protective measures.

V. RESULTS AND DISCUSSIONS

Electromagnetic Pulse (EMP)

A nuclear weapon detonated in or above the earth's atmosphere can create an **electromagnetic pulse (EMP)**, a high-density electrical field. An EMP acts like a stroke of lightning but is stronger, faster, and shorter.An EMP can seriously damage electronic devices connected to power sources or antennas. This includes communication systems, computers, electrical appliances, and automobile or aircraft ignition systems.

Radioactive contamination

Radioactive contamination, also called radiological contamination, is the deposition of, or presence of radioactive substances on surfaces or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable (from the International Atomic Energy Agency - IAEA - definition).
Such contamination presents a hazard because of the radioactive decay of the contaminants, which emit harmful ionising radiation such as alpha particles or beta particles, gamma rays or neutrons. The degree of hazard is determined by the concentration of the contaminants, the energy of the radiation being emitted, the type of radiation, and the proximity of the contamination to organs of the body. It is important to be clear that the contamination gives rise to the radiation hazard, and the terms "radiation" and "contamination" are not interchangeable.

Contamination may affect a person, a place, an animal, or an object such as clothing. Following an atmospheric nuclear weapon discharge or a nuclear reactor containment breach, the air, soil, people, plants, and animals in the vicinity will become contaminated by nuclear fuel and fission products. A spilled vial of radioactive material like uranyl nitrate may contaminate the floor and any rags used to wipe up the spill. Cases of widespread radioactive contamination include the Bikini Atoll, the Rocky Flats Plant in Colorado, the Fukushima Daiichi nuclear disaster, the Chernobyl disaster, and the area around the Mayak facility in Russia.

Sources of contamination

Global airborne contamination Atmospheric nuclear weapon tests almost doubled the concentration of 14C in the Northern Hemisphere. Plot of atmospheric 14C, New Zealand and Austria. The New Zealand curve is representative for the Southern Hemisphere, the Austrian curve is representative for the Northern Hemisphere. Radioactive contamination is typically the result of a spill or accident during the production, or use of, radionuclides (radioisotopes); these have unstable nuclei which are subject to radioactive decay. Less typically, nuclear fallout is the distribution of radioactive contamination by a nuclear explosion. The amount of radioactive material released in an accident is called the source term. Contamination may occur from radioactive gases, liquids or particles. For example, if a radionuclide used in nuclear medicine is spilled, the material could be spread by people as they walk around. Radioactive contamination may also be an inevitable result of certain processes, such as the release of radioactive xenon in nuclear fuel reprocessing. In cases that radioactive material cannot be contained, it may be diluted to safe concentrations. For a discussion of environmental contamination by alpha emitters please see actinides in the environment. Contamination does not include residual radioactive material remaining at a site after the completion of decommissioning. Therefore, radioactive material in sealed and designated containers is not properly referred to as contamination, although the units of measurement might be the same.

Containment

Large industrial glovebox in the nuclear industryContainment is the primary way of preventing contamination being released into the environment or coming into contact or being ingested by humans. Being within the intended Containment differentiates radioactive material from radioactivecontamination. When radioactive materials are concentrated to a detectable level outside a containment, the area affected is generally referred to as "contaminated".There are a large number of techniques for containing radioactive material so that it does not spread beyond the containment and become contamination. In the case of liquids this is by the use of high integrity tanks or containers, usually with a sump system so that leakage can be detected by radiometric or conventional instrumentation.Where material is likely to become airborne, then extensive use is made of the glovebox, which is a common technique in hazardous laboratory and process operations in many industries. The gloveboxes are kept under a slight negative pressure and the vent gas is filtered in high efficiency filters, which are monitored by radiological instrumentation to ensure they are functioning correctly.

Control and monitoring of contamination

Radioactive contamination may exist on surfaces or in volumes of material or air, and specialist techniques are used to measure the levels of contamination by detection of the emitted radiation.

Contamination monitoring

Contamination monitoring depends entirely upon the correct and appropriate deployment and utilisation of radiation monitoring instruments.

Surface contamination

Surface contamination may either be fixed or "free". In the case of fixed contamination, the radioactive material cannot by definition be spread, but its radiation is still measurable. In the case of free contamination there is the hazard of contamination spread to other surfaces such as skin or clothing, or entrainment in the air. A concrete surface contaminated by radioactivity can be shaved to a specific depth, removing the contaminated material for disposal.For occupational workers controlled areas are established where there may be a contamination hazard. Access to such areas is controlled by a variety of barrier techniques, sometimes involving changes of clothing and foot wear as required. The contamination within a controlled area is normally regularly monitored. Radiological protection instrumentation (RPI) plays a key role in monitoring and detecting any potential contamination spread, and combinations of hand held survey instruments and permanently installed area monitors such as Airborne particulate monitors and area gamma monitors are often installed. Detection and measurement of surface contamination of personnel and plant is normally by Geiger counter, scintillation counter or proportional counter. Proportional counters and dual phosphor scintillation counters can discriminate between alpha and beta contamination, but the Geiger counter cannot. Scintillation detectors are generally preferred for hand held monitoring instruments, and are designed with a large detection window to make monitoring of large areas faster. Geiger detectors tend to have small windows, which are more suited to small areas of contamination.

Airborne contamination

The air can be contaminated with radioactive isotopes in particulate form, which poses a particular inhalation hazard. Respirators with suitable air filters, or completely self-contained suits with their own air supply can mitigate these dangers.

Airborne contamination is measured by specialist radiological instruments that continuously pump the sampled air through a filter.

Internal human contamination

Radioactive contamination can enter the body through ingestion, inhalation, absorption, or injection. This will result in a committed dose of radiation.

For this reason, it is important to use personal protective equipment when working with radioactive materials. Radioactive contamination
may also be ingested as the result of eating contaminated plants and animals or drinking contaminated water or milk from exposed animals. Following a major contamination incident, all potential pathways of internal exposure should be considered.

Decontamination

Cleaning up contamination results in radioactive waste unless the radioactive material can be returned to commercial use by reprocessing. In some cases of large areas of contamination, the contamination may be mitigated by burying and covering the contaminated substances with concrete, soil, or rock to prevent further spread of the contamination to the environment. If a person's body is contaminated by ingestion or by injury and standard cleaning cannot reduce the contamination further, then the person may be permanently contaminated.

Low-level contamination

The hazards to people and the environment from radioactive contamination depend on the nature of the radioactive contaminant, the level of contamination, and the extent of the spread of contamination. Low levels of radioactive contamination pose little risk, but can still be detected by radiation instrumentation. If a survey or map is made of a contaminated area, random sampling locations may be labeled with their activity in becquerels or curies on contact. Low levels may be reported in counts per minute using a scintillation counter.In the case of low-level contamination by isotopes with a short half-life, the best course of action may be to simply allow the material to naturally decay. Longer-lived isotopes should be cleaned up and properly disposed of, because even a very low level of radiation can be life-threatening when in long exposure to it.
Facilities and physical locations that are deemed to be contaminated may be cordoned off by a health physicist and labeled "Contaminated area." Persons coming near such an area would typically require anti-contamination clothing ("anti-Cs").

High-level contamination

High levels of contamination may pose major risks to people and the environment. People can be exposed to potentially lethal radiation levels, both externally and internally, from the spread of contamination following an accident (or a deliberate initiation) involving large quantities of radioactive material. The biological effects of external exposure to radioactive contamination are generally the same as those from an external radiation source not involving radioactive materials, such as x-ray machines, and are dependent on the absorbed dose.

When radioactive contamination is being measured or mapped in situ, any location that appears to be a point source of radiation is likely to be heavily contaminated. A highly contaminated location is colloquially referred to as a "hot spot." On a map of a contaminated place, hot spots may be labeled with their "on contact" dose rate in mSv/h. In a contaminated facility, hot spots may be marked with a sign, shielded with bags of lead shot, or cordoned off with warning tape containing the radioactive trefoil symbol.

The radiation warning symbol

Alpha radiation consists of helium-4 nucleus and is readily stopped by a sheet of paper. Beta radiation, consisting of electrons, is halted by an aluminium plate. Gamma radiation is eventually absorbed as it penetrates a dense material. Lead is good at absorbing gamma radiation, due to its density.

The hazard from contamination is the emission of ionising radiation. The principal radiations which will be encountered are alpha, beta and gamma, but these have quite different characteristics. They have widely differing penetrating powers and radiation effect, and the accompanying diagram shows the penetration of these radiations in simple terms. For an understanding of the different ionising effects of these radiations and the weighting factors applied, see the article on absorbed dose.

Radiation monitoring involves the measurement of radiation dose or radionuclide contamination for reasons related to the assessment or control of exposure to radiation or radioactive substances, and the interpretation of the results. The methodological and technical details of the design and operation of environmental radiation monitoring programmes and systems for different radionuclides, environmental media and types of facility are given in IAEA Safety Standards Series No. RS–G-1.8[11] and in IAEA Safety Reports Series No. 64.[12]

Health effects of contamination
Biological effects

Radioactive contamination by definition emits ionizing radiation, which can irradiate the human body from an external or internal origin.

External irradiation

This is due to radiation from contamination located outside the human body. The source can be in the vicinity of the body or can be on the skin surface. The level of health risk is dependent on duration and the type and strength of irradiation. Penetrating radiation such as gamma rays, X-rays, neutrons or beta particles pose the greatest risk from an external source. Low penetrating radiation such as alpha particles have a low external risk due to the shielding effect of the top layers of skin. See the article on sievert for more information on how this is calculated.

Internal irradiation

Radioactive contamination can be ingested into the human body if it is airborne or is taken in as contamination of food or drink, and will irradiate the body internally. The art and science of assessing internally generated radiation dose is Internaldosimetry. The biological effects of ingested radionuclides depend greatly on the activity, the biodistribution, and the removal rates of the radionuclide, which in turn depends on its chemical form, the particle size, and route of entry. Effects may also depend on the chemical toxicity of the deposited material, independent of its radioactivity. Some radionuclides may be generally distributed throughout the body and rapidly removed, as is the case with tritiated water. Some organs concentrate certain elements and hence radionuclide variants of those elements. This action may lead to much lower removal rates. For instance, the thyroid gland takes up a large percentage of any iodine that enters the body. Large quantities of inhaled or ingested radioactive iodine may impair or destroy the thyroid, while other tissues are affected to a lesser extent.

Social and psychological effects

A 2015 report in Lancet explained that serious impacts of nuclear accidents were often not directly attributable to radiation exposure, but rather social and psychological effects. The consequences of low-level radiation are often more psychological than radiological. Because damage from very-low-level radiation cannot be detected, people exposed to it are left in anguished uncertainty about what will happen to them. Many believe they have been fundamentally contaminated for life and may refuse to have children for fear of birth defects. They may be shunned by others in their community who fear a sort of mysterious contagion. Forced evacuation from a radiological or nuclear accident may lead to social isolation, anxiety, depression, psychosomatic medical problems, reckless behavior, even suicide. Such was the outcome of the 1986 Chernobyl nuclear disaster in the Ukraine. A comprehensive 2005 study concluded that "the mental health impact of Chernobyl is the largest public health problem unleashed by the accident to date". Frank N. von Hippel, a U.S. scientist, commented on the 2011 Fukushima nuclear disaster, saying that "fear of ionizing radiation could have long-term psychological effects on a large portion of the population in the contaminated areas". Evacuation and long-term displacement of affected populations create problems for many people, especially the elderly and hospital patients.
Such great psychological danger does not accompany other materials that put people at risk of cancer and other deadly illness.

Hazardous materials
Radiation contamination

When nuclear weapons are detonated or nuclear containment systems are otherwise compromised, airborne radioactive particles (nuclear fallout) can scatter and irradiate large areas. Not only is it deadly, but it also has a long-term effect on the next generation for those who are contaminated. Ionizing radiation is hazardous to living things, and in such a case much of the affected area could be unsafe for human habitation. During World War II, United States troops dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki. As a result, the radiation fallout contaminated the cities' water supplies, food sources, and half of the populations of each city were stricken with disease. In the Soviet Union, the Mayak industrial complex (otherwise known as Chelyabinsk-40 or Chelyabinsk-65) exploded in 1957. The Kyshtym disaster was kept secret for several decades. It is the third most serious nuclear accident ever recorded. At least 22 villages were exposed to radiation and resulted in at least 10,000 displaced persons. In 1992 the former soviet union officially acknowledge the accident. Other Soviet republics of Ukraine and Belarus suffered also when a reactor at the Chernobyl nuclear power plant had a meltdown in 1986. To this day, several small towns and the city of Chernobyl remain abandoned and uninhabitable due to fallout.

The Goiânia accident was a radioactive contamination accident that occurred on September 13, 1987, at Goiânia, in the Brazilian state of Goiás, after an old radiotherapy source was stolen from an abandoned hospital site in the city. It was subsequently handled by many people, resulting in four deaths. About 112,000 people were examined for radioactive contamination and 249 were found to have significant levels of radioactive material in or on their bodies. In the cleanup operation, topsoil had to be removed from several sites, and several houses were demolished. All the objects from within those houses were removed and examined. Time magazine has identified the accident as one of the world's "worst nuclear disasters" and the International Atomic Energy Agency called it "one of the world's worst radiological incidents"
Another nuclear power disaster that is ongoing is Fukushima Daiichi.

CBRNs

CBRN is a catch-all acronym for chemical, biological, radiological, and nuclear. The term is used to describe a non-conventional terror threat that, if used by a nation, would be considered use of a weapon of mass destruction. This term is used primarily in the United Kingdom. Planning for the possibility of a CBRN event may be appropriate for certain high-risk or high-value facilities and governments. Examples include Saddam Hussein's Halabja poison gas attack, the Sarin gas attack on the Tokyo subway and the preceding test runs in Matsumoto, Japan 100 kilometers outside of Tokyo.

Nuclear safety

Nuclear safety covers the actions taken to prevent nuclear and radiation accidents or to limit their consequences. This covers nuclear power plants as well as all other nuclear facilities, the transportation of nuclear materials, and the use and storage of nuclear materials for medical, power, industry, and military uses. The nuclear power industry has improved the safety and performance of reactors, and has proposed new safer (but generally untested) reactor designs but there is no guarantee that the reactors will be designed, built and operated correctly. Mistakes do occur and the designers of reactors at Fukushima in Japan did not anticipate that a tsunami generated by an earthquake would disable the backup systems that were supposed to stabilize the reactor after the earthquake. According to UBS AG, the Fukushima I nuclear accidents have cast doubt on whether even an advanced economy like Japan can master nuclear safety. Catastrophic scenarios involving terrorist attacks are also conceivable. Multiple and unexpected failures are built into society's complex and tightly-coupled nuclear reactor systems. Nuclear power plants cannot be operated without some major accidents. Such accidents are unavoidable and cannot be designed around. An interdisciplinary team from MIT have estimated that given the expected growth of nuclear power from 2005 – 2055, at least four serious nuclear accidents would be expected in that period. To date, there have been five serious accidents (core damage) in the world since 1970 (one at Three Mile Island in 1979; one at Chernobyl in 1986; and three at Fukushima-Daiichi in 2011), corresponding to the beginning of the operation of generation II reactors. This leads to on average one serious accident happening every eight years worldwide.

VI. CONCLUSION AND RECOMMENDATIONS

Disasters can take place through deliberate actions of misguided human beings. A society that an endure the effects of a calamity by proper disaster management is referred to as a disaster-resilient society. Such a society has both disaster prevention and disaster management plans at hand. The horrors of Atomic bombing of the cities of Hiroshima and Nagasaki in Japan during August 1945 are still fresh in human memory. The US bomber ENOLAGAY dropped the 8,900 pound nuclear bomb over the city of Hiroshima on August 6, 1945. About 90% of the city was levelled near instantaneously. There was complete devastation over 10 sq. km of the city in which 66,000 people were killed and another 69,000 severely injured. Three days later, the tragedy was repeated at Nagasaki. The nuclear bombing destroyed one-third of the city and claimed 39,000 human casualties. Another 25,000 persons were severely injured. Over the decades man has perfected many more deadly weapons of mass destructions.

Nuclear fuel is now being used in a number of reactors that produce electricity. An accidental leakage can cause grievous injuries to people who may be exposed to radiation. The worst part of damage by nuclear radiations is that even those who survive may develop infirmities over a period of time and these may be carried over even to generations yet to be born. Manufacture of nuclear bombs is no longer a prerogative of nations that have highly developed laboratories. Nuclear technology has become more widespread. Nuclear material can be obtained by clandestine modes and even be stolen. Crude bombs can be manufactured by terrorist groups and the havoc that their use can cause to mankind can be terrific.

Protection against Nuclear Radiation:

Nuclear explosion is followed by rise of a mushroom cloud. Viewed even from a distance it can cause instant blindness. A wave of intense heat covers the site of explosion and a large area around it. By way of precaution, what needs to be done is to close all doors and windows. Radioactivity can cause damage to buildings but does not penetrate through strong solid structures.

VII. RECOMMENDATIONS

How to protect yourself from nuclear fallout (tips about radiation, building an expedient shelter, etc)

No one wants to think about a nuclear crisis – and hopefully it will never happen – but we all must accept the fact nuclear tensions are rising globally so we should prepare ourselves and our loved ones in the event the unthinkable strikes our soil. For decades, movies and some in the media have portrayed a nuclear attack as a "doomsday" event implying most people would be killed on impact … and survivors would want to die once they come out of their shelters.In reality, unless you are actually at ground zero or within a several mile radius of the blast zone (depending on the size of the nuke, of course), there is a very high probability you'll survive as long as you…

- **limit your exposure to radiation**,
- **take shelter with proper shielding**,
- **wait for the most dangerous radioactive materials to decay**.

In other words, you **CAN**survive a nuke attack … but you **MUST**make an effort to learn what to do! By learning about potential threats, we are all better prepared to know how to react if something happens.

Please realize this is being written with small nuke devices in mind (like a 1-kiloton to 1-megaton device). A larger device or a nuclear war would cause more wide-spread damage but some of this data could still be helpful. These are some very basic tips on sheltering for any type of nucear (or radiological) incident.If a nuke is launched over our continent and explodes miles above the earth, it could create an **electromagnetic pulse** (**EMP**). An EMP is a split-second silent energy burst (like a stroke of lightning) that can fry electronics connected to wires or antennas like cell phones, cars, computers, TVs, etc. Unless electronics are grounded or hardened, an area or nation could experience anything from minor interference to crippled power, transportation, banking and communications systems.

An EMP from a high-altitude nuke could affect electronics within 1,000 miles or more. *(Evidence suggests some countries and groups are working on enhanced and non-nuclear EMP weapons or e-bombs.*

What is the most dangerous part of a nuclear attack?

Both the initial nuclear radiation and residual nuclear radiation (also called radioactive fallout) are extremely dangerous.

Initial nuclear radiation is penetrating invisible rays that can be lethal in high levels.

Radioactive fallout (residual nuclear radiation) is created when the fireball vaporizes everything inside it (including dirt and water). Vaporized materials mix with radioactive materials in the updraft of air forming a mushroom cloud.

Fallout can be carried by winds for hundreds of miles and begin falling to the ground within minutes of the blast or take hours, days, weeks or even months to fall. The heaviest fallout would hit ground zero and areas downwind of that, and **80%** of fallout would occur within **24 hours**. Most fallout looks like grey sand or gritty ash and the radiation given off cannot be seen, smelled, tasted or felt which is why it is so dangerous. But as the materials decay or spread out radiation levels will drop.

More about radiation

Types of radiation – Nuclear radiation has 3 main types of radiation…

- **alpha** – can be shielded by a sheet of paper or by human skin. If alpha particles are inhaled, ingested, or enter body through a cut, they can cause damage to tissues and cells.
- **beta** – can be stopped by skin or a thicker shield (like wood). Beta particles can cause serious damage to internal organs if ingested or inhaled, and could cause eye damage or possible skin burns.
- **gamma** – most dangerous since gamma rays can penetrate the entire body and cause cell damage throughout your organs, blood and bones. Since radiation does not stimulate nerve cells you may not feel

anything while your body absorbs it. Exposure to high levels of gamma rays canlead to radiation sickness or death, which is why it is critical to seek shelter from fallout in a facility with thick shielding!

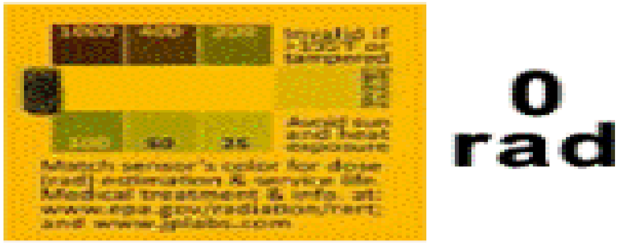
Radiation detection devices – You cannot see, smell, taste or feel radiation, but special instruments can detect even the smallest levels of radiation. Since it may take days or weeks before First Responders could get to you, consider having these devices handy during a crisis or attack since they could save your life.

survey meter – measures rate of exposure or intensity of radiation at that specific location if you stayed there for an hour … like a speedometer in a car (cost: $300-$1,000+)

dosimeter– a pen-like device you can wear that measures total dose or accumulated exposure to radiation as you move around (needs a charger too). Dosimeters cost about $45-$65+ each and some dealers offer 3 dosimeters + a charger for about $240 or so.

KFM kit – (**Kearny Fallout Meter**) measures radiation more accurately than most instruments since it's charged electrostatically. Find plans online or available as a low-cost kit ($40-$75). And it's a great science project for kids.

NukAlert– a patented personal radiation meter, monitor and alarm small enough to fit on a key chain. The unit warns you with chirping sounds if it detects radiation. (cost: $145 – $160)



RADsticker– postage stamp sized card (cost: $2-$5 ea)

Measuring radiation – Radiation was measured in units called roentgens (pronounced "rent-gens" and abbreviated as "R") … or "rads" or "rem". An EPA document called "Planning Guidance for Response to A Nuclear Detonation 2nd Edition June 2010" explains … 1 **R** (exposure in air) ≅ 1 **rad** (absorbed dose) ≅ 1 **rem** (whole-body dose). Although many measuring devices and older documentation use R and rem, officials and the media now use sievert (Sv) which is the System International or SI unit of measurement of radiation. The formula to convert sieverts to rems is quite simple … 1 Sv = 100 R (rem).

How many rads are bad? – High doses of radiation in a short span of time can cause radiation sickness or even death, but if that high dose is spread out over a long period of time, it's not as bad.According to FEMA, an adult could tolerate and recover from an exposure to 150R (1.5 Sv) over a week or 300R (3 Sv) over a 4-month period. But 300R (3 Sv) over a week could cause sickness or possibly death. Exposure to 30R (0.3 Sv) to 70R (0.7 Sv) over a week may cause minor sickness, but a full recovery would be expected. But radioactive fallout decays rapidly so staying in a shelter with proper shielding is critical!

The "seven-ten" rule – For every sevenfold increase in time after the initial blast, there is a tenfold decrease in the radiation rate. For example, a 500 rad level can drop to 50R in just 7 hours and down to 5R after 2 days (49 hours). In other words, if you have shelter with good shielding and stay put for even just 7 hours … you've really increased your chances of survival. Your detection devices, emergency radio or cell phone [if the last 2 are working, that is] can assist you in knowing when it's safe to come out.

So how do I protect myself and my family?

Basic shelter requirements – Whether you build a shelter in advance or throw together an expedient last-minute shelter during a crisis, the area should protect you from radiation and support you for **at least 2 weeks**. Some basic requirements for a fallout shelter include …

- shielding
- ventilation
- water and food
- sanitation and first aid products
- radiation monitoring devices, KI (potassium iodide), radio, weapons, tools, etc

Reduce exposure – Protect yourself from radioactive fallout with …

- **distance** – the more distance between you and fallout particles, the better
- **shielding** – heavy, dense materials (like thick walls, earth, concrete, bricks, water and books) between you and fallout is best. Stay indoors or below ground. *(Taking shelter in a basement or a facility below ground reduces exposure by* ***90%****. Less than 4 inches of soil or earth can reduce the penetration of dangerous gamma rays by half.)*
- **time** – most fallout loses its strength quickly. The more time that passes after the attack, the lower the danger.

Indoor shelter locations – If you don't have a fallout shelter, these options could provide protection from dangerous radiation by using proper shielding materials.

- **basement** – find the corner that is most below ground level (the further underground the better)
- **1-story home / condo / apartment** – if no underground facility, find a spot in center of home away from windows
- **trailer home** – find sturdier shelter if possible (like a basement or brick or concrete building)
- **multi-story building or high-rise** – go to center of the middle section of building (above 9th floor if possible). Note: if rooftop of a building next to you is on that same floor, move one floor up or down since radioactive fallout would accumulate on rooftops. Avoid first floor (if possible) since fallout will pile up on ground outside.

Make an expedient shelter – Some very basic ways to build an expedient last-minute shelter in your home, apartment or workplace to help protect you from dangerous radiation include…

- Set up a large, sturdy workbench or table in location you've chosen. If no table, make one by putting doors on top of boxes, appliances or furniture.
- Put as much shielding (e.g. furniture, file cabinets, appliances, boxes or pillowcases filled with dirt or sand, boxes of food, water or books, concrete blocks, bricks, etc.) all around sides and on top of table, but don't put too much weight on tabletop or it could collapse. Add reinforcing supports, if needed.
- Leave a crawl space so everyone can get inside and block opening with shielding materials.
- Leave 2 small air spaces for ventilation (about 4-6″ each) – one low at one end and one high at other end. (This allows for better airflow since warm air rises.)
- Have water, radiation detection devices, KI, battery
- operated radio, food and sanitation supplies in case you have to shelter in place for days or weeks.

In summary, those within the blast zone of Ground Zero (depending on the size of the nuke) won't make it

BUT ..if you are a few miles outside the zone your chances of surviving it are high but you MUST have detection devices to monitor levels of radiation and a plan to stay sheltered for at least 48 hours or up to a few weeks. First Responders will have to wait for the deadly fallout to decay before they enter a hot zone so the more you prepare, the better your odds of surviving a terrorist nuke.

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