

The Provenance of Nuclear Radioactivity & Radiations and its Deep Developmental Impact on the Mankind

Geeta Sakhuja

Assistant Professor, Department of Physics, Hans Raj Mahila Maha Vidyalaya College, Jalandhar, Punjab, India

ABSTRACT: This assessment has an important consideration for the nuclear energy upon the creation of the radioactivity being generated and mobilized through various Energy Agency. The entire system related to human health issues within the broadest sense, encompasses man and his world, comprising both animate and inanimate components.

This paper examines the empirical evidence incorporated with human-made nuclear radioactivity from nuclear energy especially while maintaining the viability of radioactive mechanisms which may cause the uncontrolled highly dangerous harmful effects of radionuclides in the human body health as a result the Radiation can even damage the DNA in the cells of people exposed to it. This, in turn the paradigm for the health risks of nuclear power at this moment and in the future because it is the DNA that passes on instructions for growth and development to the next generation.

KEYWORDS: Radioactive Mechanisms, Ionizing Radiation, Atoms, Alpha, Beta, and Gamma Radiation.

I.INTRODUCTION

NUCLEAR ENERGY AND RADIATIONS – Nuclear power certainly has its pros and cons. It is considered to be a climate-friendly energy source because it generates power without releasing carbon dioxide, which is a greenhouse gas thought to be harmful to the atmosphere. However, there are safety concerns that come with nuclear power, including the possibility that a nuclear power plant could accidentally release radiation into the environment or be targeted for a terrorist attack. There is also the issue of what to do with radioactivity. The risks associated with nuclear power and radioactivity is a fairly general term that can be used to describe the transfer of energy through space away from a source. There are many types of radiation. When we talk about radiation as a danger to humans through the rest of this site, we will primarily be talking about 'Ionizing radiation'. Ionizing radiation is generated through nuclear reactions and can be very harmful to human health. Nuclear reactions can be naturally occurring, or artificial. There are three basic types of radiation. These include alpha, beta, and gamma radiation. Each radiation source is unique in the type of radiation it emits, and its risk to humans. So what is Radiation? Radiation is a fairly general term that can be used to describe the transfer of energy through space away from a source. Radiation is all around us. It is in our environment and has been since the Earth was formed. As a result, life has evolved in the presence of significant levels of ionizing radiation. It comes from outer space (cosmic), the ground (terrestrial) and even from within our own bodies. It is in the air we breathe, the food we eat, the water we drink and the materials used to build our homes. Some foods such as bananas and Brazil nuts naturally contain higher levels of radiation. Brick and stone homes have higher radiation levels than homes made of other materials such as wood. The largely built of granite, contains more radiation than most homes. A lot of our exposure is due to radon, a gas from the Earth's crust that is present in the air we breathe. The natural radiation that is always present is known as "background" radiation. Background levels can vary greatly from one location to the next. When we talk about radiation as a danger to humans through the rest of this site, we will primarily be talking about 'Ionizing radiation'. Ionizing radiation is generated through nuclear reactions and can be very harmful to human health. Nuclear reactions can be naturally occurring, or artificial. There are three basic types of radiation. These include alpha, beta, and gamma radiation. Each radiation source is unique in the type of radiation it emits, and its risk to humans.

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Radiation is energy in the process of being transmitted. It may take such forms as light or tiny particles much too small to see. Visible light, the ultra-violet light we receive from the sun, and transmission signals for TV and radio communications are all forms of radiation that are common in our daily lives. These are all generally referred to as 'non-ionizing' radiation, though at least some ultra-violet radiation is considered to be ionizing.

Radiation particularly associated with nuclear medicine and the use of nuclear energy, along with X-rays, is 'ionizing' radiation, which means that the radiation has sufficient energy to interact with matter, especially the human body, and produce ions, i.e. it can eject an electron from an atom.

X-rays from a high-voltage discharge were discovered in 1895, and radioactivity from the decay of particular isotopes was discovered in 1896. Many scientists then undertook study of these, and especially their medical applications. This led to the identification of different kinds of radiation from the decay of atomic nuclei, and understanding of the nature of the atom. Neutrons were identified in 1932, and in 1939 atomic fission was discovered by irradiating uranium with neutrons. This led on to harnessing the energy released by fission.

II. TYPES OF RADIATION

Nuclear radiation arises from hundreds of different kinds of unstable atoms. While many exist in nature, the majority are created in nuclear reactions. Ionizing radiation which can damage living tissue is emitted as the unstable atoms (Radio Nuclides) change ('decay') spontaneously to become different kinds of atoms. The principal kinds of ionizing radiation are:

Alpha particles

These are helium nuclei consisting of two protons and two neutrons and are emitted from naturally-occurring heavy elements such as uranium and radium, as well as from some man-made transuranic elements. They are intensely ionizing but cannot penetrate the skin, so are dangerous only if emitted inside the body.

Beta particles these are fast-moving electrons emitted by many radioactive elements. They are more penetrating than alpha particles, but easily shielded – the most energetic of them can be stopped by a few millimeters of wood or aluminum. They can penetrate a little way into human flesh but are generally less dangerous to people than gamma radiation. Exposure produces an effect like sunburn, but which is slower to heal. The weakest of them, such as from tritium, are stopped by skin or cellophane. Beta-radioactive substances are also safe if kept in appropriate sealed containers.

Gamma rays These are high-energy beams much the same as X-rays. They are emitted in many radioactive decays and may be very penetrating, so require more substantial shielding. Gamma rays are the main hazard to people dealing with sealed radioactive materials used, for example, in industrial gauges and radiotherapy machines. Radiation dose badges are worn by workers in exposed situations to detect them and hence monitor exposure. All of us receive about 0.5-1 mSv per year of gamma radiation from cosmic rays and from rocks, and in some places, much more. Gamma activity in a substance (e.g. rock) can be measured with a scintillometer or Geiger counter.

X-rays are also ionizing radiation, virtually identical to gamma rays, but not nuclear in origin. (However the effect of this radiation does not depend on its origin but on its energy.)

Cosmic radiation consists of very energetic particles, mostly protons, which bombard the Earth from outer space. It is more intense at higher altitudes than at sea level where the Earth's atmosphere is most dense and gives the greatest protection.

Neutrons are particles mostly released by nuclear fission (the splitting of atoms in a nuclear reactor), and hence are seldom encountered outside the core of a nuclear reactor.* Thus they are not normally a problem outside nuclear plants. Fast neutrons can be very destructive to human tissue. Neutrons are the only type of radiation which can make other, non-radioactive materials, become radioactive.

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III. ROUTINE SOURCES OF RADIATION

Radiation can arise from human activities or from natural sources. Most radiation exposure is from natural sources. These include: radioactivity in rocks and soil of the Earth's crust; radon, a radioactive gas given out by many volcanic rocks and uranium ore; and cosmic radiation. The human environment has always been radioactive and accounts for up to 85% of the annual human radiation dose.

RADIATION EFFECTS ON LIVING CELLS AND IMPACT ON HUMAN HEALTH

Radiation is a mutagen, which eventually can lead to cancer. Radiation can either kill cells or damage the DNA within them, which damages their ability to reproduce and can eventually lead to cancer. When radiation is present, high energy particles pass through your body. These can collide with atoms in your body and disrupt atomic structure. Atoms make up your DNA, so over time, your DNA can be damaged. Often, it is the replication a mechanism of cells that is damaged, so uncontrolled cell division occurs- which is the definition of cancer. The biggest concern associated with a nuclear power accident is the negative effects that exposure to radiation can have on the human body. It is interesting to note that we are exposed to radiation naturally just by living our lives. Natural background radiation comes from outer space, and even radiates up from the ground below us. You may also have been exposed to a medical procedure, such as a CT scan, X-ray or nuclear medicine, such as an MRI, that utilized different types of radiation to diagnose problems or treat a disease.

For most people, the low-level exposure to radiation that comes from the environment and medical procedures does not result in any detectable health problems. However, if a person were exposed to significant amounts of radiation over a period of time, this exposure could damage body cells and lead to cancer. If a person were to be exposed to an acute dose of high-levels of radiation, the result would be radiation sickness. Radiation sickness is defined as illness caused by exposure to a large dose of radiation over a short period of time. Symptoms may include skin burns, nausea, vomiting, diarrhea, hair loss, general weakness and possibly death. In addition to personal health concerns, There are also environmental health concerns associated with nuclear power generation. Nuclear power plants use water from local lakes and rivers for cooling. Local water sources are used to dissipate this heat, and the excess water used to cool the reactor is often released back into the waterway at very hot temperatures. This water can also be polluted with salts and heavy metals, and these high temperatures, along with water pollutants, can disrupt the life of fish and plants within the waterway. The functions of living tissue are carried out by molecules, that is, combinations of different types of atoms united by *chemical bonds*. The proper functioning of these molecules depends upon their *composition* and also their *structure*. Altering chemical bonds may change composition or structure. Ionizing radiation is powerful enough to do this. There are several ways that radiation physically interacts with your body we tend to think of the effects of radiation in terms of how it impacts living cells. For low levels of exposure, the biological effects are so small they may not be detected. The time between radiation exposure and the detection of cancer is known as the latent period. This period can be many years. It is often not possible to tell exactly what causes any cancer. In fact, the National Cancer Institute says other chemical and physical hazards and lifestyle factors (e.g., smoking, alcohol consumption and diet) make significant contributions to many of these same diseases. The data show high doses of radiation may cause cancers. But there are no data to establish a firm link between cancer and doses Even so; the regulations assume any amount of radiation may pose some risk. Many atomic bomb survivors in 1945 and emergency workers at the 1986 Chernobyl nuclear power plant accident experienced this syndrome. Among plant workers and firefighters battling the fire at Chernobyl, 134 received high radiation doses and suffered from acute radiation sickness. Of these, 28 died within the first three months from their radiation injuries. Two workers died within hours of the accident from non-radiological injuries. Because radiation affects different people in different ways, it is not possible to say what dose is going to be fatal If the exposure These effects can result from a mutation in the cells of an exposed person that are passed on to their offspring. These effects may appear in the direct offspring if the damaged genes are dominant. Or they may appear several generations later if the genes are recessive. While scientists have observed genetic effects in lab animals given very high doses of radiation, no evidence of genetic effects has been seen in the children born to Japanese atomic bomb survivors. High frequency radiation or fast moving particles plow into a living cell with enough energy to knock electrons free from molecules that make up the cell. These molecules with missing electrons are called ions. The presence of these ions disrupts the normal functioning of the cell the most severe

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damage to the cell results when the DNA (deoxyribonucleic acid) is injured. DNA is at the heart of the cell and contains all the instructions for producing new cells. The DNA is a complex molecule formed of two long strands that are twisted around each other and linked by chemical subunits. There are two major ways that radiation injures the DNA inside your cells. 1) The water in your body tends to absorb a large portion of the radiation and becomes ionized. When water is ionized it readily forms highly reactive molecules called free radicals. These free radicals can react with and damage the DNA molecule. 2) Alternatively radiation can collide with the DNA molecule, itself, ionizing and damaging it directly. Symptoms of radiation sickness: severe burns that is slow to heal, sterilization, cancer, and other damage to organs. High doses are rapidly (within days or weeks) fatal. Mutations or changes in the DNA can be passed along to offspring's. Mutations are generally for the worse. Depending upon the type and severity of the damage caused to the DNA by the radiation

IV. RADIATION DAMAGES

Radiation damage to organisms can be classified as somatic or genetic damage. Somatic damage is damage to the organism itself, resulting in sickness or death. The effects may appear almost immediately if a massive dose of radiation is received; for smaller doses, a delayed effect, usually in the form of cancer, may only appear years later. Genetic damage is damage to the genetic machinery of reproductive cells, creating problems that often afflict the offspring. The biological effects of a particular source of radiation depend on several factors: The energy of radiation – the higher the energy content of the radiation, the more damage it can cause.

The penetrating ability of the radiation: Different types of radiation vary in their ability to penetrate human tissues: -rays and X-rays are highly penetrating, particles can penetrate approximately 1 cm of the skin tissue, and particles will not penetrate the upper dermal layer of the skin.

The ionizing ability of the radiation The ionizing ability of radiation also varies a lot. -rays are very penetrating but cause little ionization. On the other hand, particles, though not very penetrating, will cause serious damage inside the body because of its powerful ionizing effect. Therefore, ingestion of particles emitters, such as plutonium or radium, is particularly damaging.

The chemical properties of the radiation source When a radioactive nuclide is ingested; its capacity to cause damage depends on how long it remains in the body. For example, both krypton-85 and strontium-90 are -particles emitters. Because krypton (a noble gas) is chemically inert, it passes through the body quickly and does not have much time to cause damage. Strontium, on the other hand, is chemically similar to calcium and can accumulate in the bones, where it can cause leukemia and bone cancer.

The susceptibility of the affected tissues Different tissues also has different sensitivity to radiation. Some are more sensitive than others when exposed to the same type radiation. Specialized cells and cells undergoing active cell divisions are more susceptible. For example, radiation is 100 times more dangerous to the fetus during the third to seventh weeks of pregnancy than it is to pregnant mothers.

The duration of exposure to radiation The dose required to produce a certain amount of damage depends on the period over which the dose is received. A dose that is deadly within a short period of time may lead to very few symptoms if the same dose is spread over the normal life-time of the individual. Some effects of radiation exposure may not be evident for many years.

V. POST-ACCIDENT EXPOSURE

These low exposure levels are achievable for normal nuclear power and medical activities, but where an accident has resulted in radioactive contamination their application has no net health benefit. There is a big difference between what is desirable in the normal planned operation of any plant, and what is tolerable for dealing with the effects of an accident. Here, restrictive dose limits will limit flexibility in managing the situation and thus their application may increase other health risks, or even result in major adverse health effects, as near Fukushima since March 2011 (see

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earlier endnote). The objective needs to be to minimize the risks and harm to the individual and population overall, rather than focusing on radiation in isolation.

This is recognized to some extent in the occupational health limits set for cleaning up such situations: the IAEA sets 100 mSv as the allowable short-term dose for emergency workers taking vital remedial actions, and 500 mSv as allowable short-term dose for emergency workers taking life-saving actions. At Fukushima, 250 mSv was set as the allowable short-term dose for workers controlling the disabled reactors during 2011. Following NRA consideration of the Fukushima experience, as well as overseas standards and the science, 250 mSv is now the proposed allowable dose in emergency situations in Japan from April 2016.

But even these levels are low, and there has been no corresponding allowance for neighboring members of the public – ALARA was the only reference criterion regardless of its collateral effects due to prolonging the evacuation beyond a few days. The death toll and trauma from prolonged evacuation at Fukushima were clearly very much greater than the risks of elevated radiation exposure after the first few days. This led to the IAEA in May 2013 publishing allowable dose rates for members of the public living normally in affected areas, measured 1m above the contaminated ground. A level of 220 mSv/yr over a full year is "safe for everyone" providing any ingested radioactivity is safe. Shorter term, at 40 times this level, 170 mSv for one week is provisionally safe, and at four times the yearly level – 880 mSv – is provisionally safe for one month.

In March 2011, soon after the Fukushima accident, the ICRP said that it “continues to recommend reference levels of 500 to 1000 mSv to avoid the occurrence of severe deterministic injuries for rescue workers involved in an emergency exposure situation.” For members of the public in such situations, it recommends “reference levels for the highest planned residual dose in the band of 20 to 100 millisieverts (mSv)”, dropping to 1 to 20 mSv/yr when the situation is under control. When making decisions on evacuations, optimization of all the health risks (not just radiation exposure) is required. Rather than ALARA, a concept of As High As Relatively Safe – AHARS – would be more appropriate in dealing with emergency or existing high exposure situations, based on scientific evidence. This would be similar to the 680 mSv Tolerance Dose allowable to 1950s (assuming gamma & beta radiation), and it would take into account the dose rate. This AHARS approach is supported by Allison (2011) and Cuttler (2012 & 2013) among others and an AHARS level of 1000 mSv/yr or 100 mSv per month is suggested. This would also mean that most or all of the displaced residents from near the Fukushima plant could return home, without any elevated cancer risk. Another proposal is for As High as Naturally Existing – AHANE. That is the highest naturally occurring radiation exposures in the world, experienced by a large number of people without discernable negative health effects. At Ramsar in Iran, about 2000 people are exposed at least 250 mSv/yr with no adverse effect. But in Guarapari, Brazil (pop. 73,000), Kerala, India (pop. 100,000), and Yangjiang, China (pop. 80,000) the average exposures are about 50 mSv/year, 38 mSv/year and 35 mSv/year respectively. In all cases, the residents have life expectancies at least as long as their national peers and cancer rates slightly lower than fellow countrymen. US Navy shipyard worker data confirm the safety of 50 mSv/yr.

VI. CHERNOBYL – NUCLEAR POWER REACTOR

Immediately after the Chernobyl nuclear power plant disaster in 1986, much larger doses were experienced. Apart from the residents of nearby Pripjat, who were evacuated within two days, some 24,000 people living within 15 km of the plant received an average of 450 mSv before they were evacuated. A total of 5200 PBq of radioactivity (iodine-131 equivalent) was released. In June 1989, a group of experts from the World Health Organization agreed that an incremental long-term dose of 350 mSv should be the criterion for relocating people affected by the 1986 Chernobyl accident. This was considered a "conservative value which ensured that the risk to health from this exposure was very small compared with other risks over a lifetime". (For comparison, background radiation averages about 150-200 mSv over a lifetime in most places.) Out of the 134 severely exposed workers and firemen, 28 of the most heavily exposed died as a result of acute radiation syndrome (ARS) within three months of the accident. Of these, 20 were from the group of 21 that had received over 6.5 Gy, seven (out of 22) had received between 4.2 and 6.4 Gy, and one (out of 50) from the group that had received 2.2-4.1 Gy.⁵ A further 19 died in 1987-2004. There has been no increase attributable to Chernobyl in congenital abnormalities, adverse pregnancy outcomes or any other radiation-induced disease in the

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general population either in the contaminated areas or further afield. Reports two decades after the accident make it clear that the main health effects from the accident are due to the evacuation of many people coupled with fear engendered, and thousands have died from suicide, depression and alcoholism. The 2006 Chernobyl Forum report said that people in the area suffered a paralyzing fatalism due to myths and misperceptions about the threat of radiation, which contributed to a culture of chronic dependency. Some "took on the role of invalids." Mental health coupled with smoking and alcohol abuse is a very much greater problem than radiation, but worst of all at the time was the underlying level of health and nutrition. Psycho-social effects among those affected by the accident are similar to those arising from other major disasters such as earthquakes, floods and fires. After the shelter was built over the destroyed reactor at Chernobyl, a team of about 15 engineers and scientists was set up to investigate the situation inside it. Over several years they repeatedly entered the ruin, accumulating individual doses of up to 15,000 mSv. Daily dose was mostly restricted to 50 mSv, though occasionally it was many times this. None of the men developed any symptoms of radiation sickness, but they must be considered to have a considerably increased cancer risk.

VII. FUKUSHIMA – NUCLEAR POWER REACTORS

The March 2011 accident at Fukushima Daiichi nuclear power plant in Japan released about 940 PBq (iodine-131 equivalent) of radioactive material, mostly on days 4 to 6 after the tsunami. In May 2013 UNSCEAR reported that "Radiation exposure following the nuclear accident at Fukushima Daiichi did not cause any immediate health effects. It is unlikely to be able to attribute any health effects in the future among the general public and the vast majority of workers." The only exception is the 146 emergency workers that received radiation doses of over 100 mSv during the crisis.⁷ Thyroid doses in children were significantly lower than from the Chernobyl accident. Some 160,000 people were evacuated as a precautionary measure, and prolonging the evacuation resulted in the deaths of about 1100 of them due to stress, and some due to disruption of medical and social welfare facilities. The highest internal radioactivity from ingestion was 12 kBq, some 1000 times less than the level causing adverse health effects at Goiania (see below). Certainly the main radiation exposure was to workers on site, and the 146 with doses over 100 mSv will be monitored closely for "potential late radiation-related health effects at an individual level." Six of them had received over 250 mSv – the limit set for emergency workers there, apparently due to inhaling iodine-131 fume early on. There were around 250 workers on site each day.

VIII. ANALYSING THE INTERNATIONAL SCENARIO ON NUCLEAR ENERGY

So, will we allow an accident in Japan, in a 40-year-old reactor at Fukushima, arising out of extreme natural stresses, to derail our dreams to be an economically developed nation? a few European countries, particularly Germany, decide to phase out nuclear power that should not become a blanket argument to take a view against our nuclear program. We should be careful not to be carried away by the barrage of anti-nuclear news often being generated by many of the same nations and enjoying the maximum benefits from it. The economically developed world has a well-trained habit of presenting their success in a distorted context to misguide emerging nations like India, which are a potential challenge to their neo-age proxy-imperial economic subjugation. What is needed for our India, we Indians has to decide The greenest sources of power are definitely solar and wind. With abundant sunshine and places of high wind velocity, the nation definitely has potential for these forms of energy. But solar and wind power, despite all their advantages, are not stable and are dependent excessively on weather conditions. Nuclear power, on the other hand, provides a relatively clean, high-density source of reliable energy with an international presence. Today, there are 29 countries operating 441 nuclear power plants, with a total capacity of about 375 GW(e). The industry now has more than 14,000 reactor-years of experience. Sixty more units, with a total target capacity of 58.6 GW, were under construction.

IX. CONCLUSION

Now, let us delve more into the other issue — that of plant safety. Throughout the history of nuclear power generation there have been four major incidents of plant failure — the Kyshtym accident in fuel reprocessing in 1957, the relatively smaller Three Mile Island meltdown (United States), the much bigger Chernobyl accident (USSR, 1986) and the recent Japanese incident at Fukushima. The first accident was purely due to underdeveloped technology, and much

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of the blame for the next two disasters is attributed to human error. Even in the case of the Fukushima disaster of 2011, there were extraordinary natural forces in action — the rare occurrence of the tremendous stress load of an earthquake coupled with the unprecedented shear load of a tsunami. Of course, there is a need for better technology and more stable plant design across the world, but the occurrence of four failures in six decades cannot be made out as a case for completely disbanding the technology — which is one of our foremost keys to graduating beyond the fossil fuel-based low-end energy. The best of technological progress, while being the biggest ally of mankind, does come at an incremental risk. The key is to learn and evolve to mitigate the risk, rather than use the first incident as an excuse to disband science. Let us take a few examples. In 1903, the Wright brothers translated into reality the remarkable dream of controlled human flight. Not more than half a decade later, in 1908, the first flight disaster occurred, which severely injured Orville Wright and killed his co-passenger. Many accidents followed, and even today air accidents kill more than 1,500 people every year. Imagine whether we would be flying between distant cities, across oceans and continents, if the incident of 1908, or the ones later, were used as a reason to disband human flight? When the mighty ship Titanic set sail in 1912, it was heralded as the pioneering mission in the field of large and comfortable ocean liners. But on its first voyage it struck an iceberg and sank, killing more than 1,500 people, more than two-thirds of those on board. But that never stopped our quest for bigger and faster means of ocean travel. The very first attempt to send man to the moon, Apollo-1, met with an accident and killed three prominent astronauts. It took another 10 missions, with mixed results, before Apollo-11 finally made it to the moon in 1969, with Neil Armstrong setting foot on the lunar surface and declaring to the world those never-to-be-forgotten words: “One small step for man, one giant leap for mankind.” Indeed, that small step was preceded by many a stumble. Every single atom in the universe carries an unimaginably powerful battery within its heart, called the nucleus. This form of energy, often called Type-1 fuel, is hundreds of thousands, if not millions, of times more powerful than the conventional Type-0 fuels, which are basically dead plants and animals existing in the form of coal, petroleum, natural gas and other forms of fossil fuel. To put things in perspective, imagine a kilometer-long train, with about 50 freight bogies, all fully laden with the most typical fossil fuel — about 10,000 tons of coal. The same amount of energy can be generated by 500 kg of Type-1 fuel, naturally occurring Uranium, enough to barely fill the boot of a small car. When the technology is fully realized, one can do even better with naturally occurring corium, in which case the material required would be much less, about 62.5 kg, or even less according to some estimates and thus enough to fit in a small bag.

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