ISSN 2348 – 8034
Impact Factor- 3.155

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

RADIOACTIVE WASTE: EMERGENCE, TYPES & MANAGEMENT

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ABSTRACT

Wastes arising from nuclear activities, defense-related nuclear- weapon activities and mining of radioactive materials and radioactive materials present in atmosphere poses a mammoth formidable problem for handling and protecting the environment from such devastating hazardous wastes to preserve environment and ecological balance for sustained growth of universe so that the dwellers continue to live in present and leave option for living in coming days for future generations. The typical growth of arsenals and continued growth of technology for useful energy generation in unfriendly manner is creating and generating situation where one and all will on the doorstep of devastation and destruction. The use of technology and resources of radioactive nature requires new technological development for waste tackling and handling in safe and just manner.

Keywords- *LLW, HLW, Fission, Fusion, Reactors, Burial, Nuclear energy, radiation.*

I. INTRODUCTION

The human kind has developed a lot and quest for development and taking over others in name of superiority and proving to be Master / Leader / Choudhary of world is continuing. The needs are enormous and its fulfillment is unlimited and is unleashing many new and unfolded avenues from centuries. The use of any typical type of technology is bound to have merits and demerits. The development of science for generation of energy and diagnosis of things has lead to many innovations in field of nuclear and atomic arena. This has lead to development of newer types of products. This new development as of now is old enough and starts from Second World War era for this new civilization which we are now witnessing. Wars are always bad but irony is that all developments happen at a faster pace when need is emergent and rapid. The unlimited amount of energy release and controlled use of these, which remains a question in many areas, is still continuing.

We are presently taking of development of radiations, radioactivity uses and wastes and hazards because of these. To begin with the radiation one can clearly say that Radiation is energy travelling through space. The most common example of radiation is Sunshine It delivers light, heat and suntans and many others effects which we limit with use of sunglasses, shade, hats, clothes and sunscreen. Undoubtedly the importance of sunshine is that no life can be imagined without lots of sunlight, but we have increasingly recognized that too much exposer may be dangerous. Sunshine consists of radiation in a range of wavelengths from long-wave infra-red to short-wavelength ultraviolet, which is responsible for hazards. Beyond ultraviolet are higher energy kinds of ionizing radiation which are used in medicine and which we all get in low doses from space, from the air, and from the earth and rocks. It can cause damage to living tissue and be used for treatment.

There are various other materials which exhibit radiations which can be puts to ones use for medicines and for energy generation. The exposure in medicines can heal some wounds and one can have useful effects and over exposer lead to devastation.

The other group is of arsenal which includes the chemical weapons or arsenals and the fusion and fission of atomic which leads to atomic and hydrogen bombs.

In any case the usefulness is always defined for the creativity and the residual effects and the waste often has to be dealt with utmost care. These types of wastes produced are more deadly and require more technological and scientific removal or disposal.

II. TYPES OF NUCLEAR REACTIONS & RADIATIONS

Basically we have three distinct types

1 Radioactivity
2 Radiation
3 Nuclear Reactions and Energy

RADIOACTIVITY is basically described as property of certain substances to give off invisible "radiations" that could be detected by films. It involves three different kinds of radiation known as rays which carry energy in straight line like light rays given off by certain materials referred as radioactive materials.

Alpha rays
Beta rays

ISSN 2348 – 8034
Impact Factor- 3.155

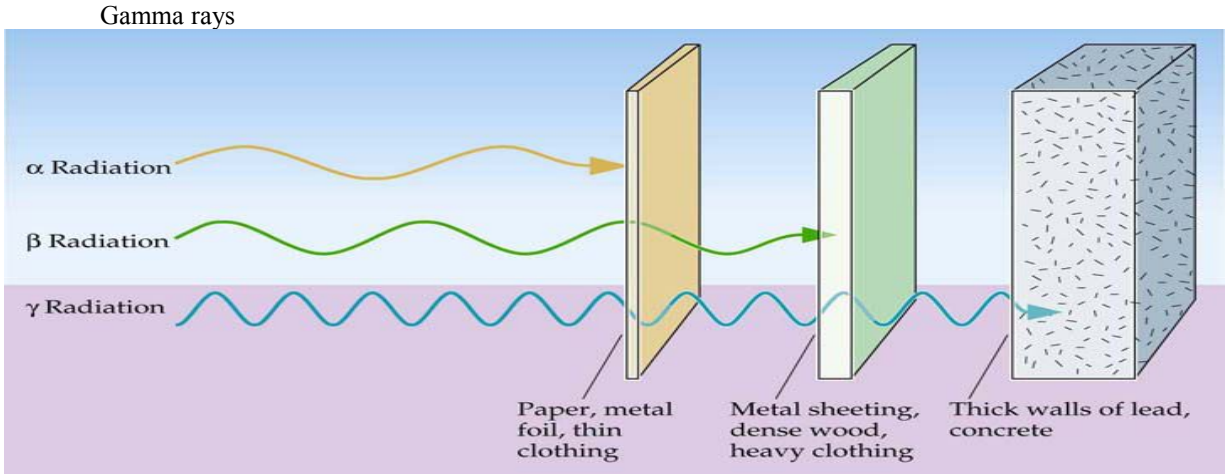

Figure 1 Different types of rays

Radioactivity comes from the nucleus of the atom which have many protons and neutrons. The atoms are in unstable state and the atom undergoes radioactive decay i.e. breakdowns.
In alpha decay, the nucleus ejects two protons and two neutrons.
In case of Beta decay occurs when a neutron in the nucleus splits into a proton and an electron.
Where as in Gamma decay, after decay reaction nucleus releases energy.
Radioactivity occurs because everything in nature tends to move toward lower energy through decay and decay of any type gives off energy which comes conversion of mass into energy and since speed of light (c) is such a large number, a tiny bit of mass is capable of generating huge amount of energy as we know that $E=mc^2$. Here E is energy, m is mass and c speed of light.
Radioactive decay depends on chance though it is possible to predict the average behavior of lots of atoms, but impossible to predict exactly which atom will decay. The most widely used prediction is of half-life prediction which is dependent on time taken for one half of the atoms in any sample to decay.
Applications of Radioactivity
Satellites use radioactive decay from isotopes with long half-lives for power because energy can be produced for a long time without refueling.
Isotopes which are extremely dangerous are useful in medical imaging; carbon-14 isotopes are used by archeologists to determine age by carbon dating.
Sources of Radioactivity are Primordial from before the creation of the Earth, Cosmogenic formed as a result of cosmic ray interactions and Human produced: enhanced or formed due to human actions (minor amounts compared to natural).

RADIATIONS : are flow of energy through space. Light, radio waves, microwaves, and x-rays are forms of electromagnetic radiation. These radiations are not nuclear reactions. Radiation becomes harmful when it has enough energy to remove electrons from atoms which is known as ionization . Visible lights and UV light are example of ionizing radiation. Ionizing radiation absorbed by people is measured in a unit called the rem and received by individual is known as dose.
Ionizing radiation is a natural part of our environment. There are two main sources of radiation a) background radiation which is limited to 0.3 rem per years as per WHO standards and b) radiation from medical procedures such as x-rays to which one is exposed.
X-rays are photons like visible light photons only with much more energy. Medical diagnostic x-rays are used to produce images of bones and teeth on x-ray film. High level Therapeutic x-rays beams are made to overlap the infected area are used to destroy diseased tissue, such as cancer cells. The development of powerful computers have made it possible to go for three dimension X rays which are popularly known as computerized axial tomography or CT scan.
A typical radiation exposure to human being as

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Impact Factor- 3.155

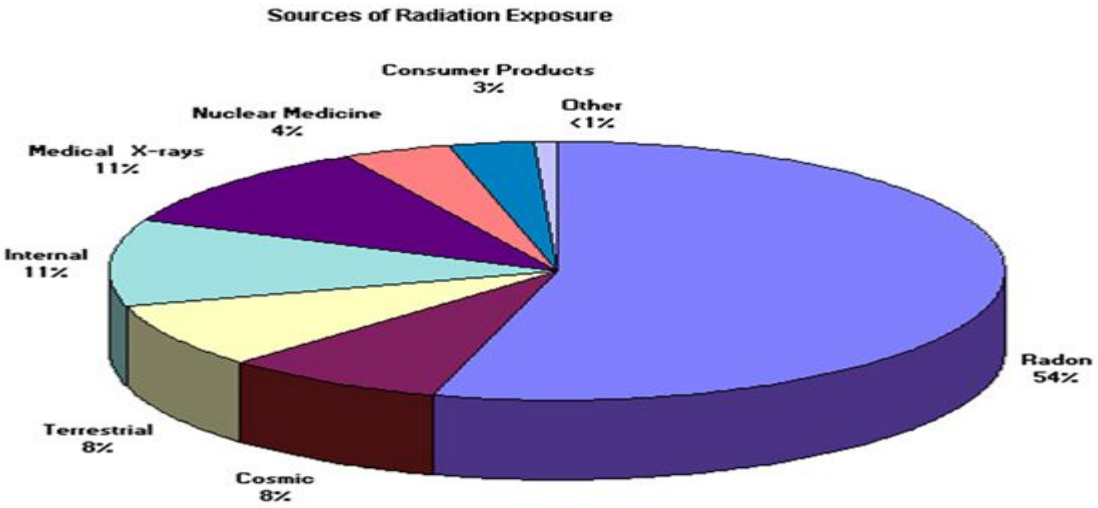

Figure 2 Sources of Radiations

III. NUCLEAR REACTIONS AND ENERGY

A nuclear reaction is a process that changes the nucleus of an atom.

If one take apart a nucleus and separate all of its protons and neutrons, the separated protons and neutrons would have more mass than the nucleus is expected to have. The mass of a nucleus is reduced by the energy that is released when the nucleus comes together. Nuclear reactions can convert mass into energy. When distinct protons and neutrons come together in a nucleus, energy is released. The release of energy dictates the level of energy left out in the final nucleus. The energy of the nucleus depends on the mass and atomic number.

The nucleus reaction as can be of fusion and fission types.

A fusion reaction is a nuclear reaction that combines, or fuses, two smaller nuclei into a larger nucleus. As positively charged nuclei repel each other the process of fusion is difficult.

In fission reactions large nucleus are split in into smaller pieces. A fission reaction typically happens when a neutron hits a nucleus with enough energy to make the nucleus unstable.

Applications of Radioactive radiations are as

Medicine
- Chemotherapy
- Power pacemakers
- Diagnostic tracers

Agriculture
- Irradiate food
- Pesticide

Energy
- Fission
- Fusion

Food Irradiation
- Food can be irradiated with g rays from ^{60}Co or ^{137}Cs.
- Irradiated milk has a shelf life of 3 mo. without refrigeration.
- USDA has approved irradiation of meats and eggs

The best known nuclear resources and wastes generated are ones from the energy cycles only . Here the entire process has been shown.

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Impact Factor- 3.155

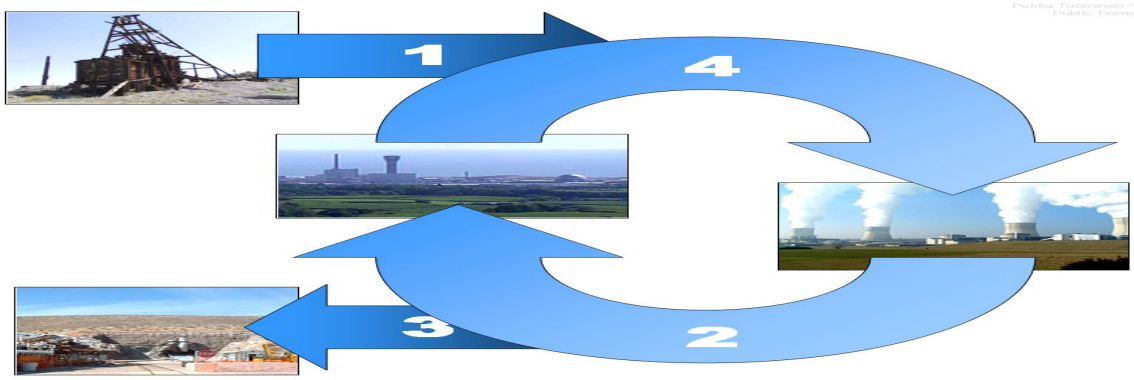

Figure 3 showing the Fuel Back end

The illegal and louse nuke markets are as follows
Since 1993 to 2011 the IAEA has recorded total of 2164 incidents which involve
399 unauthorized possession and related criminal activities , 16 incidents of procession of high enriched uranium (HEU) or plutonium, 588 incidents of theft or loss of nuclear or other radioactive material, 124 cases of other unauthorized activities, including the unauthorized disposal of radioactive materials or discovery of uncontrolled sources , etc..

IV. NUCLEAR WASTE TYPES

Disposing nuclear waste solutions are still being worked out . Nuclear waste is the available most hazardous and potential devastating waste which can remain threat even after thousand years. The silent killer as and when will effect is also not known and will not remain in the physical boundaries what we have limited for present national setup. To discuss these one needs to classify the waste in possible ways. Common Classification of waste on basis of radioactivity is as
1.low level which contributes to total 90% of such waste
2.intermediate level which contributes to total 07% of such waste and
3.high level which contributes to total 03% of such waste only.

Low level wastes are the wastes generated from hospitals and industry and nuclear fuel cycle. Common among these are glove boxes , paper, rags, tools, shielding materials, clothing, filters. Out of the available low level wastes some are highly active and their disposal needs shielding during handling and transport. Ordinary low level wastes can be buried in the shallow burials. The time periods of isotopes to decay is around 10 to 50 years in this case.

Intermediate-level wastes are the ones which contains higher amounts of radioactivity. Common examples are resins, chemical sludge and metal reactor nuclear fuel cladding. The disposal may require shielding even by solidifying in concrete or bitumen. The short lived wastes such as non-fuel materials from reactors) can be disposed by burying in shallow repositories whereas the Long-lived waste from fuel and fuel reprocessing can be disposed by depositing in geological repositories only.

ISSN 2348 – 8034
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High**-level wastes* ***which constitutes only 03 % of total waste of this kind is responsible for 95 % radioactive radiation or radioactivity. Main constituents are fissions products and transuranic elements generated in reactor core and are often very hot which will last for thousands to millions of years. The most dangerous high level wastes is very tedious for geological disposal or burial. Special measures and means are to be adopted for stopping the radiations and radioactivity. Commonly we employ these methods for disposals.

Above ground disposal
Geological disposal,
Deep borehole disposal, Disposal at subduction zones,
Ocean disposal and even
Disposal in outer space.

Typical views of different types of High level waste disposal are as follows:

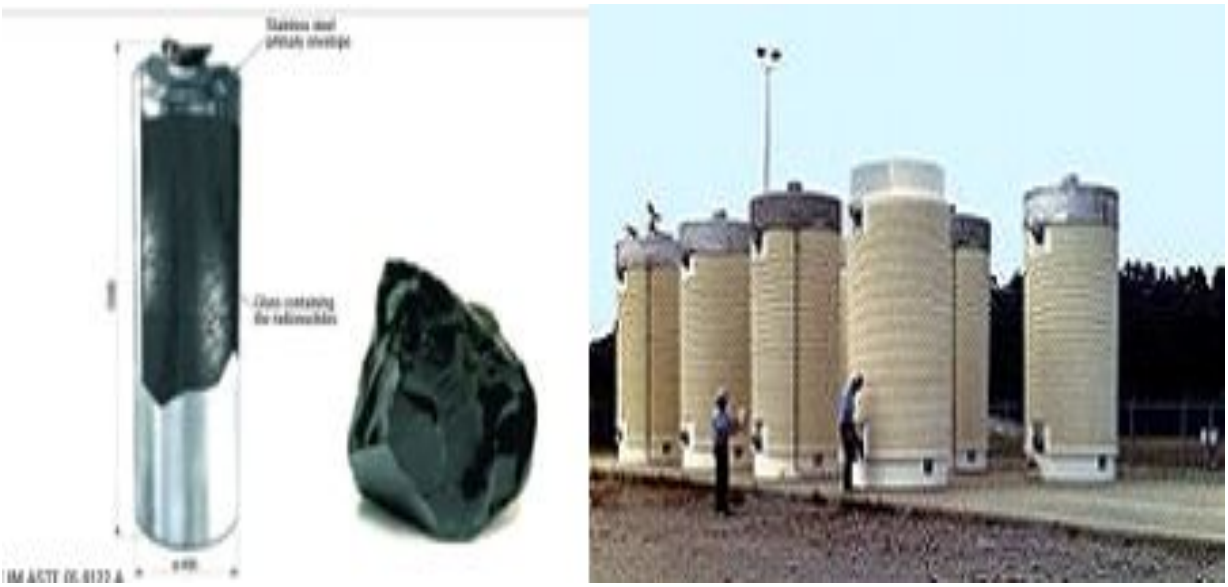

Figure 4 View of disposal of high level wastes in container and subduction zones (Source Internet based literature)

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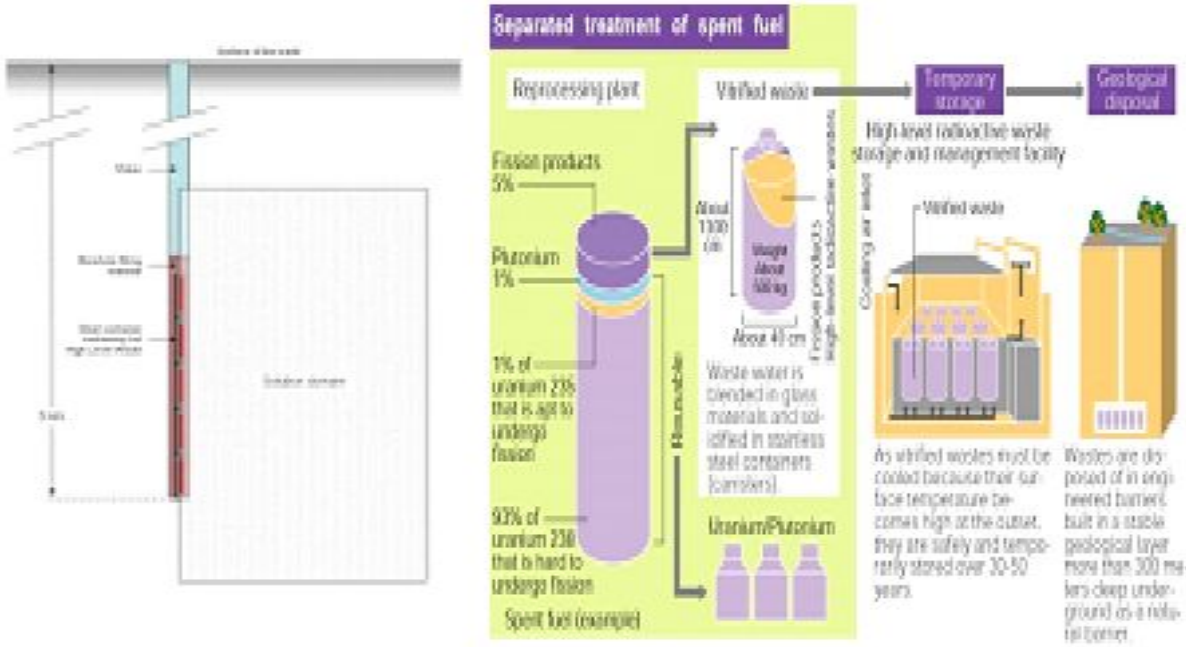

Figure 5 showing deep borehole disposal and provision for separate treatment for spent fuel. (Source Internet based literature)

V. RADIOACTIVE WASTE MANAGEMENT SCENARIO IN INDIA

The arsenal growth and nuclear power generation are two discussed aspects in India also which are responsible for such type of waste generation. Major data's of energy generation is only available. Growth of any nation is judged by per capita energy generation of consumption of energy we see that the nuclear electricity generation is taking lead in India also.. At present India ranks 26 th in the 30 nation pool generating electricity by nuclear options. Here only 2.65 % demand is met by this means. Against 75%, 47%, 42.24%, 34.65%, 31.21%, 28.87%, 19.80%, 14.41% and 12.44% of France, Sweden, the Republic of Korea, Japan, Germany, UK, USA, Russia and Canada, respectively. The reactors in operation produce in the latter countries nearly 63, 9,13, 44, 21, 13, 97, 20 and 10 GW energy, respectively; India's reactors in operation yield 1.9 GW only as per IAEA Report of 2000. IN other words one can say that the radioactive wastes getting generated in India is extremely low compared to developed countries. The continued option of nuclear option of energy generation and weaponization continues the waste of such type will grow and will call for deeper waste management schemes.

In India energy generation comprehensive program includes the nuclear radioactive waste management as integral part of the program. Only Low-level Radioactive Waste and intermediate-level waste arise from operations of reactors and fuel reprocessing facilities. Here low-level radioactive waste liquid are retained as sludge after thorough chemical treatments which makes it decontaminating they are solidified and these solids are compacted, bailed or incinerated depending upon the nature. Solar evaporation techniques for liquid wastes, reverse osmosis or / and immobilization using cement matrix technology is used for treatment of wastes Technology of underground engineered trenches in near-surface disposal facilities are utilized for disposal of solid waste. These burial disposal sites are kept under continuous surveillance and monitoring. Much Advanced High efficiency particulate air (HEPA) filters are used to minimize air-borne radioactivity. India has a relatively long experience of handling radioactive waste management facilities. The facilities are set up at Kalpakka, Kakrapara, Narora, Rawatbhata, Tarapore, Trombay, Hyderabad and Jaduguda, along with the in use growth and expansion of nuclear power and fuel-reprocessing units. As per standard and developed technology Multiple barrier approach is followed in handling solid waste.

The development of new technology and adaption of newer versions like that of used in fast breeder test reactor at Kalpakkam, new challenges of reprocessing new burnt fuels and handling new types of liquid and solid waste are to be taken care of. Here one is required to reprocess the burnt carbide fuel from this reactor. The shorter cooling time is going to pose new problems, adequate technology has to be thought and developed. Use of carbide fuel would result in new forms of chemicals and processing operational products in the reprocessing cycle. Provision of new needed mechanism of containing radioactivity and preventing leaks and possible

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Impact Factor- 3.155

wartime measures of destructions of these most modern technology reactors are going to provide new challenges in general and for fast-reactor fuel reprocessing in particular.

VI. CONCLUSION

The growth, need, urbanization and the might display of nations are witnessing the growth nuclear options use in many environments and thereby isolated growth of waste disposal mechanism of this deadly type of waste handling is posing huge problems. The concentrated efforts for any and typical types of radiations, whether it is manmade, artificial or natural, have to be taken up. The growing nuclear arsenal; and utilizing the fission and fusion technology for green and developmental purposes are paving ways of destruction for the human kind and universe. The madness generated by the power is adding to the situation. Concentrated effort to tackle such types of situation can only lead to a peaceful solution. The throwing blame for all wrong doings will only add to the problem. Concentrated approach for newer disposal and sustained management is required to be tackled in state of art manner. Here protection is only way of safety and avoidance to uncontrolled waste management is way left. The approach on individual basis here converges to national and humankind and universal basis. The have ones and have-nots both will be equally affected.

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