Radioactive waste management analysis

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***Abstract*- radioactive waste ia a waste that is generated after the radioactive material in the nuclear reactor is exhausted or produced during the production of nuclear weapons.**
Since in advancements in field of nuclear fuel or nuclear energy was on a pretty large scale which thereafter resulted in mass production of radioactive waste, radioactive waste management became an necessary and crucial subject to deal with it. If not properly handled or disposed, any radiation leak can cause an imminent danger to human life as well as environment. The paper lays emphasis on radioactive waste generation along with its classification, storage, processing, Treatment

1. INTRODUCTION

Radioactive waste is kind of radioactive materials which are generated as by-products of generation of power by nuclear fuel and other applications of nuclear fuel in the respective field of medicine and research purposes. Radioactive waste is a hazardous material to almost all form of life whether it be human, plants or animals as well as environment. It is regulated by government agencies to protect human life and environment.

2. GENRATION OF RADIOACTIVE WASTE

Radioactive waste is generated from a number of reasons like nuclear fuel cycle processing of nuclear weapons, medical waste, industrial radioactive waste as well as naturally occurring radioactive materials (NORM). Among all of these reasons for generation of waste the main waste generator are nuclear fuel cycle and nuclear weapons processing. In a nuclear fuel cycle radioactive waste is generated at the beginning as well as the end of the cycle. Waste from the front end of the nuclear fuel cycle is usually alpha emitting waste from extraction of uranium. The waste often contains radium and its decayed products where the back end of the nuclear fuel cycle mostly contains used fuel rods, containing fission products that emit gamma radiation and actinides that emit alpha particles, such as uranium-234, neptunium-237, plutonium-238, americium-241 and even sometimes some neutron emitters as californium. [1]

Radioactive waste generated from reprocessing of nuclear weapons are likely to contain some alpha emitting actinides such as Pu-239 which is a fissile materials used in various applications such as bombs, plus some materials with much higher specific activities. It also contains beta and gamma particles that emits tritium and americium but in a particularly minute amount.

Medically generated radioactive waste generally contains beta particles and gamma rays emitter. Y-90 for treating lymphoma, Sr-89 for treating bone cancer, I-131 for treatment of thyroid cancer, Co-60 Ir-192 Cs-137 for treatment of brachytherapy, and external radiotherapy, these are few isotopes used in research and treatment in field of medicine.

Naturally-Occurring Radioactive Materials (NORM) which includes all radioactive elements found in our environment. Hence, the term is specifically used for all naturally occurring radioactive materials where human activities have increased the potential for exposure compared with unaltered situation. Radioactive elements with long time period such as uranium, thorium and potassium and any of their decayed products such as radium and radon are examples of NORM. These elements are present in Earth's crust and its atmosphere and it is concentrated in some places, such as uranium can be mined. The NORM is generally found in coal industry, oil and gas industry, metal mining and smelting, mineral sands, fertilizer and building industries.

High intensity radioactive waste is a by-product produced by recycling of used nuclear fuel, which in its final form will be disposed of in a permanent disposal facility. The used nuclear fuel consists of about 95 percent of uranium, about 1 percent are heavy elements such as curium, americium and plutonium-239, and hence the best option for nuclear enabled weapons. They have a long half-life span, some of them take hundreds or thousands of years to loose all of their radioactive potency [2].

The quantity of fission product i.e. spent nuclear fuel produced each year by a fully sized and functional commercial nuclear power plant is approximately50, 000 times the fission products of the bomb of Hiroshima are created by Japanese nuclear power plants each year. Most of this radioactive is being temporarily stored at the respective site of the nuclear power plant and must be away from natural environment or any plant or living force of nature [2].

Transuranic waste accumulation began in 1940's when United States nuclear defense program started. It was discovered that bedded salt present in freash flowing water, can be easily mined and geologically stable can be used or is an ideal medium for permanently isolating radioactive waste from rest of the environment.

Some appropriate sites for radioactive waste disposal were a tested remote desert area of south eastern New Mexico in United States of America.

Different Forms of Radioactive Waste

There are generally five kinds of radioactive waste as specified by the Environmental Protection agency (EPA) which are as follows:

1. Low-level waste(LLW)- contaminated industrial waste
2. Transuranic waste(TRUW) from the production of nuclear weapons.
3. Uranium mill tailings from the mining and milling of uranium ore.
4. Spent nuclear fuel (SNF) from reactors and High-level waste(HLW) Spent reactor fuel and other highly radioactive wastes generated at reprocessing plants.
5. Naturally occurring radioactive materials(NORM)

3. CLASSIFICATION OF RADIOACTIVE WASTE

Classification of radioactive waste differs from nation to nation. However, THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) [4], which is responsible for publishing of Radioactive Waste Safety Standards (RADWASS), has hence classified the radioactive waste into six different categories which are as follows:

a. Exempt waste (EW).
b. Very short lived waste (VSLW).
c. Very low level waste (VLLW)
d. Low level waste (LLW).
e. Intermediate level waste (ILW).
f. High level waste (HLW).

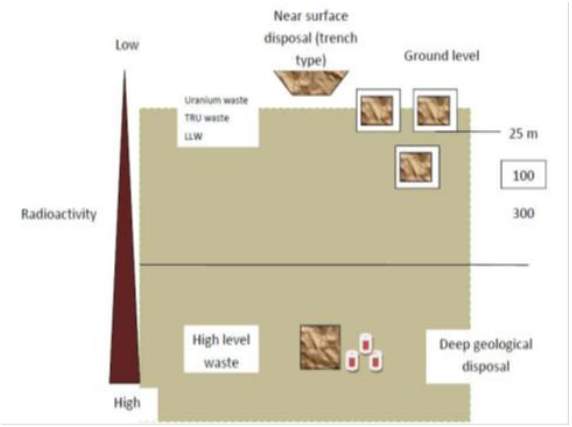


Fig 1: Disposal of Radioactive waste based on amount of radioactivity. Source: Japan atomic energy agency. [3]

4. PROCESSING OF RADIOACTIVE WASTE

The basis of radioactive waste management is not difficult. Radioactive materials although become less radioactive over a given period of time, the best way of disposing radioactive waste is to store them till they lose their radioactivity. Different radioactive materials have different half-lives, implying different storage time.

For example, cobalt-60, a radioactive isotope having a half-life of 5 years has been used widely in medical field for cancer treatment. Thus, 2 pounds of radioactive cobalt-60 five years later would decay to a one pound. Every five years the quantity decreases to half its original. Thus, after 10 half-lives have elapsed, the material becomes non-radioactive [1].

Very short-lived radioactive wastes are disposed of by storing them in buildings until they are nonradioactive. HLW from nuclear fuel cycle require

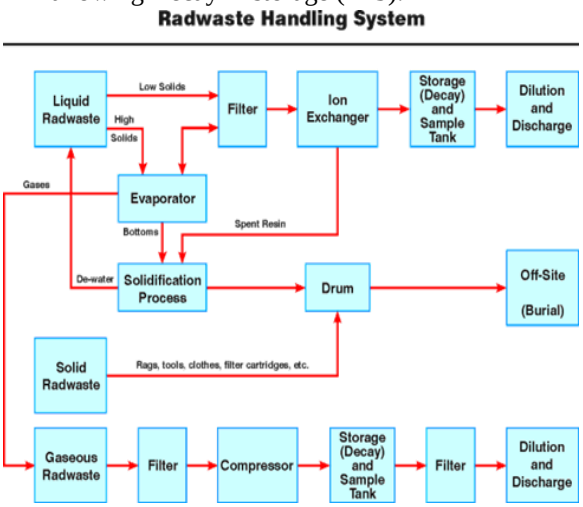
storage of thousand years, whereas ILW and LLW need hundred year or less for becoming non-radioactive. [8]

Since solids, liquids, and gases have different characteristics, each must be processed differently. The waste must also be processed in such a manner as to minimize the risk of exposure to the public.

Liquids are processed to remove the radioactive impurities.

These processes include [9]:

1. Filtering.
2. Routing through demineralizers,
3. Boiling off the water leading to evaporation which leaves solid particles which are further treated as solid radioactive wastes.
4. Storing the liquid for a specific time thereby allowing Decay in storage (DIS).



5. TREATMENT OF RADIOACTIVE WASTE

1. Radioactive waste transmutation-this method means conversion of radioactive isotopes into non-radioactive isotopes.
2. Vitrification-storing of radioactive materials for a huge span of time requires a form of waste that will neither react nor degrade for a long span of time and vitrification is one such method used to store it for a long period of time.

6. CONCLUSION

Radioactive waste must be properly identified, differentiated, transported and disposed of after appropriate treatment. With the growth in sector of nuclear application, the amount of radioactive waste is also increasing. It is important to properly dispose radioactive waste to prevent any radiation leak to living organisms.

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