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A Review of Nuclear Waste Management and its Disposal Method

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Abstract: The management of radioactive wastes generated from different sources is an alarming situation for the world. Radioactive waste contains radioactive material which is a by-product of nuclear power generation and other applications of nuclear fission or nuclear technology, such as research and medicine. Since these wastes have a lot of hazardous impact to most forms of life and the environment, various steps have been taken in order to protect the environment. In this paper we have discussed the strategy to manage nuclear waste and its disposal according to their properties.

Keywords: Radioactive Waste ,Nuclear power

I. INTRODUCTION

The waste containing radioactive material is known as radioactive waste. Radioactivity naturally takes a long time to decays. So radioactive waste has to be isolated and confined in appropriate disposal facilities for a sufficient period until it no longer poses a threat. The time radioactive waste must be stored for depends on the type of waste and radioactive isotopes. It can range from a few days for highly radioactive isotopes to millions of years for slightly radioactive ones. Current major approaches to managing radioactive waste have been segregation and storage for short-lived waste, near-surface disposal for low and some intermediate level waste, and deep burial or partitioning / transmutation for the highlevel waste.[1] Radioactive waste can be in gas, liquid or solid form, and its level of radioactivity can vary. The waste can remain radioactive for a few hours or several months or even hundreds of thousands of years.

II. GENERATION OF RADIOACTIVE WASTE

Radioactive waste is produced from a number of sources like nuclear fuel cycle and nuclear weapons reprocessing, medical wastes, industrial wastes, as well as naturally occurring radioactive materials. Amongst all these nuclear fuel cycle and nuclear weapons produce majority of waste. In nuclear fuel cycle radioactive waste is generated in front end as well as at back end of the cycle. Waste from the front end of the nuclear fuel cycle is usually alpha-emitting waste from the extraction of uranium. It generally contains radium and its decay products where the back end of the nuclear fuel cycle mostly contains spent fuel rods, contains fission products that emit beta and gamma radiation, and actinides that emit alpha particles, such as uranium-234, neptunium-237, plutonium238 and americium-241, and even sometimes some neutron emitters such as californium (Cf). Waste from nuclear weapons reprocessing likely to contain alpha-emitting actinides such as Pu-239 which is a fissile material used in bombs, plus some material with much higher specific activities, such as Pu-238 or Po. It also contains beta or gamma emitting tritium and americium but in very small amount. Medical wastes generally contain beta particle and gamma ray emitters. Y-90 for treating lymphoma , I-131 for treating thyroid cancer, Sr-89 for treating bone cancer, Ir-192 for brachytherapy, Co-60 for brachytherapy and external radiotherapy , Cs137 for brachytherapy, external radiotherapy are few isotopes used for medication.

III. TYPES OF RADIOACTIVE WASTE

According to the United States Nuclear Regulatory Commission more than 104 licensed nuclear facilities are located inside of the United States. These reactors total 20% of the energy consumption being used. There are five types of radioactive waste- high level, low level, intermediate level, mining and milling and transuranic waste. All types of nuclear wastes have their own separate storage and clean-up procedures.[2]

IV. CLASSIFICATION OF RADIOACTIVE WASTE ACCORDING TO DISPOSAL

Different trends have been used for classification of radioactive wastes; one of these is based on the disposal concept. This method of classification has been derived mainly from the safety aspects of radioactive waste disposal, but can be developed into the other stages of radioactive waste management. It is reasonable to start classification from the point of disposal to keep consistency among the different stages of radioactive waste management. The International Atomic Energy Agency has proposed a quantitative classification for radioactive wastes relevant to disposal concept. Five categories are proposed taking in account a group of the properties, such as half-life and heat generation capacity [3].Boundary levels between classes are presented as orders of magnitude and typical characteristics of waste classes and summarized in Table 1. A more detailed classification of radioactive waste which provides a further subdivision of wastes within waste classes will depend on individual national programmes or requirements. Also addressed are suggestions for application of the modified classification system to actual disposal facilities .Application of a classification system for the management of radioactive waste implies an adequate separation of wastes generated.

Sl N o	Waste Classes	Typical Characteristics	Disposal Options
1	Exempt Waste (EW)	Activity levels at or below clearance levels, which are based on an annual dose to members of the public of less than 0.01 mSv	No Radiological restrictions
2	Low And Intermediate Level Waste) LILW)	Activity levels above clearance levels and thermal power below about 2kW/m3	
2.1	Short Lived Waste (LILW-SL)	Restricted long lived radionuclide concentrations)limitation of long lived alpha emitting radionuclides to 4000 Bq/g in individual waste packages and to an overall average of 400 Bq/g per waste package)	Near surface or geological disposal facilit y
2.2	Long Lived Waste (LILW-LL)	Long lived radionuclide concentrations exceeding limitations for short lived waste	Geological disposal facilit y
3	High Level Waste (HLW)	Thermal power above about 2kW/m3 and long lived radionuclide concentrations exceeding limitations for short lived waste	Geological dispo salfacilit y

Table-1 Different types of nuclear waste and their characteristics

V. MANAGEMENT OF RADIOACTIVE WASTE

Proper disposal of radioactive wastes is essential to ensure protection of the health and safety of the public and quality of the environment including air, soil, and water supplies. Effective management involves segregation, characterization, handling, treatment, conditioning and monitoring prior to final disposal.TheLow and intermediate level waste is

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comparatively easy to dispose of. The level of radioactivity and the half life of the radioactive isotopes in low level waste are relatively small. Storing the waste for a period of 10 to 50 years [410]will allow most of the radioactive isotopes in low level waste to decay.In Solid waste substantial amount of LIL wastes of diverse nature, gets generated in different nuclear installations. Treatment and conditioning of solid wastes are practiced, to reduce the waste volume in ways, compatible to minimizing the mobility of the contained radioactive materials. A wide range of treatment and conditioning processes are available today with mature industrial operations involving several interrelated steps and divers technologies. A brief summary of the various radioactive waste management practices followed in India has been presented below.

The main concern is for the management of high level wastes.Most of the radioactive isotopes in high level waste emit large amounts of radiation and have extremely long half-lives (some longer than 100,000 years) creating long time periods before the waste will settle to safe levels of rad
cations must be used for its disposal which must be far away from locality and without ground water with long time storing capacity. the vitrification process is followed for the high level wastes using different types of melters like Pot melters,Ceramicmelters and Cold Crucible melters.

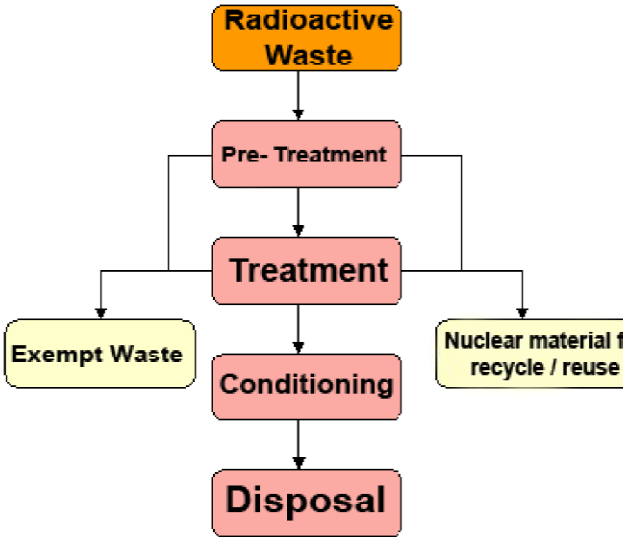

Fig.1 Block diagram of nuclear waste management. source[10]

Electronics waste, commonly known as e-waste, is generally generated from obsolete electronic devices. Recycling is the process of recovering material from old electronic devices to new electronic devices. The rising consumption of electronic domestic goods and up gradation of ICT tools has led to an increase in e-waste levels, which could be hazardous posing a possible threat towards sustainable environment for future generations. When e-waste gets heated, toxic chemicals are released into the air polluting the atmosphere. The one of the biggest environmental impacts from e-waste is damage to the atmosphere. Extracting valuable minerals from e-waste is very complicated. The metals can be removed from e-wasteby burning, leaching, and other processes that produce toxic by-products in air, water, and soil. Burning of e-waste releases fine particles which travel hundreds of miles and bring about negative consequences to respiratory health issues increasing the risk for a wide range of chronic diseases and cancers.

Soil gets contaminated from e-waste through irrigation process. When e-waste is improperly disposed in regular landfills the contaminants seep directly from the e-waste into the soil, causing contamination of underlying groundwater or contaminating crops that may be planted in that soil. Soil is also indirectly impacted by electronic waste recycling process through contact with contaminated water. Water gets contaminated by e-waste through landfills and improper recycling of e-waster. Surface water is affected by the chemical processes used to extract precious metals like gold from electronic devices. These processes typically filter precious materials away from less valuable materials like plastic using acids and other toxic chemicals that, when improperly regulated are released into local water sources such as streams, ponds, and rivers. Through these ways, acidification and toxification of water can extend to communities miles away from a recycling site,

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impacting public and ecosystem health in many, many ways. Ground water gets impacted by improper disposal or dumping of e-waste as heavy metals (like lead, arsenic, and cadmium) and other persistent chemicals leach from landfills and illegal dump sites into ground water tables, affecting people and life of both land and sea animals

V. CONCLUSION

Disposal of radioactive waste is a complex issue, not only because of the nature of the waste, but also because of the stringent regulatory structure for dealing with radioactive waste.Radioactive waste disposal practices have changed substantially over the last twenty years. Evolving environmental protection considerations have provided the impetus to improve disposal technologies, and, in some cases, clean up facilities that are no longer in use. Designs for new disposal facilities and disposal methods must meet environmental protection and pollution prevention standards that are stricter than were foreseen at the beginning of the atomic age.

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