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CODEN: IAASCA **REVIEW ARTICLE**

Can We Dump The Nuclear Waste Problem?

[1]Dhiraj Dhawan, [2]Nidhi Gauba Dhawan, [3]Raaz K Maheshwari
[1]Deputy Manager, NTPC BHEL Power Projects Limited (NBBPL),
Unchahar, Rai Bareilly, Uttar Pradesh
[2]Amity Institute of Environmental Sciences, Amity University Uttar Pradesh (AUUP), Noida, Uttar Pradesh
[3]Department of Chemistry, Sh Baldev Ram Mirdha Govt (PG) College,
Nagaur, Rajasthan

ABSTRACT

The disposal of nuclear waste is becoming one of the most important concerns in the 21st Century. The major issue in managing nuclear wastes is the time that they are likely to persist as a hazard. Nuclear wastes are typically the by-products of nuclear power production and other functions that exploit the nuclear fission technology. Radioactive waste is classified in diverse classes like: High-level waste (HLW), Intermediate-level waste (ILW), Low-level waste (LLW) and Very low-level waste (VLLW). The present article presents the primary concerns and the feasible solutions. Some long term disposal methods like Geological disposal, Transmutation, Waste re-use and Space disposal are also presented.
Keywords: *Nuclear waste, Nuclear hazards, primary concern, feasible solutions.*

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INTRODUCTION

Since the institution of the nuclear age, the concern over the dilemma of disposal of nuclear waste is becoming a major concern in the 21st Century. Nuclear waste includes a range of material that entails diverse type of management to shield general population and the surroundings. One of the issues in managing nuclear wastes is the time that they are likely to continue hazardous. This depends on the type of radioactive isotopes present in them, and chiefly the half lives (The half-life is the time it takes for a given radioactive isotope to lose half of its radioactivity. After four half lives the level of radioactivity is 1/16th of the original and after eight half-lives 1/256th) attribute of each of those isotopes. [4] The rate of decay of an isotope is inversely proportional to its half-life; a short half-life means that it decays rapidly. Hence, for each kind of radiation, the higher the intensity of radioactivity in a given amount of material, the shorter the half-lives involved.

What is nuclear waste?

Nuclear waste or the radioactive wastes are wastes that have radioactive matter. Nuclear wastes are usually the by-products of nuclear power generation and other applications that utilize the nuclear fission technology, such as wide scale applications in research, medicine, industry and in the generation of electricity by nuclear fission. The wastes may be in the form of gases, liquids, sludge or solids, and their nature, physical and chemical form, volume and activity are all closely related to the original nuclear process [4].

Fig. 1.1 Nuclear waste symbol

Types of nuclear wastes

The expression 'radioactive waste' includes a broad range of material, range from wastes that can be put securely into a dustbin to substance that require isolated handling, intense shielding and cooling to be handled safely. To be lucid, radioactive waste is considered in diverse classes [5]. These are:

High-level waste (HLW)

Radioactive waste that is sufficiently radioactive for the decay, heat to significantly raise its temperature and the temperature of its environment. This means that heat production has to be considered when designing storage and dumping facilities. This category of waste includes:

- The fluid deposit that contains most of the radioactivity from the reprocessing of exhausted nuclear fuel;
- This material subsequent solidification;
- Exhausted fuel (if it is declared a waste); or
- Whichever other waste with comparable radiological characteristics.

Intermediate-level waste (ILW)

Intermediate-level waste has radioactivity rank that are upper than low-level waste however which do not produce enough heat to necessitate extraordinary storage or disposal facilities. But, like other radioactive waste it still needs to be restricted to protect workers from the radiations. Intermediate-level waste (ILW) arise largely from the reprocessing of used up fuel and from general procedures and maintenance at nuclear sites, and can consist of metal objects such as fuel shell and reactor gears, graphite from reactor cores, and sludge from the treatment of radioactive liquid effluents.

Low-level waste (LLW)

Most Low-level waste (LLW) in the present day come up from the process of nuclear power stations and nuclear energy reprocessing facilities, as well as the decommissioning and clean up of nuclear sites. Operational LLW is mainly lightly polluted miscellaneous waste released from maintenance and monitoring, such as plastic, paper and metal. LLW from decommissioning is mainly composed of soil, building materials, metal plant and equipment. For Example in UK most LLW from nuclear certified sites is currently disposed of at the Low-Level Waste Repository (LLWR) near Drigg in Cumbria*.

*The Low Level Waste Repository (LLWR) is a site near Drigg in West Cumbria which is the national UK facility for the disposal of solid, predominantly, low level radioactive waste (LLW). The site was previously the location of a Royal Ordnance Factory for the Ministry of Defence until 1959 when it became a radioactive waste disposal site. The site receives, handles and disposes of radioactive wastes from across the UK by burial.

Very low-level waste (VLLW)

VLLW is a division of LLW and falls into two different categories:

- **Low-volume VLLW ('dustbin disposal'):** Radioactive waste that can be safely disposed of to an unnamed destination with municipal, commercial or industrial waste. The radioactive hazard from such material is low enough that controls on disposal of this material, after elimination from the premises where the wastes arose, are not necessary.
- **High-volume VLLW ('bulk disposal'):** Radioactive waste that can be disposed of to specific landfill sites. Subsequently the waste is removed from its site of origin; it is then subjected to controls on its disposal, which is specified by the environmental regulators prevailing in the region.

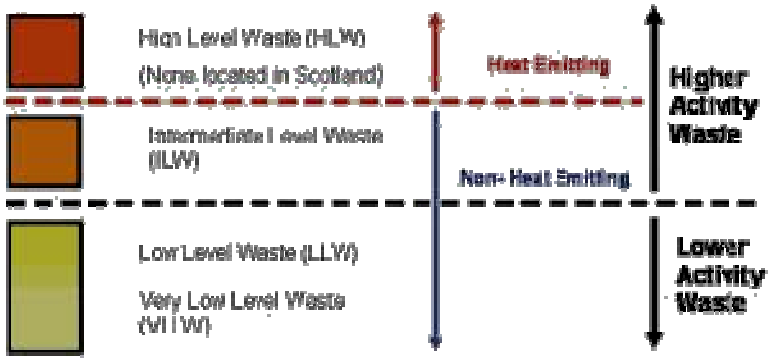

Fig. 1.2 Types of nuclear wastes

The primary concerns

The goal of radioactive waste management is to deal with radioactive waste in a way that protects human health and the environment now and in the future without imposing undue burdens on future

generations. The World Nuclear Agency, [8] has listed the some views and concerns that include the following:

- Till date the nuclear industry has no way out to the 'waste problem', so cannot predict support for creation of new plants until this is remedied.
- The transportation of nuclear waste presents an unacceptable risk to people and the environment.
- Plutonium is the most hazardous substance on the earth.
- There is a possible terrorist risk to the large amount of nuclear wastes at present being stocked up and the danger that this waste could escape or be dispersed as a result of terrorist action.
- As nuclear wastes remain dangerous for tens of thousands of years. This undoubtedly poses a huge risk to our coming generations.
- In case it is put into a geological repository, the waste may surface again and threaten our coming generations.
- Man-made radiations vary from natural radiations.
- The costs nuclear waste management is so high that nuclear power can never be economic.
- The waste must be disposed of into space.
- Nuclear waste should be transmuted into harmless materials before disposal.

Feasible solutions

The common principles that are employed in the management of radioactive wastes are:

- concentrate-and-contain
- dilute-and-disperse
- delay-and-decay

The first two methods are used in the management of non-radioactive wastes as well. The waste is either concentrated or then secluded, or it is diluted to adequate stage and subsequently released to the environment. Delay-and-decay on the other hand is exclusive to nuclear waste management; it means that the waste is stored and is allowed to decrease its radioactivity naturally through decay of the radioisotopes in it [7]. Specific long-term management methods include:

- **Geological disposal:** This process of geological disposal utilizes the method of burrowing nuclear waste into the earth to the spot where it is out of human contact. There are a numerous issues that can come up as a consequence of insertion waste in the earth like: The waste requires to be properly protected to stop any material from leaking out. Leakage from the waste could contaminate the water table in case the burial place is over or beneath the water level. In addition, the waste requires proper binding to the burial site and also structurally sustaining in the event of a major seismic event, which could result in abrupt contamination [6].

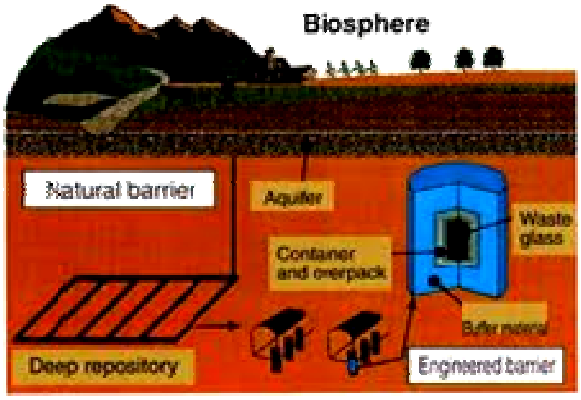

Fig. 1.3 Geological Disposal of Nuclear waste

- **Transmutation:** Transmutation also creates a way out for extended period of disposal. It particularly involves converting a chemical constituent into a new less detrimental one. Common conversions include going from Chlorine to Argon or from Potassium to Argon. The driving force behind transmutation is chemical reactions that are sourced from an external stimulus, such as a proton hitting the reaction materials. Natural transmutation may also happen over an extended period of time. Natural transmutation also act as the standard force behind geological storage on the

hypothesis that giving the waste sufficient inaccessible time will allow it to turn into a non-fissionable substance that causes a small or no threat [2].

- **Waste re-use:** As the title suggests, the procedure involve taking waste and separating the valuable components from those that are not as useful. In particular, it involves extracting the fissionable material from the irradiated nuclear fuel. The apprehension about re-processing has mainly focused around nuclear proliferation and how re-processing would allow fissionable material to spread [1].

Fig. 1.4 Nuclear waste Re-use symbol

- **Space disposal:** Space disposal also appears as an option, but is not a very viable option. Particularly, space disposal targets on placing nuclear waste on a space shuttle and sending the shuttle into outer space. This becomes a problem from both the point of view: practicality and economic standpoint. As the quantity of nuclear waste that can be transported on a single spaceship would be very little compared to the huge amount of waste that we need to deal. In addition, the possibility of the shuttle explosion en route to space would only result in nuclear waste to reach out far beyond any rational measure of control [3].

CONCLUSIONS

It can be concluded form the above discussion that 'radioactive waste' includes wastes that necessitate isolated handling, intense shielding and cooling before being disposed off safely. Views and concerns presented by The World Nuclear Agency, [8] can be easily dealt with along with protection of human health and the environment. This could be achieved by following the common principles utilized for management of radioactive wastes viz. concentrate-and-contain; dilute-and-disperse and delay-and-decay. Thus, the procedures or plans that different countries have in place to store; reprocess and dispose of used fuel and wastes shall be followed strictly to have a safe future for coming generations as well as the present populations.

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