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SAFETY IN WASTE MANAGEMENT PLANTS - AN INDIAN PERSPECTIVE.

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Abstract

Assurance of safety of public and plant workers and protection of the environment are prime objectives in the design and construction of Waste Management Plants. In India, waste management principles and strategies have been evolved in accordance with national and international regulations and standards for radiation protection. The regulations governing radiation protection have a far-reaching impact on the management of the radioactive waste. The wastes arise at each stages of the fuel cycle with varying chemical nature, generation rate and specific activity levels depending upon the type of the facility. Segregation of waste based on its chemical nature and specific activity levels is an essential feature, as its aids in selection of treatment and conditioning process. Selection of the process, equipment and materials in the plant, are governed by safety consideration alongside factors like efficiency and simplicity. The plant design considerations like physical separation, general arrangement, ventilation zoning, access control, remote handling, process piping routing, decontamination etc. have major role in realizing waste safety. Stringent quality control measures during all stages of construction have helped in achieving the design intended safety. These aspects together with operating experience gained form basis for the improved safety features in the design and construction of waste management plants. The comprehensive safety is derived from adoption of waste management strategies and appropriate plant design considerations. The paper briefly brings safety in waste management programme in India, in its current perspective.

1. INTRODUCTION

India has adopted a closed Fuel cycle. Radioactive waste arises at each stage of the fuel cycle. The physical and chemical nature, waste generation and specific activity levels, are dependent on the type of the facility. Thus the treatment and conditioning methods adopted will also be dependent on the waste origin. The operation of Nuclear Power Plants (NPP) generates large volumes of low level (LLW) waste streams and small quantities of Intermediate Level Waste (ILW) in the form of spent ion exchange resin. On the other hand the operation of a Fuel Reprocessing Plant (FRP) generates small volumes of High Level Waste (HLW) containing more than 99% of the radioactivity of the spent fuel, and moderate volumes of ILW. The treatment and immobilization methods for each waste stream are suitably selected to meet the design criteria. These will also dictate the type of the facility needed, extent of shielding and remote handling, containment, instrumentation and control requirement, redundancy & reliability. The overall safety pertaining to radioactive waste

management, is governed by strategy adopted on one hand and reliability of the plants built to implement the same. How these two aspects are effectively interwoven, in the context of Indian waste management program, is briefly brought out in the following paragraphs.

2. MANAGEMENT STRATEGY

The design of waste management plants is aimed at minimizing the release of radioactivity to the environment in line with the principle of ALARA. For this approach adopted are waste minimization, segregation, recycle and reuse and improved process for treatment and conditioning. Improvement is sought in disposal methodology using multi barrier concept by constant up gradation of different types of engineered barriers. Some of the application of these strategies to improve the waste safety in Indian plants is enumerated.

2.1 Segregation

Over the years there has been constant effort, to make improvement in terms of waste generation, characteristics, and segregation at source. These measures have helped in bringing down requirements of waste processing, their complexity thus improving waste safety. Segregation of Tritium waste streams in PHWRS has made their independent management possible. Thus stringent liquid route discharge limit could be met by controlled release of these through air route by use of solar/steam evaporation.

2.2 Improvement in treatment processes

Alkaline ILW stream, which are high in salt loading are not amenable for ion exchange treatment. Compatible with this chemistry is developed specific ion-exchangers. This offers adequate decontamination and reduction in secondary waste generation by one order of magnitude.

2.3 Conditioning process

No immobilization technique for spent ion exchange resins from purification systems of NPP'S was in use in the initial years of operation. These are now being conditioned in polymer matrix prior to disposal. Blended cement formulation is also developed for waste compatibility and product quality improvements.

A past practice in FRP using certain chemicals has generated HLW with its chemistry incompatible with standard vitreous matrix developed. Matrix therefore suitably modified to ensure compatibility viz. lead borosilicate glass for sulfate bearing waste. Selection of appropriate chemicals in present FRP has helped in control the HLW chemistry favorably making them amenable for incorporation in standard vitreous matrix.

2.4 Storage and disposal

For disposal of Low and Intermediate level waste packages Near Surface Disposal (NSD) are in use. These are co-located with the nuclear facility avoiding large distance transport of waste. NSD facilities are in use for more than 30 years are being assessed for their long term integrity, as a useful feed back for future design. Vitrification of HLW and its final

disposal in deep geology is aimed at, for very long term isolation of radionuclide. Presently site investigations are in progress to identify suitable geological formations. In the mean time safe interim storage and cooling is being met in specially constructed Solid Storage Surveillance Facility (SSSF). With a view to improve both technology and economic aspects of safety in immobilization of HLW, studies are also taken up for actinide separation and development of Synroc as a second-generation matrix.

3. PLANT DESIGN

A waste management plant is essentially a radio chemical plant. The design of such plant needs to incorporate adequate features for safe handling of radioactive waste, apart from conventional safety required in chemical plants. Radioactive safety features are made a part of design in a manner to restrict both internal and external exposure. Adopting suitable ventilation and zoning scheme achieve control of internal exposures. Shielding and remotisation techniques are employed to restrict the external exposure. Implementation of radioactive safety in waste management plants can be achieved through suitable piping and equipment layout, built-in provisions of decontamination and decommissioning, in service inspection and adequate redundancy. Major features as applicable to Indian Waste Management plants are summarized.

3.1 Layout

The waste processing building is physically separated from the building housing utilities. Radioactivity zoning of process buildings is carried out. Based on this, ventilation scheme, barrier / access control are implemented. Waste processing equipments are adequately shielded and containment provided depending upon level and nature of waste streams. Use of increased thickness/density of shielding walls and windows has helped to comply with revised permitted dose rate on the external wall surface. Hot cells are provided to house equipments for processing high active streams. While concept of a single cell for housing all the equipments was initially used, merit has found in use of compartmentalization of cells. This has facilitated segregation of equipment based upon activity inventory, replacement, repair and remotisation requirement helping in restricting exposures during operation and maintenance. Thus HLW vitrification cell requiring high degree of remotisation is kept devoid of liquid waste inventory. Further, equipment dealing with pre-treatment of HLW is compartmentalized in cells which permits planned entry. Similarly small shielded enclosures adjacent to main cells are planned for housing pumps, samplers, control valves, etc.

3.2 Piping

The arrangements for process piping layout is planned, in a manner to have shorter route, minimization of dead legs, unintended siphon, and prevention of back flow of process fluids in utility lines due to mal-operation .For these, measures taken are, providing proper slopes in piping and locating the transmitter area and process utility distribution area at the highest possible elevation from the respective process equipment. HLW and ILW waste generating and treatment plants are physically separated involving waste transfer lengths up to 500 meters. These are transferred through pipelines provided with multi envelopes. These comprise secondary pipes and stainless steel boxing in concrete trench. Design provision is

made for ascertaining integrity of primary pipe regularly. Such systems are not accessible for repairs. Spare lines are provided for possible switch over in future.

3.3 Redundancy

Sufficient redundancy and flexibility in process equipment, their throughput and transfer modes are taken as essential feature of the plant. These make allowance for variation in waste composition and quantities of waste. This brings down frequent requirements of intervention and avoidable exposures.

3.4 Quality Control

Another vital area of improvement in plant safety is stringent quality control measures taken for all components of plant. Vast improvement in plant reliability and safety is achieved through such a measure including stricter quality control and selection of raw materials. Use of indigenously developed Nitric Acid Grade (NAG) stainless steel, in handling of HLW is one such example.

4. CONCLUSION

The waste management philosophy in India is constantly upgraded keeping pace with the latest international standards and practices. Whenever satisfactory treatment modes were not available, the waste was managed without foreclosing option of treatment in future. For example, spent resin, which has been in storage, will be retrieved, as conditioning methods are now available. As regards to design safety of the plants proper, focus is on increased safety margins that would result in improved safety in management of radioactive waste in new plants and retrofitting such features in operating plants in a phased manner. Such a twin pronged approach, is helping to maintain a high level of safety standards in waste management progarmme in India.