Operating Experience in the Treatment and Storage of LLW in Turkey – 15010

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ABSTRACT

Treatment and storage of low-level radioactive wastes (LLW) are being carried out in Radioactive Waste Management Unit (RWMU) at Cekmece Nuclear Research and Training Center (CNRTC) in Istanbul. The wastes are generated from nuclear research and nuclear applications mainly in medicine, biology, agriculture and construction industries. The facility where the radioactive waste is treated and stored is referred to as the Cekmece Radioactive Waste Management Facility (CRWMF). At this facility, waste is segregated and processed according to their physical and radiological properties. According to these specifications, LLW are classified as exempt waste, very low level waste (VLLW) etc. Decay storage is applied at a designated area for short lived radionuclide. Long lived spent radioactive sources are immobilized in retrievable packages. Generally liquid radioactive wastes are decontaminated by filtration or chemical precipitation. The radioactive sludge or filtration media from liquid waste processing is solidified using cementation. Solid waste is compacted into drums for size reduction. TENORM wastes and contaminated metal wastes are handled for decontamination and size reduction. Then these types of waste are placed in 20 ton bulk containers for long term storage.

INTRODUCTION

Treatment and storage of low-level radioactive wastes (LLW) are being carried out in Radioactive Waste Management Unit (RWMU) at Cekmece Nuclear Research and Training Center (CNRTC) in Istanbul. The wastes are generated from nuclear research and nuclear applications mainly in medicine, biology, agriculture and construction industries. The facility where the radioactive waste is treated and stored is referred to as the Cekmece Radioactive Waste management Facility (CRWMF). At the CRWMF, waste pre-treatment methods are selected based on radiological protection standards, waste minimization factors, pre-treatment technology, economical factors and requirements for the further treatment. Expected results of pre-treatment are; improving overall safety, minimization of exposure and decreasing costs in subsequent waste management steps [1].

The principal aim of treating and processing Low Level Waste (LLW) is reduction of size and potential hazards of the waste. This is generally archived by conditioning it into a stable solid form that immobilizes it and provides containment to ensure that the waste can be safely handled during transportation, storage and final disposal.

At CRWMF, radiological characterization methods are selected based on parameters such as the type of emitted radiation (alpha, beta, gamma, and neutron), total activity and specific activity of different radionuclide and the form of radioactivity (e.g., induced activity in a matrix, fixed and loose surface contamination, dissolved or particulate in liquids, airborne, etc.)

Non-Destructive-Assay (NDA) techniques allow measurements to be taken from outside of the package and without disturbing the contents. Typically used for assessing of gamma emitting radionuclide, neutron emissions, etc. NDA methods include computational methods, such as scaling factors, which calculate or infer the activity of waste from some other easily measured parameter. These methods are usually performed on waste packages or objects of defined geometry, using the geometry for the calculation of the counting efficiency and for scaling total activity.

Fig. 1. X Ray for Non-Destructive Technique

Direct measurement of pure beta emitters, such as tritium, C-14, Sr-90 and Ni-63, etc. generally requires destructive sampling of the waste followed by sophisticated radiochemical analysis techniques. This may require considerable time (and cost) per sample in a specialized laboratory. Measurement of alpha emitters can be accomplished either by radiochemical analysis of samples or by the use of neutron passive counting or “neutron interrogation” techniques performed on conditioned samples or waste packages.

Processing of solid radioactive waste

Solid wastes generated from research laboratories and research reactor comprises; protective cloths, contaminated papers, wooden materials, concrete, contaminated soil, spent contaminated equipment, glass, ceramics; plastic materials, metal waste, spent filters of gas cleaning systems and ion exchange resins. As can be seen in Figure 2, approximately 12% of the waste received is solid waste.

The key objective of processing this type of waste is to change waste characteristics to improve safety and compatibility with disposal environment. In addition, the processing of solid waste leads to volume reduction and reduction of disposal cost. The extent of volume reduction achieved depends on types of waste and treatment option. Processes such as shredding are used to improve efficiency of treatment and the subsequent volume reduction. Majority of receiving radioactive waste at CRWMF is disused radioactive sources as shown in Figure 2.

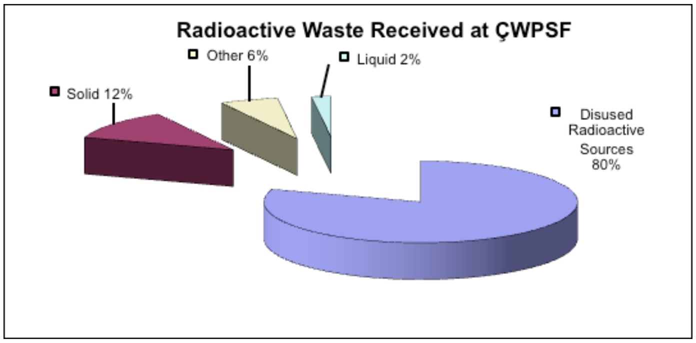

Fig. 2. Radioactive Wastes

Compaction

Compaction is the most simple and efficient method of waste volume reduction especially for large amounts of compactable solid waste. In CRWMF, an in-drum low force (50 kN) compactor is used for compaction of solid waste (Figure 3) to achieve a volume reduction factor between 10 – 20, dependent on the type of the waste. In some cases, such as waste containing plastics only give a volume reduction of approximately 45%.

Fig. 3. Compactor (50 kN)

Decontamination techniques are used at CRWMF as a waste minimization method, by reducing the contamination to levels acceptable for disposal as non-radioactive waste. Decontamination also minimizes personnel exposure during subsequent waste handling and treatment operations, to transfer waste to lower category (by contamination), or for product recovery for reuse. Decontamination efficiency of a material is given by the decontamination coefficient K, which is calculated by Equation 1.

$$K = (Ao-Af) / Ao \qquad \text{(Eq. 1)}$$

where Ao - radioactivity of material surface before decontamination, Af - radioactivity of material surface after decontamination.

Processing of liquid radioactive waste:

Approximately 1-3 m^3 /year of liquid radioactive waste received at the CRWMF is from TR-2 Research Reactor, medical applications (clinical measurements) and research laboratories in Turkey. Main radionuclides in the liquid waste include C-14, H-3, Tl-201, I-125, I-131, Tc-99m, Cr-51, Cs-137, Cs-134, Co-60, Ag-110m, Sb-124, Mn-54 and natural uranium. The specific activity of this stored material is not higher than 103 kBq/m^3.

On arrival, liquid radioactive waste is segregated according to their chemical properties and collected in a receiving tank (2000 liters). Then chemical precipitation processes are applied to precipitate the radionuclides from the solution using the batch plant shown in Figure 4. After precipitation, the sludge, containing the bulk of radioactivity is solidified into 200 L drums using cement in an in-drum cementation unit, as shown in Figure 5.

Fig. 4. Liquid Radioactive waste chemical precipitation unit.

Fig 5. In-drum cementation unit.

These 200 L drums, are classified as a Type A package according to the IAEA transport regulations provided that the surface dose rate and the dose rate at one meter does not exceed 2 mSv/h and 0.1mSv/h respectively, as per IAEA transport regulations.

Processing of disused radioactive sources

Disused radioactive sources are generated from research and nuclear applications mainly in medicine, biology, agriculture, quality control in metal processing and construction industries in Turkey. Disused sources are defined as sources that are no longer used and there is no intention of using them again in the practices they were authorized for. Currently the number of disused radioactive sources is increasing every day. The safe management of disused sources in Turkey includes these steps: classification, pre-treatment, conditioning and interim storage [2].

Classification step covers classification and identification of the disused source. Disused sources with half-life lower than 30 years are considered short lived radioactive waste. In addition other criteria is available as a waste (such as;< 4000 bq/m3 for alpha emitters). Mainly sources are segregated into the following groups:

Short-lived is transferred to interim storage for decay until exempted levels for disposal are reached.
Long-lived: conditioned in such a way that the source is made safe and then transferred to a proper interim store while awaiting eventual disposal.

After classification and pre-treatment of spent sealed sources, each disused radioactive source is characterized by using appropriate analytical methods. Following this, the sources are dismantled from their original shield in hot cell and immobilized in concrete/lead shield for long term storage.

Fig. 6. Disused radioactive sources.

Containment of the disused sources is achieved by high integrity encapsulation system. Special lead shielding devices were designed to limit radiation exposure. A 200 l drum was used as a conditioned waste package for the disused sources and represents a Type A package under the IAEA transport regulations [3].

CONCLUSIONS

The wastes are generated from nuclear research and nuclear applications mainly in medicine, biology, agriculture and construction industries in Turkey. CRWMF is the designated and licensed facility for these wastes. The principal aim of treating and processing Low Level Waste (LLW) is reduction of size and potential hazards of the waste according to national and international regulations.

REFERENCES

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