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Volume Reduction of Decommissioning Waste in KAERI

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1. Introduction

KAERI has been conducting decommissioning activities of Korea Research Reactor (KRR) 1 & 2 and a Uranium Conversion Plant (UCP) for the last decade. A large amount of radioactive waste was generated from the decommissioning works of these facilities. Thus, the waste needs to be reduced and stabilized through decontamination or treatment before disposal. In this work, introduction on the volume reduction of dismantled wastes from decommissioning of the KRR 1 & 2 and the UCP is presented.

2. Decommissioning of KRR 1 & 2 and UCP

The first research reactor in Korea, KRR-1, was a Training Research Isotope General Atomic (TRIGA) Mark-II type (open pool and fixed core), and its power was 100 kWth at its construction and it was up-graded to 250 kWth by KAERI. Its construction was started in 1957, and its first criticality was reached in 1962, and it had been operated for 36,000 hours until it was finally shut down in 1995. The second reactor, KRR-2, was a TRIGA Mark-III type with an open pool and a movable core and its power was 2 MWth. Its first criticality was reached in 1972 and it had been operated for 55,000 hours until the decision to decommission it in 1996.

KRR 2 has been dismantled and the reactor hall has been decontaminated and is being used as a waste storage area. Auxiliary facilities have also been dismantled and decontaminated. These facilities include 12 laboratories, 12 hot cells, underground pipe galleries and ventilation systems. In addition to the reactor complexes, there are 10 outbuildings which were associated with reactor operation that will be decontaminated and dismantled. Several of these buildings were used for liquid waste treatment and storage, as well as solid waste storage. All wastes will be recovered from these buildings and processed for storage in a repository. The solar evaporation system will also be decommissioned and dismantled. KRR 2 and associated buildings were completed in the first half of 2009 with a total budget of ₩20 billion KRW. The KRR 1 was preserved as a historical monument with all radioactive materials removed from the reactor pool and reactor hall, the pool water cleaning system replaced and all surface areas decontaminated. In 2009 following a leak of about 13.5 tons of pool water to the environment it was decided to fully decommission the reactor. Decommissioning of the KRR-1 reactor has been taking place from 2011 to 2014 with an estimated budget of 3.3 billion KRW.


Fig. 1 KRR 1 & 2

UCP was used to manufacture 100 tons of UO_2 powder for the Wolsong-1 CANDU reactor, which has been shut down and is minimally maintained for the prevention of contamination by the deterioration of its equipment. The conversion plant has a building area of 2,950 m^2 and two main conversion processes. ADU (Ammonium Di-Uranate) and AUC (Ammonium Uranyl Carbonate) processes are installed, respectively, in the back and front sides of the building. UCP has two lagoons, which is to store all waste generated from the plant operation. Sludge waste is stored in the 150m^3 and 100m^3 lagoons, which were constructed in concrete. In 2000, the decommissioning of the plant was finally decided upon and a decommissioning program was launched to complete by 2010. In the middle of 2004, a decommissioning program obtained the approval of the regulatory body and decommissioning activities started. The Decommissioning work was completed in the first half of 2011 with a total budget of ₩12 billion KRW.


Fig. 2 UCP and lagoon

3. Radioactive Waste from the Decommissioning

All the solid wastes from the decommissioning of KRR 2 were categorized into three groups based on their radioactivity; radioactive, restricted releasable and not-contaminated waste. The radioactive waste, which has a higher radioactivity than 0.4 Bq/g for beta/gamma, was packed into drum. The radioactivity level of the not-contaminated waste is less than MDA, which was calculated as 0.013 Bq/g by considering the detection condition. 1,857 tons of the concrete waste was free released and 330 tons of conditionally releasable waste was stored. The restricted releasable waste will be treated according to a pre-determined route. In the near future, a study on a local disposal or long term storage of this waste will be carried out. 395 tons (1,460 drums of 200L) were classified as radioactive waste, categorizing 40.2 tons of steel waste, 268.9 tons of concrete waste and 85.9 tons of other waste.

Solid wastes from the decommissioning of UCP were categorized into two groups based on their radioactivity; radioactive and restricted releasable waste. Classification criteria of restricted releasable waste are less than 0.2 Bq/g of alpha for steel and 0.04 Bq/g for others. There is a strong emphasis on the decontamination of materials for re-use. The metal waste was decontaminated by a chemical decontamination with ultrasonic for the stainless steel and melting for the carbon steel. The releasable waste was 126 tons. Radioactive waste was generated after completion of the decommissioning as follows: Solid waste was about 10,795 drum of 200L. Most of the waste is soil.

Fig. 3 Radioactive waste from KRR-2 and UCP

4. Volume Reduction of Decommissioning Waste

All the solid wastes from the decommissioning should be sent to a disposal site but an estimated disposal cost is very high. Thersfore, these wastes should be minimized by an additional treatment.

There are lots of non radioactive and releasable wastes in the soil (132 drums) and concrete (794 drums) wastes from the KRR 2 because of insufficient time and budget during the project time. It is expexted that wastes will be reduced by simple sorting. This will be performed with KRR-1 decommissioning work. Metal wastes are 178 drums and a large portions of them was not radioactivated. Metal waste except for radioactivated metal waste could be decontaminated by melting decontamination and could be released. Melting facility is constructing now in KAERI and the throughput is 350kg per batch.

Fig. 4 Melting decontamination equipment

Most solid wastes from the UCP are soil (8,482 drums) and concrete (1,356 drums). Soil waste will be decontaminated by a combined technology of an electrokinetic method and a soil flushing method. It is estimated that the volume of waste could be reduced over 80 % with the soil treatment technology developing by KAERI. Concrete waste will be decontaminated by a volume reduction technology using thermal and mechnical treatment. It is estimated that the volume of waste could be reduced over 60 % with the concrete treatment technology developing by KAERI.

Fig. 5 Soil treatment equipment

Fig. 6 Concrete treatment equipment

The decommissioning wastes will be reduced over 70 vol.% by above volume reduction technologies.