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# Decommissioning of TRIGA Mark-II Type Reactor

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## 1. Introduction

The first research reactor in Korea, KRR-1, is a TRIGA Mark-II type with open pool and fixed core. Its power was 100 kWth at its construction and it was upgraded to 250 kWth. Its construction was started in 1957. The first criticality was reached in 1962 and it had been operated for 36,000 hours. The second reactor, KRR-2, is a TRIGA Mark-III type with open pool and movable core. These reactors were shut down in 1995, and the decision was made to decommission both reactors. The aim of the decommissioning activities is to decommission the KRR-2 reactor and decontaminate the residual building structures and site, and to release them as unrestricted areas. The KRR-1 reactor was decided to be preserve as a historical monument. A project was launched for the decommissioning of these reactors in 1997, and approved by the regulatory body in 2000. A total budget for the project was 20.0 million US dollars. It was anticipated that this project would be completed and the site turned over to KEPCO by 2010.

However, it was discovered that the pool water of the KRR-1 reactor was leaked into the environment in 2009. As a result, preservation of the KRR 1 reactor as a monument had to be reviewed, and it was decided to fully decommission the KRR-1 reactor. Dismantling of the KRR-1 reactor takes place from 2011 to 2014 with a budget of 3.25 million US dollars.

The scope of the work includes licensing of the decommissioning plan change, removal of pool internals including the reactor core, removal of the thermal and thermalizing columns, removal of beam port tubes and the aluminum liner in the reactor tank, removal of the radioactive concrete (the entire concrete structure will not be demolished), sorting the radioactive waste (concrete and soil) and conditioning the radioactive waste for final disposal, and final statuses of the survey and free release of the site and building, and turning over the site to KEPCO.

In this paper, the current status of the TRIGA Mark-II type reactor decommissioning projects was introduced.

## 2. Decommissioning Activities

The side and top views of the TRIGA Mark-II type reactor are shown in Figure 1. The reactor core is placed at the bottom of the 6.25 m high open tank with 2 m diameter. A graphite reflector enclosed in aluminum casing surrounds the core. A 2.5 inch wide annular groove in the upper part of the reflector body is provided to contain a special irradiation facility (rotary specimen rack, RSR). There are four beam tubes to derive a neutron beam with three radial and one tangential direction on the outer face of the core. The two radial and tangential beam port stops at the outer radius of the reflector. The other radial one is running through the graphite reflector. The steel shadow shield, the size of which is 101.6(L) X 101.6(W) X 10.2(t) cm, is into the bio-shield concrete. The graphite thermal column to use a thermal neutron flux is filled with the graphite block (10.2(L) X 10.2(W) X 118(D) cm) into an aluminum container lined with Boral, the size of which is 122(L) X 152(W) X 162(D) cm, located into the bio-shield concrete.

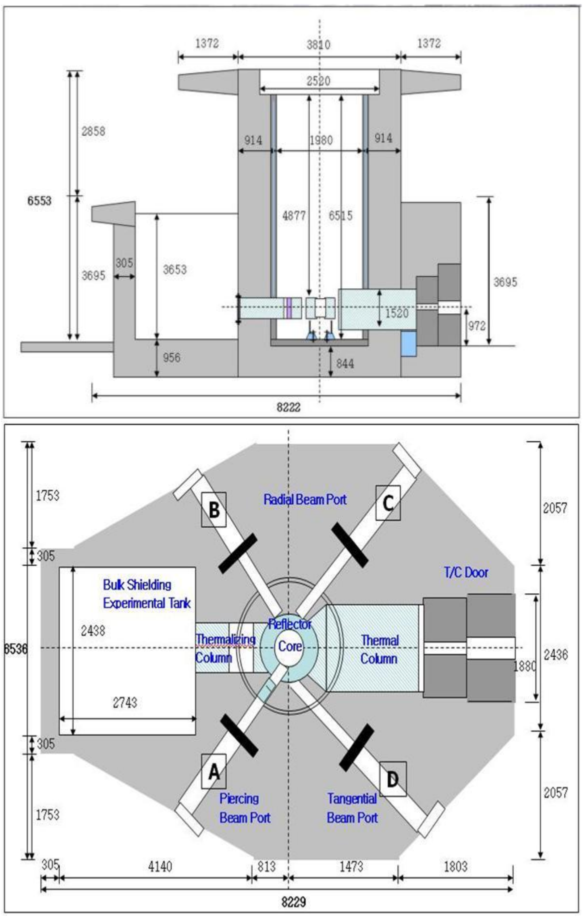


Fig.1 The side and top view of the TRIGA Mark-II type reactor

The reactor is dismantled in order of pipe in the reactor, RSR, thermal and thermalizing columns, beam ports around the core, core assembly, aluminum lining in the reactor tank, beam port tube in the bio-shield concrete, and radioactive bio-shield concrete.

Reactor component removal begins with removal of pipe such as remaining control rod drives and guide tubes. The RSR, inserted into the graphite reflector like a ring, was separated and moved to a bulk-shielding experimental tank (BSET) to dismantle it with a specially developed tool (Figure 2). It is highly radioactive part and the radioactivity is 5 mSv/hr. The special tool for the RSR is operated remotely and installed with two wheel saws to cut inner and outer side of the RSR. When the RSR is moved and dismantled, a lead shielding plate is covered on its upper part. The inner and outer sides of the RSR upper part is cut using a special tool and the stainless steel parts in the RSR such as chain, bearing, and bolt are removed in the water tank. This sequence reduces personnel exposure and allows a more controlled removal process by utilizing the lead and water shielding during component dismantlement.

Fig.2 Dismantling of the RSR

A greenhouse is installed in front of the thermal column door to dismantle the thermal column. The graphite blocks in the thermal and thermalizing columns, are pulled out (Figure 3). And the aluminum container lined with Boral for graphite blocks is cut using a wheel saw operated remotely to reduce personnel exposure. The beam ports consisted of bellows and tube types around the core are sectioned to simplify the dismantling operations of the reactor core assembly. The reactor core is removed and placed into the BSET to dismantle. The top and bottom grids of the reactor core are removed and the inner and outer side of the graphite reflector bottom part is cut to remove graphite block fabricated as one body (Figure 4). The core support is removed from the tank bottom. The upper part aluminum lining in the reactor tank is removed using a grinder manually and the lower part, the height of which is 1.5m from bottom, is removed using a wheel saw operated remotely.

Fig.3 Dismantling of the thermal column

Fig.4 Dismantling of the graphite reflector

Table 1 shows an exposure dose of worker as a dismantling item. Dose of thermal column dismantling is higher than other dismantling items because its working volume is much and it takes longer time. But an average dose per day is lower than the core and reflector dismantling. Consequently, total maximum exposure dose of four dismantling item, the dose of which is 1.36 mSv, is less than a tenth of the standard dose recommend by ICRP (20 mSv/y).

Table 1. Exposure dose of worker as a dismantling item

| Item | Exposure dose [μSv] | Working period [day] | Remark |
|---|---|---|---|
| RSR | 11.0~217.3 | 20 | Remote dismantling |
| Thermal Column | 5.5~643.5 | 25 | Manual dismantling |
| Core and Reflector | 6.6~364.2 | 10 | Manual dismantling |
| Reactor tank lining | 38.8~130.8 | 12 | Manual dismantling |

### 3. Radioactive Waste Management

All solid wastes from the decommissioning of the KRR-1 were categorized into two groups as their radioactivity: a radioactive and releasable waste. The radioactive waste above 0.4 Bq/g for beta/gamma is stabilized and packed into 200 L drum for final disposal. The releasable waste less than 0.4 Bq/g for beta/gamma is packed into a container and released according to a pre-determined procedure after obtaining from regulatory body. The solid waste generated from the KRR-1 dismantling is four 200 L drum and two 4 $M^3$ container. Graphite blocks from the thermal column and the graphite reflector are packed into the 4 $M^3$ container. Metal waste is cut a small piece using a band saw and nibbler to pack into the 200 L drum without void volume.