RADIOACTIVE WASTE, HANDLING, PACKAGING AND DISPOSAL

- DEMONSTRATED BY THE RENEWAL OF A RESEARCH REACTOR -

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ABSTRACT

Between 1985 and 1987 the HMI research reactor in Berlin, was backfitted and modernized. Radioactive waste of approximately $3\cdot10^8$ MBq was treated during the campaign. The mass of waste, approximately 11 Mg was distributed on 21 drums (400 l) and 6 drums (400 l) with concrete shielding as well as 5 cast ion casks. The drums were sent to the interim storage facility Gorleben. The casks will remain at the HMI until the final repository "Konrad" is operational. This report displays the way these wastes were handled and packed up during dismantling as well as storage. The German conception for final disposal of radioactive waste is also referred to.

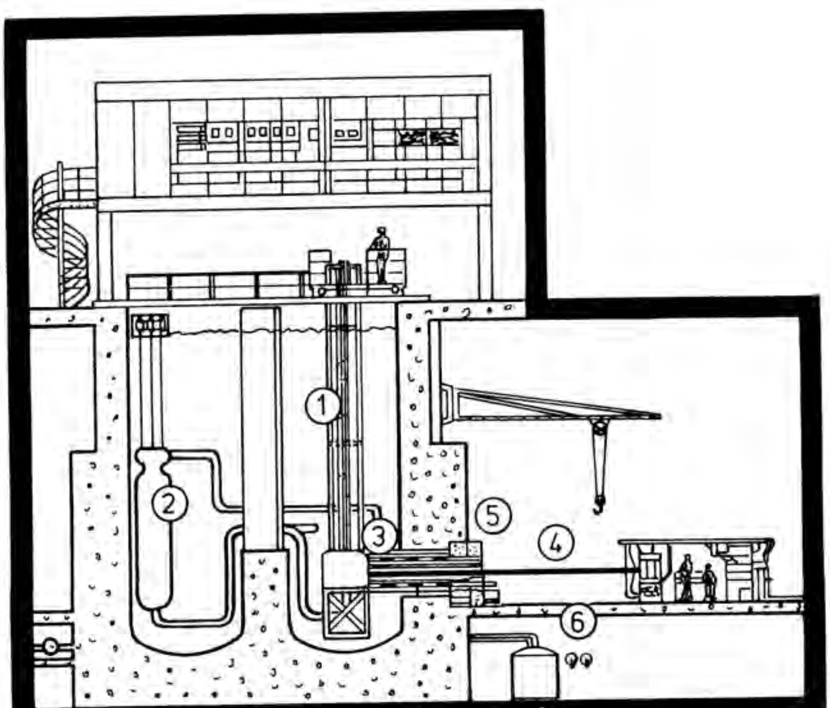

Fig. 1. The Reactor BER II Before Rebuilding.

Problem Statement

The HMI research reactor BER II, a 5-MW-swimming-pool reactor, is being rebuilt at the present. The aim is to increase power from 5 to 10 MW as well as to expand the experimental facilities. Figure 1 shows the reactor before rebuilding. The main components which are no longer in use but packed up as radioactive waste, are marked therein.

The dismantling conception was largely determined by the radiation protection aspects. All radioactive waste from the reactor pool was dismantled under water-shielding and partly also taken apart. In the process, the geometry of the planned waste containers was taken as a measure for the size of section of the waste. According to the package plan the waste was sorted according to activity (e.g. separation of activated high-grade steel pieces from aluminum structure parts). Thus, the radiation dose to personnel, and by adapting the shielding to the waste, the storage volume was optimized.

Fig. 2. Handling of Drums With Lost Concrete Shielding.

Low-Level Radioactive Waste in Drums and Concrete Shieldings

Quantitatively the largest share of low-level radioactive waste was produced during dry removal of the thermal column, a special experimental facility in form of graphite blocks. Figure 2 shows the packing up of the graphite into 400 l drums partly with concrete shielding. During dismantling, shielding and remote control were only necessary when working in the direct vicinity of the reactor.

Further typical components which were activated or not decontaminable include the pieces of the beam tubes leading into the pool. Figures 3 and 4 show the operation of remotely controlled cutting instruments and manipulators under water. Moreover a plasma cutter, an underwater power press and a frame press were used. The device for underwater operation were controlled from a working platform which was situated in the reactor pool (Fig. 5).

The secondary waste generated (paper, gloves, plastics, contaminated metallic pieces, etc.) was either packed up into 400 l drums or into plastic foils and collected in a 20 feet container. This waste was taken over from the GNS for further treatment.

The nonmetallic secondary waste is being high-pressure compacted into pellets. As far as possible the metallic waste is recycled (melting).

Larger amounts of waste such as that from back-fitting of nuclear power plants are conditioned directly at the plant site by way of portable instruments. As an example Fig. 6 shows the mobile high-pressure compactor FAKIR which is used for the production of pellets from loose waste or 180 l drums with radioactive waste.

Fig. 3. Operating of Remotly Controlled Cutting Manipulators.

Fig. 4. Operating of Remotly Controlled Cutting Manipulators.

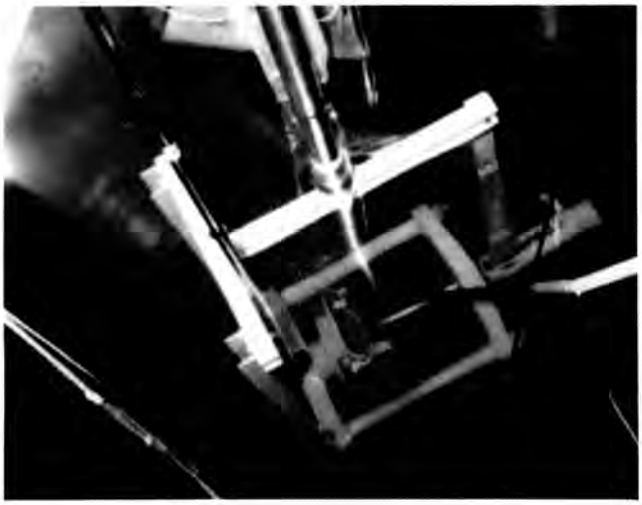

Fig. 5. Operation of the Underwater Press From the Working Platform.

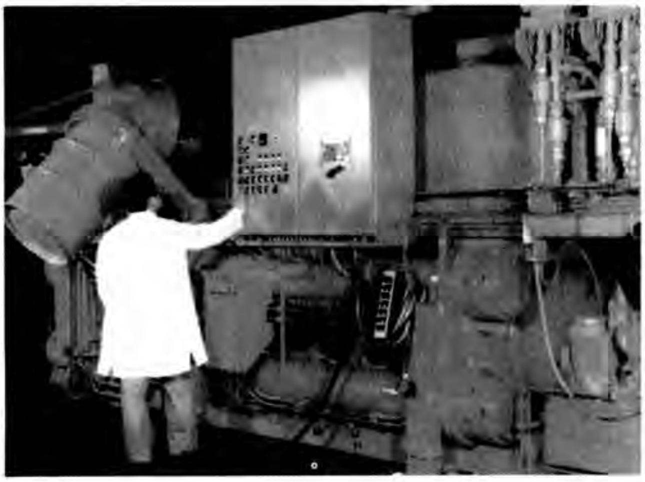

Fig. 6. FAKIR, a Mobile High-Pressure Compactor.

Radioactive Waste in Cast Iron Casks

Reactor pieces located in the direct vicinity of the reactor core with high neutron flux during operation were separated underwater. For underwater packaging of activated pieces with high dose rate MOSAIK cast iron casks were used. After loading, the casks were closed underwater and dried outside the pool afterwards. These are mainly the following parts:

- aluminum shell of the core, graphite and small steel parts
- absorber elements, high-grade steel joint elements
- connection fittings of the thermal column made from graphite and aluminum.

The loading of a cast iron casks in the reactor pool of the BER II is displayed in figs. 7 and 8. Figure 9 shows MOSAIK casks.

Documentation and Storage of the Waste

The conditioning of the BER II waste was done in regard to the existing storage possibilities for radioactive waste in the FRG. Currently, it is possible to store conditioned waste from nuclear facilities at an interim site near the town of Gorleben. A large part of the BER II waste has been brought there in the meantime.

It is planned to use the shut-down mine Konrad as a national final repository, following suitable qualification. The cast iron casks correspond to the presently known specifications for final storage casks for this future final repository Konrad. The radioactive waste in cast iron casks and in drums with lost concrete shielding (VBA), which meet the specification of this future national final repository are expected to be restored in the Konrad mine beginning in 1992. Radioactive waste conditioned in drums must be delivered in containers with standardized dimension filled up with concrete.

For transportation as well as the final storage Konrad the following dose rate limits at the waste packaging are valid:

Fig. 7. Loading of Cast Iron Casks in the Reactor Pool.

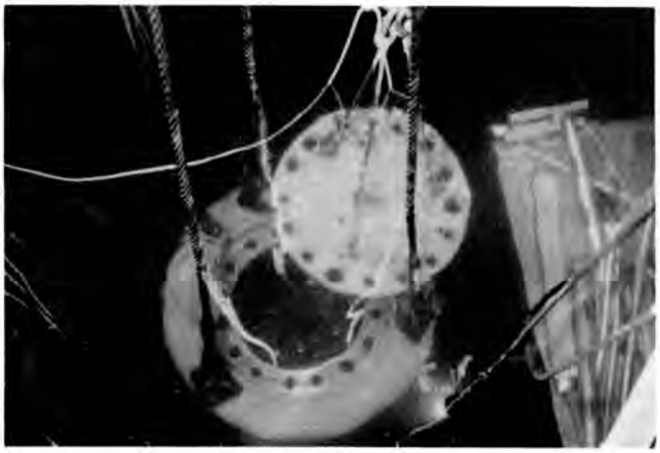

Fig. 8. Loading of Cast Iron Casks in the Reactor Pool.

Fig. 9a. MOSAIK Casks.

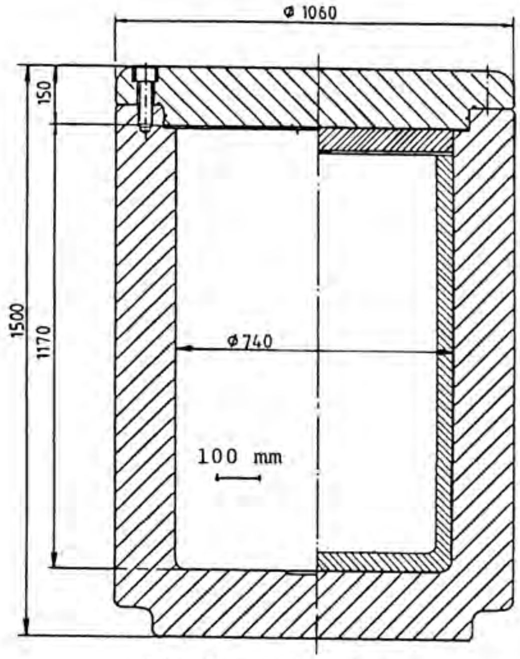

Fig. 9b. MOSAIK Casks.

- 2.0 mSv/h at the surface of all packing
- 0.1 mSv/h at 1 m distance from shieldings
- 0.1 mSv/h at 2 m distance from containers.

The content of every waste container was recorded for documentation. In order to determine the radioactive inventory calculations for all packed materials were made, the results of which yield the nuclide composition. The activity for these nuclide spectra was determined for every waste container from the measured dose rate through a shielding calculation.

Fuel Elements

The MTR-fuel elements used last in the reactor were only partially burnt down and were stored until reprocessing in a special fuel pool (Fig. 10). The quality and temperature of the water and the release of aerosols in continuously monitored.

For dry interim storage and transport of fuel elements from nuclear reactors it is planned to use casks made of cast iron. They guarantee the necessary shielding, cooling and the containment of activity. They are equipped with test connections for functional checks. Casks of this type (CASTOR) meet a international safety standard.

Fig. 10. Storage Pool for Partly Burnt Down Fuel Elements.

SUMMARY

Through rebuilding of a small research reactor it has been demonstrated how radioactive waste can be handled, conditioned and documented. In the process, the most modern dismantling equipment and conditioning methods were used and found useful. This was also confirmed by the authority who supervised the dismantling work. The total dose received by the personnel was only 30 mSv (collective dose of approximately 20 workers of the contractor firms).