

## **DISPOSAL OF THE CONTROL RODS OF THE EXPERIMENTAL AND RESEARCH REACTOR (FMRB) OF PTB, GERMANY**

W. Anspach, DETEC GmbH, D-63754 Alzenau  
Dr. B. Christ, DETEC GmbH, D-63754 Alzenau

### **ABSTRACT**

This paper describes the usual way in Germany for the disposal of radioactive waste based on the example for packaging and conditioning of the control rods of the FMRB. As reference, the disposal of the components at Morsleben final repository (ERAM) is evaluated. At present other solutions for disposal will be studied due to the fact, that acceptance for emplacement in ERAM has been stopped for the time being.

### **INTRODUCTION**

The experimental and research reactor (FMRB) of the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig was definitely shut down in December 1995 after 28 years of operation (Fig. 1). An application according to section 7 (3) German Atomic Energy Act for decommissioning and partial dismantling (1) was filed late in January 1998. It is planned to dispose of the activated and contaminated components of the FMRB as quickly as possible so that the remaining buildings can be used soon for conventional purposes and the radioactive waste produced during dismantling emplaced in an intermediate or final repository (Gorleben intermediate repository facility, final repository for radioactive waste Morsleben – ERAM, Konrad repository, which is not available at present) in the first half of the year 2000. The control rods are among the components which are to be disassembled and conditioned in packages in such a way that they can be disposed of in ERAM. As acceptance for emplacement in the Morsleben repository has been stopped for the time being and as this repository will most likely be closed, the control rods will be so conditioned that they meet the provisional acceptance criteria of the Konrad repository and the conditions for the interim storage at present possible. The statements below which are based on a conditioning of the control rods in compliance with ERAM conditions apply mutatis also to other disposal variants.

The special features of the control rods, procedures of characterization and classification, the choice of containers, dismantling, and packaging will be described below.

### **PROCEDURE FOLLOWED FOR THE DISPOSAL OF THE CONTROL RODS**

#### **Description of the component to be disposed of**

The neutron-absorbing part of the control rods consists of an AgInCd alloy enclosed in a stainless steel sheath. The mass of the absorber material of one rod is approx. 3,0 kg, whereas one control rod including damping piston and damping cylinder is about 7,5 kg in mass (Fig 2). Owing to the differences in the use of the control rods in the two cores of the FMRB and their different irradiation history, the activity inventory of the control rods differs by a factor 4 (approx.  $1,03 \text{ E}+11 \text{ Bq}$  to approx.  $4,24 \text{ E}+11 \text{ Bq}$ ).

#### **Component characterization**

##### *Determination of the activity*

The data available at PTB as regards activity, nuclide composition and contamination were sufficient for reactor operation, not, however, for the formulation of a final concept for packaging, conditioning and transport which would meet all requirements. The activity was, therefore, chiefly determined by calculation, a procedure commonly followed in practice and permissible according to ERAM's emplacement conditions. The nuclide composition of the different materials was

determined through activation calculations; the activities and the activity history were determined by inverse calculation on the basis of the dose rate measurements and the nuclide composition. With a view to ensuring optimized disassembly and packaging, the control rods' activities were, therefore, calculated for sections each 5 cm in length.

#### *Dose rate measurements/dose rate calculations*

These activity and dose rate calculations furnish the data required to combine the results of the dose rate measurements with the activity calculations. A calculation model is established on the basis of the nuclide vectors available from the activation calculations, the geometric boundary conditions and the dose rate measurements. The nuclide-specific activity inventory stated for the control rod sections in the receiving can follows from the nuclide vector and the dose rates.

#### **Disassembly of the control rods and guide tubes**

Absorber and tie rods will be separated above the damping unit. Depending on the packaging and transport concept, the absorber will be cut to appropriate lengths. To prepare the disassembly proper of the absorber, the guide tubes and the tie rods will be separated at the flanged connections.

While the upper parts of the tie rods and guide tubes can be removed from the reactor well, the respective lower parts must first remain under water for radiation protection reasons.

The appropriate lengths of the sections for absorber rod disassembly will be fixed on the basis of the nuclide-specific activities determined by activation calculations and on the basis of the boundary values specified in ERAM's disposal conditions and in the transport regulations. The control rods will be disassembled in situ, under water, in the reactor well. The tool used for this purpose will be a hydraulic chopper (alternative: a compass saw).

#### **Packaging of the control rods**

The control rods must be packaged so that ERAM's conditions and the regulations for the transport of radioactive materials are complied with. For technical reasons on site and during transport it has been planned to package the control rods in drums with suitable shielding.

#### **Conditioning of the control rods**

Disposal of the control rods in ERAM and assignment to radiation protection group S5 require, among other things, that the QM6 quality characteristic be complied with. This can be achieved when the waste is immobilized in concrete or when the radioactive waste itself can be classified as a solid body with a compressive resistance  $>10 \text{ N/mm}^2$ . It is not intended to immobilize the control rods in concrete to prevent the formation of gas due to the hydrolytic decomposition of the aluminum.

#### **Transport concept**

The transport concept is based on the packaging of conditioned 200 l drums with drum container (FC100). The FC100 will be delivered in a 20" container which can take up two FC100. The roof of the 20" container will be removed with the aid of a hoisting sling. The FC100 will be fastened to the yoke equipped with a hook and supplied together with the container; via the hatch (D = about 2,8 m) the FC100 will be transported to the rear reactor hall. The FC100 will be loaded with the aid of the grab provided in the container cover.

### **Alternative Solutions**

As acceptance for emplacement in the Morsleben repository has been stopped for the time being and as this repository will most likely be closed, the control rods might be so conditioned that they meet the provisional acceptance criteria of the Konrad repository and/or the conditions for the Gorleben interim storage. At present, it is to evaluate, whether there is a common solution for packing and conditioning of control rods in order to meet the requirements of each German repository.

### **RESULTS**

It will be shown within the scope of the paper to what extent the theoretical considerations are in agreement with the concepts actually presented for dismantling, packaging, conditioning and transport.

As the dose rate is clearly lower than that of power reactors, work can be carried out without remote handling devices, using bar-mounted tools under water. Work will be done within the framework of the operation authorization granted, under the supervision of the competent authority.

### **DOCUMENTATION**

The operating data of the control rods and the data necessary to carry out the work and qualify the content of waste packages are managed by the DADOR program (2) (Decommissioning And Decontamination Of Research-reactors), which is under development in cooperation between PTB and DETEC. This program takes into account - in addition to the disposal conditions of ERAM - the provisional acceptance criterion of the Konrad repository, including the properties of the substances and their compounds, in compliance with the Ground Water Ordinance, and the conditions of other potential interim stores.

The program automatically compiles the required data and enters them in the respective form. It is a special feature of this program that the waste data can be traced back from the waste package to the former place of installation.

### **LITERATURE**

- (1) W. Hajek "Aktivitäten der Physikalisch-Technischen Bundesanstalt (PTB) auf dem Gebiet der Stilllegung und des Rückbaus des Forschungs- und Meßreaktors Braunschweig (FMRB)", V. Stilllegungskolloquium Hannover, 1997
- (2) S. Niemeyer, W. Hajek "Database for the Decommissioning of Research Reactors", 2nd Workshop EC Database on the Decommissioning of Nuclear Installations, Hannover 1997

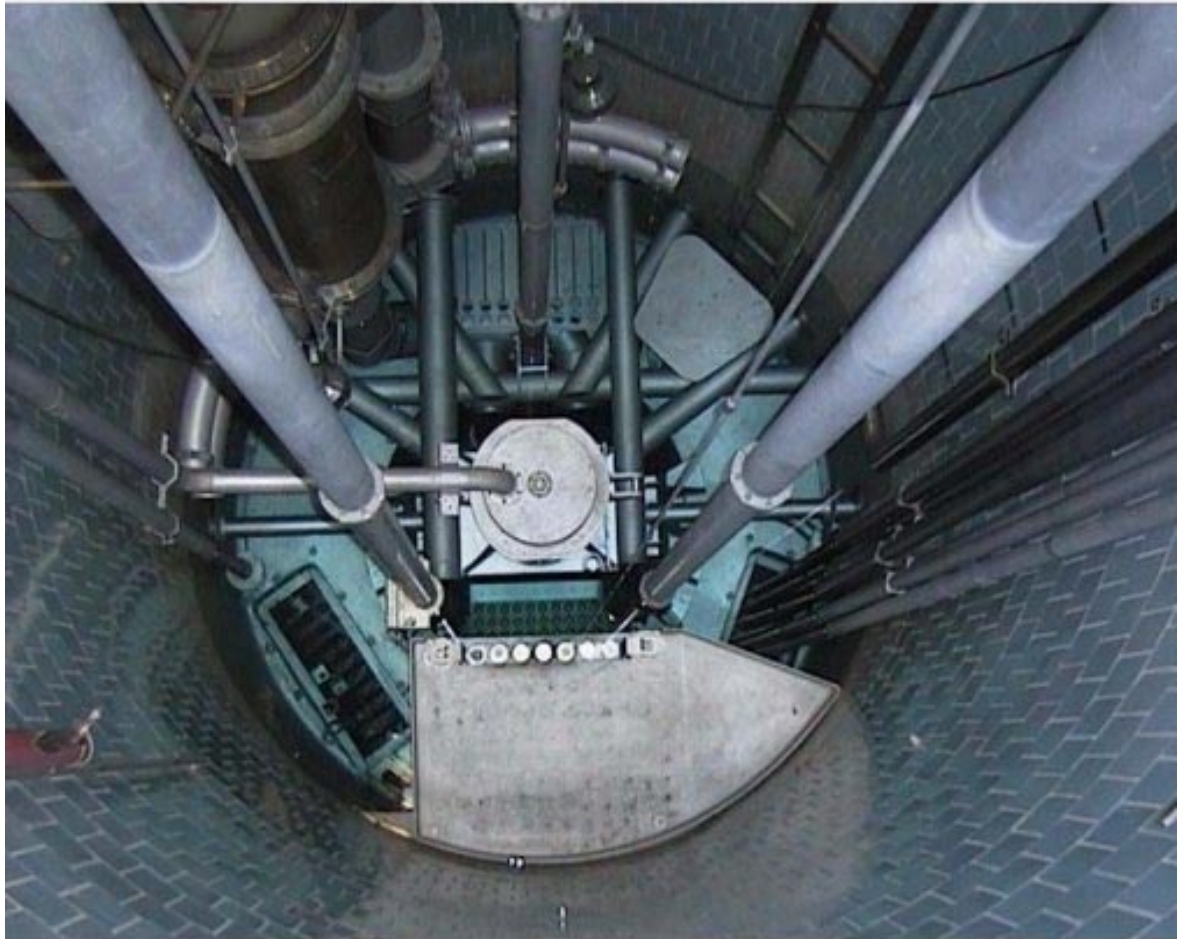


Figure 1: View into the reactor pond



Figure 2: Parts of the control rod