Concepts for the Interim Storage of Spent Fuel Elements from Research Reactors in the Federal Republic of Germany

by

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1. Introduction

Research reactors have been operated in the Federal Republic of Germany since the late fifties. These are Material Test Reactors (MTR) and Training, Research and Isotope Facilities of General Atomic (TRIGA). A total of seven research reactors, i.e. three TRIGA and four MTR facilities were still in operation at the beginning of 1996. Provisions to apply to the back-end of the fuel cycle are required for their continued operation and for already decommissioned plants. This was ensured until the end of the eighties by the reprocessing of spent fuel elements abroad.

In view of impending uncertainties in connection with waste management through reprocessing abroad, the development of a national back-end fuel cycle concept was commissioned by the Federal Minister of Education, Science, Research and Technology in early 1990. Development work was oriented along the lines of the disposal concept for irradiated light-water reactor fuel elements from nuclear power plants. Analagously, the fuel elements from research reactors are to be interim-stored on a long-term basis in adequately designed transport and storage casks and then be directly finally disposed without reprocessing after up to forty years of interim storage.

As a first step in the development of a concept for interim storage, several sites with nuclear infrastructures were examined and assessed with respect to their suitability for interim storage. A reasonably feasible reference concept for storing the research reactor fuel elements in CASTOR MTR 2 transport and storage casks at the Ahaus interim storage facility (BZA) was evaluated and the hot cell facility and AVR store of Forschungszentrum Jülich GmbH (KFA) were proposed as an optional contingency concept for casks that cannot be repaired at Ahaus /1/. Development work was continued with detailed studies on these two conceptual variants /2/ and the results are presented in this paper.

2. Reference Concept for the Storage of Research Reactor Fuel Elements at the Ahaus Interim Storage facility (BZA)

The Ahaus interim storage facility completed by Brennelement-Zwischenlager Ahaus (BZA) GmbH in late 1990 was originally intended for the interim storage of spent light-water reactor fuel elements until reprocessing.

After the abandonment of national reprocessing and termination of the precedence of reprocessing over direct final disposal and in view of commitments to accept reprocessing waste, the interim store is today intended to fulfil a temporal and technical buffer function until direct final disposal of the spent fuel elements from light-water reactors and for other spent fuel elements which cannot be reprocessed for technical and economic reasons.

2.1 Use of the BZA Interim Storage Hall

The BZA interim storage hall has a surface area of approx. 7700 m^2 and comprises two storage areas with the reception and maintenance area located in between. Each storage area is divided into 16 standard and 8 edge segments. The capacity of the hall was first designed for the interim storage of a maximum of 420 LWR fuel element casks of the types CASTOR Ia, IIa and Ic (class 1, $P_{th} > 5$ kW).

For the interim storage of spent fuel elements from the high-temperature reactor (THTR) in CASTOR THTR/AVR transport and storage casks (class 2, $P_{th} \leq 5$ kW) it was possible to fill one standard segment with 64 casks stacked on two levels due to the small dimensions and mass of this type of cask.

For the storage of spent research reactor fuel elements in CASTOR MTR 2 transport and storage casks (class 2, $P_{th} \leq 5$ kW), twenty transport aisles with four setdown areas each can be utilized between the standard segments. The CASTOR MTR 2 casks can be stacked on three levels due to their low overall height and mass. This provides a total storage capacity for 240 CASTOR MTR 2 casks, which is clearly more than the required storage capacity estimated in /1/ up to the year 2010 for the spent fuel elements arising from all research reactor facilities (Fig. 1).

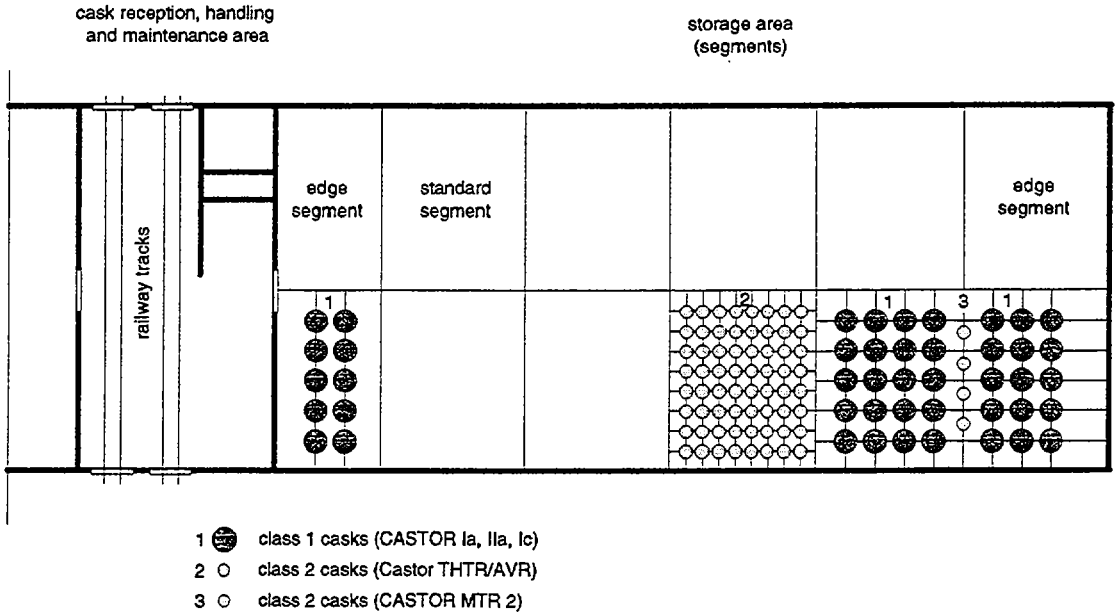

Fig. 1: Simplified ground plan of one storage area of the Ahaus interim storage hall

Licensing under road traffic law of the CASTOR MTR 2 transport and storage cask as a type B (U) package was applied for in December 1993 and the § 6 AtG (Atomic Energy Act) application for the storage of spent research reactor fuel elements in CASTOR MTR 2 casks at BZA was filed in September 1995.

2.2 BZA Safety and Repair Concept

The safety concept for the interim storage of spent fuel elements at BZA is based, in particular, on design requirements for transport and storage casks as a tight enclosure so that any undue release of radionuclides is excluded both in normal operation and under conceivable accident conditions. According to design, the sealing function of both lid barriers is monitored during storage so that any deterioration or failure of a sealing barrier is detected and repair measures for restoring the two-barrier system can be initiated.

Only in the exceptional case /3/ that the functional loss of both sealing barriers is detected and the cask concerned must be opened and emptied for repair can such repair not be carried out at BZA. The incidental conditions of the currently still valid §6 AtG licences therefore contain the demand for removal of a defective cask from BZA and transport to another nuclear facility suitable for repairs. For this reason, the reactor operators are already contractually obliged to retransfer and furnish proof of the transfer to another nuclear facility prior to the shipment of fuel elements /4/.

The aspects of the obligation to retransfer and possible solution approaches are assessed with a view to responsibilities under atomic energy law. Since the incidental provisions of the § 6 AtG notice of approval issued for the Gorleben fuel element store (BLG) in June 1995 no longer contain any requirement to furnish proof of retransfer in the case of repairs, BZA GmbH also expects this regulation for their notice of approval so that the obligation to retransfer in the case of repairs formulated in §4, para. 1a, of the storage contract would become inapplicable.

2.3 Use of the KFA's Hot Cell Facility as a Central Cask Repair Site

In the KFA's hot cell facility, CASTOR THTR/AVR transport and storage casks are currently loaded with canisters containing spent HTR fuel elements (type AVR) and prepared for storage in the AVR store. Both

facilities are part of the KFA's waste treatment and storage building. The installations required for the handling and repair of casks are largely available. Any operating means, adaptation measures and modifications additionally required for research reactor fuel element handling, fuel element support and lifting systems and CASTOR MTR 2 casks can be procured and installed or carried out with reasonable technical expenditure.

Even if it can be expected that the incidental provisions of the BZA licence will no longer contain any requirement to furnish proof of the availability of external repair facilities, a use of the hot cell facility for the exceptional cases described in the BZA repair concept could be maintained as an option. The incorporation of the BZA exceptional repair cases into the KFA repair concept would permit the opening and emptying of MTR 2 casks and would make it possible to avoid such repair measures as the addition of a welded lid at Ahaus.

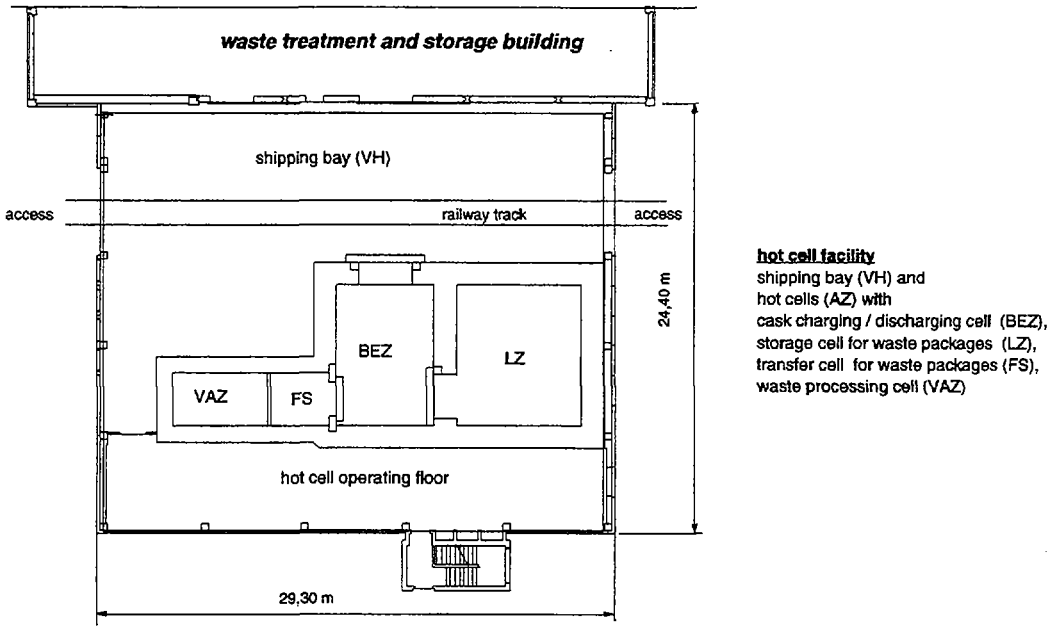

Fig. 2: Simplified ground plan of the hot cell facility as part of the waste treatment and storage building

3. Contingency Concept for the Storage of Research Reactor Fuel Elements in the KFA's Waste Treatment and Storage Building

3.1 Investigation of Alternative Interim Storage Possibilities

In examining and assessing alternative interim storage possibilities it was first checked from the statics aspect whether the available storage areas in the storage hall of the waste treatment and storage building are suitable for the interim storage of CASTOR MTR 2 casks. The result was negative.

Since the CASTOR THTR /AVR casks in the AVR store are alternately stacked on one and two levels and since 56 setdown positions on the second level remain free when the store is completely filled, it was checked again with a view to the permissible floor load whether these setdown positions could be used for the storage of CASTOR MTR 2 casks. This result was positive.

Stacking of the CASTOR MTR 2 casks on three levels causes a floor load approximately comparable to that of the CASTOR THTR/AVR cask stack. The height in the case of stacking the MTR 2 casks on three levels is approx. 5.3 m and thus lower than that of a THTR/AVR double stack of approx. 5.7 m, so that positioning with the existing bridge crane is possible.

In the case of a partial use of the reserve setdown area, which for reasons of store charging and possible repairs is not filled, sufficient storage capacity is available from a technical point of view.
However, complete filling of the second level and filling of the reserve setdown area is not proposed. In that case, the cask monitoring system would have to be modified to comply with the additional number of casks.

Apart from possible regulatory aspects, there are also operational aspects speaking against an extended use of the AVR store for the interim storage of fuel elements from all research reactor facilities.

3.2 Interim Storage of MTR Fuel Elements from the KFA's FRJ-2 Reactor in the AVR Store

According to KFA demand assessments, a maximum of twenty-four CASTOR MTR 2 casks will be needed up to the year 2010 for disposal of the MTR fuel elements from the KFA's FRJ-2 reactor (DIDO). On account of this small number, a use of the AVR store offers itself for the storage of these fuel elements.

The casks could either be set down in free edge positions or on the reserve setdown area in the case of stacking on three levels, involving reasonable extra operating expenditure.

3.3 Interim Storage of the Fuel Elements from all Research Reactor Facilities in an Extended AVR Store

A storage area of 55 setdown positions can be provided by extending the AVR store by two building axes. The setdown area can then be defined and the base statically designed as in the existing store. Should this contingency concept be applied, the storage arrangement of the THTR/AVR casks can be adapted to the constructional modifications to comply with the operation cycles. Moreover, the KFA's own MTR fuel elements can then also be interim-stored there.

4. Conclusions

According to the reference concept, it is intended to temporarily store the fuel elements from German research reactors in CASTOR MTR 2 transport and storage casks in the fuel element interim storage hall at Ahaus. The licensing application according to §6 AtG has been filed by BZA GmbH.

Since the BZA repair concept does not provide for the opening and emptying of casks to restore tight enclosure in the event of a possible loss of the casks' sealing function, the incidental provisions of the §6 AtG licences currently valid for BZA contain the demand for removal of defective casks from BZA and transport to another nuclear facility suitable for repairs. The reactor operators are therefore obliged, in accordance with the currently valid BZA storage contract, to retransfer such casks and to furnish proof of the transfer to another nuclear facility.

The studies deal with the legal aspects of the obligation to retransfer and demonstrate in describing the reference concept that the KFA could assume the function of a central cask repair site. Suitable nuclear installations for handling and repairing CASTOR MTR 2 casks are largely available in the hot cell facility. Installations additionally required for handling the research reactor fuel elements as well as technical modifications to the fuel element baskets of the MTR 2 casks are described in the concept.

The studies for the description of a contingency concept as an alternative to the reference furthermore show that the option for interim storage of the MTR fuel elements from the KFA's FRJ-2 reactor (DIDO) in the existing AVR store is given due to free storage capacity and that the option of an interim storage site as an alternative to Ahaus could be opened up by extending the KFA's AVR store.

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