PREPARATION, LOADING AND STORAGE OF CASTOR THTR/AVR-CASKS FOR SPENT FUEL ELEMENTS - PART OF THE DECOMMISSIONING OF THE HIGH TEMPERATURE REACTOR AVR

R. Theenhaus, St. Halaszovich and S. Storch
Forschungszentrum Jülich GmbH
Jülich, Germany

ABSTRACT

Shipment of spent fuel elements of the AVR reactor to the interim storage site at the Forschungszentrum Jülich KFA has started in August 1993.

The handling procedure involves the preparation of the transport-storage casks, their remote loading with two stainless steel flasks, each of them containing 950 spherical fuel elements, the closing of the casks, the leak testing, the dose rate measurements, smear tests, the transportation and stacking of the casks and finally their connection with the permanent electronic leak control system.

The handling strictly follows the manual which is part of the license and it is inspected by a member of the supervising ministry and an independent expert ordered by the ministry. Until the end of 1993 32,300 fuel elements have been transferred to the storage site.

INTRODUCTION.

The AVR reactor was shut down for decommissioning in late 1988. As part of the decommissioning, about 300,000 spherical graphite fuel elements which have been irradiated during the power operation of the reactor have to be accommodated in transport-storage casks for intermediate storage. A general paper on this item has been presented at WM'90. After the licenses for the storage site and handling have been granted in June 1993 work has begun loading and storing one cask every week. At that time about 100,000 fuel elements were stored in a water pond inside the hot cell facilities HZ (Heiße Zellen) of the KFA, another 100,000 fuel elements in the dry storage AVR-TL (AVR-Trockenlager) inside the hot cells of the waste storage facilities and a 100,000 fuel elements were being located in the reactor core. Since different parties, i.e. the company AVR GmbH and a number of KFA departments, are taking part in the decommissioning activities, it is organized and performed in a project's frame work.

OVERVIEW

The spent AVR-fuel elements have to be stored at KFA until they can be disposed off in a final storage site. For this purpose the AVR-fuel store AVR-BL (AVR-Behälterlager) has been built. It is part of the low level waste storage building and consists of a double gate lock and the storage hall. Until the end of January 1994 20 CASTOR THTR/AVR transport and storage casks have been put into position. At the end of the champaign in 1997 there will be 158 casks in the hall connected with a permanent leak control system.

The CASTOR THTR/AVR casks (Fig. 1) has specially been designed for the transportation and storage of spent graphite fuels from the German prototype gas cooled height temperature reactor THTR 300 and its precursor the AVR reactor at KFA. These elements are graphite spheres with 6 cm diameter containing coated uranium and thorium oxide particles. The spherical elements are enclosed in stainless steel cans. At the Jülich Center these are the so called dry storage cans, TLK (Trockenlagerkanne) each of them containing 950 elements. The TLKs are plugged and sealed with elastomer rings. Additionally they can be welded tight if necessary. The CASTOR THTR/AVR casket is loaded with two TLKs and closed hermetically by the primary and secondary lids (Fig. 2). Long term vacuum tightness is achieved by aluminum gaskets. A protective cap is mounted at the top of the

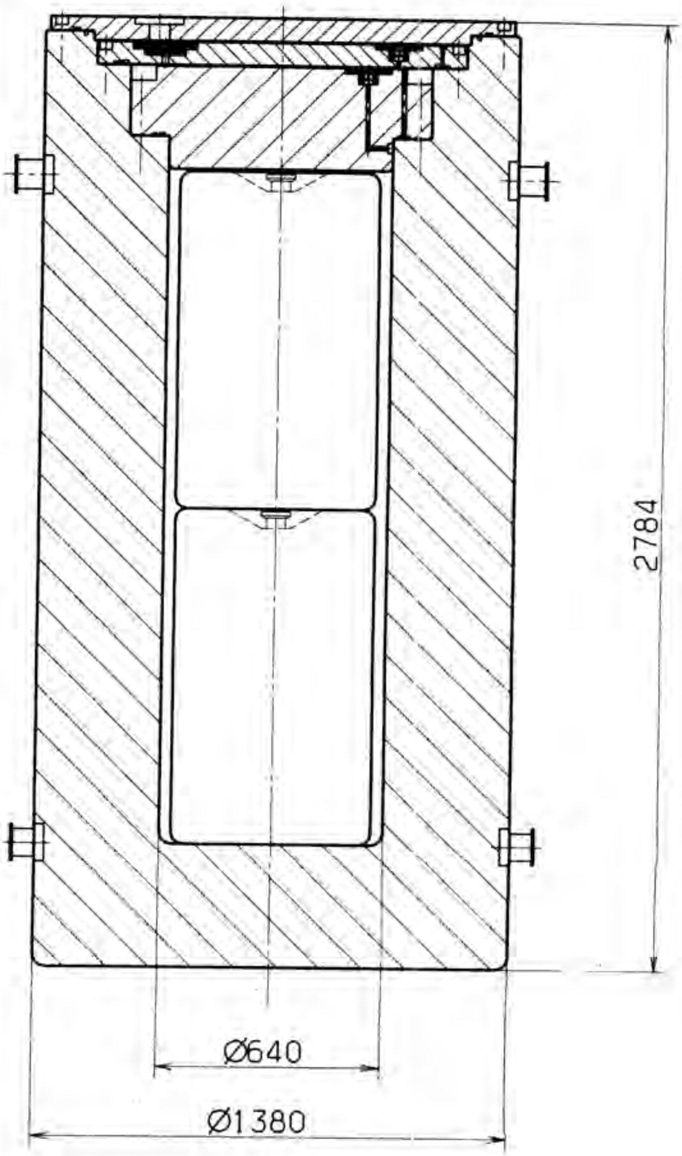

Fig. 1. CASTOR THTR/AVR cask.

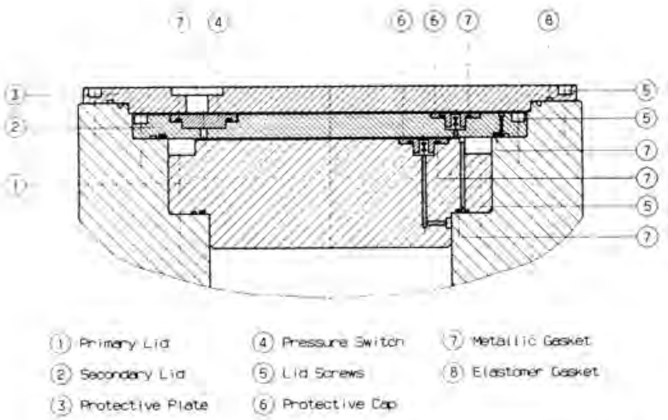

Fig. 2. Sealing system of the CASTOR THTR/AVR.

cask. Less than 10^{-7} mbar liter per second leakage is required by the licensing authority. Between the primary and secondary lids there is an overpressure of 6 bars. Leakage will be indicated by pressure drop and a pressure switch in the secondary lid, which is connected to the leak control system will trigger alarm at 3 bars.

It is essential to keep all contact surfaces in perfect conditions and tighten the screws of the lids uniformly to achieve the required density. Long term integrity of the sealing is ensured by low moisture content in the casks atmosphere minimizing the corrosion.

The well trained crew prepares, loads and shifts one cask into the storage hall in three and a half days. An independent expert designated by the supervising ministry follows the handling. Documentation is largely computerized. Two sets of the documents are kept in separate archives.

CASK PREPARATION AND LOADING

Cask preparation, loading, leak testing and radiological tests are carried out in the hot cell area of the waste storage building. This area is covered by the loading hall, which is equipped with a 50 tons crane. The hall contains an assembly station and the hot cells. These are divided into the AVR-TL, the loading cell BEZ (Be- und Entladezelle) and the working cell BZ (Bearbeitungszelle).

The assembly station is equipped with a 5 tons carne and supports for the lids. One of the supports is swivel-mounted. The BEZ is equipped with a 750 kg crane and a power manipulator, which can handle 800 kg pieces with the gripper and carry 4 tons on a hook. A laser sighting mechanism is fixed on the power manipulator for accurate positioning of the primary lid. In the BZ there is the remote welding apparatus installed.

The BEZ is accessible, after the shielding door on the side towards the loading half has been opened. During the entire procedure the CASTOR THTR/AVR cask remains an a flat-bed trailer in an upright position. A removable scaffold is fixed on the trailer framing the cask. It enables access to the top of the cask.

STEPS OF THE PROCEDURE

The crew leader controls all activities according to a detailed manual. The steps of the procedure are as follows.

- Positioning of the empty cask on the trailer at the assembly station,
- removal of the protective cap and of the lids,
- preparation of the sealing systems (Fig. 1) including visual control, cleaning and if necessary manual rework of all metallic surfaces which contact the gaskets and of the gaskets themselves,
- fixing of the gaskets in the grooves of the lids,
- positioning of the primary lid on the cask,
- opening of the shielding door of the BEZ,
- positioning of the cask in the BEZ,
- removal of the primary lid with the power manipulator,
- inserting three sections of a protective collar on the rim of the cask's shaft,
- filling the shaft with argon.

• The crew leaves the BEZ.
  - Closing of the shielding door.
• The following operations are carried out remotely
  - opening of the shielding door of the neighboring storage cell,
  - transfer of the TLKs into the BEZ,
  - closing of the shielding door of the storage cell,
  - dose rate measurements on the TLKs,
  - weighing of the TLKs,
  - loading of the TLKs into the cask,
  - removal of the protective collars,
  - positioning of the primary lid on the cask.
• With the primary lid in place the radiation level is low enough to allow access to the BEZ
  - opening of the shielding door of the BEZ,
  - measurement of the neutron and gamma dose rate on the cask's surface, smear testing,
  - transfer of the cask to the assembly station,
  - closing the shielding door of BEZ,
  - tightening of the primary lid's screws,
• The screws of both lids are tightened in three runs using an electrically driven twin machine screwdriver. The torque for each run is specified and electronically controlled.
  - Helium leaktesting of the primary lid,
  - installation of the pressure switch in the secondary lid,
  - positioning of the secondary lid on the cask,
  - tightening of the secondary lids screws,
  - helium leak testing of the secondary lid (Fig. 3),
  - helium leak testing of the pressure switch,
  - checking of the switch,
  - pressure built-up between the lids,
  - fixing of the protective cap,
  - fixing of the VACOSS seal on the protective cap,
  - removal of the scaffold,
  - final radiological check,
  - transfer to the storage hall of AVR-BL,
  - passing the double gate lock,

- positioning of the cask with the crane,
- connecting the pressure switch with the leak control system (Fig. 4),
- removal of the trailer and closing the gates.

INSPECTIONS

Essential steps of the above outlined procedure are inspected by the technical expert who is designated by the responsible ministry. The records of these steps are signed by both the crew leader and the expert declaring by this, that the work has been performed correctly. The complete sets of declarations must be proven by the ministry before the cask is allowed to be shipped to the storage hall.

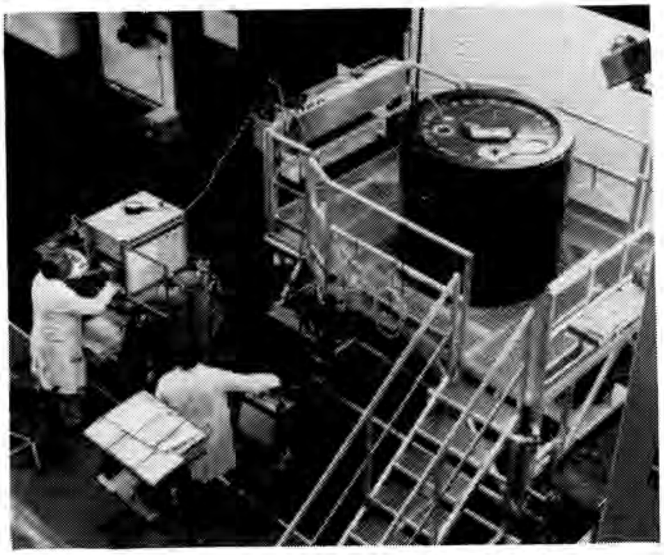

Fig. 3. Assembly station.

Fig. 4. CASTOR THTR/AVR in the storage hall.

The fissile material is under IAEA and EURATOM control. Visual control by TV-cameras in the BEZ, at the assembly station and in the storage hall are part of the safeguard measures. The VACOSS-seal prevents undetected access to the fuel outside of the TV controlled areas.

EXPERIENCE AND OUTLOOK

Extended cold testing of the equipment, training of the crew before starting hot operation and feed back of experience have led to a safe routine handling without accidents.

The mean gamma dose rate has been 1.7 μSv/h with a maximum value of 2.6 μSv/h. The mean neutron dose rate has been 1.1 μSv/h and the maximum valve 1.3 μSv/h.

In consequence of the low radiation level and of the minimized residence time for workers respectively, the dose to men per month is less than 0.1 mSv.

Under these conditions it is expected that the transfer of all 300,000 spent fuel elements to the AVR-BL will be completed in 1997.

REFERENCES

1. R. THEENHAUS, S. STORCH "The AVR High-Temperature Reactor-Operating Experience, Storage and Final Disposal of Spent Fuel Elements", Waste Management '90, Tucson, Arizona, February 25 - March 1, 1990. Vol. 2 p. 681.