THE APPLICATION OF THE CASTOR HAW 20/28 CG AND CASTOR V/19 FOR TRANSPORT AND STORAGE IN GERMANY

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Summary

Since 1993 the interim storage of spent fuel and high-level vitrified residues in transport and storage casks has taken an important part in the fuel cycle in Germany. Up to now, about 400 casks have been stored at the German storage facilities at Ahaus, Gorleben, Greifswald and at the research center in Jülich.

Under the current reprocessing contracts concluded between the German base-load customers and COGEMA the vitrified residues have to be returned to Germany by 2003, i. e. about 2800 high-level waste canisters corresponding to 100 casks. Additional 700 high-level waste canisters will be returned by 2005 under the current reprocessing contracts concluded with BNFL. At present, these residues are transported from COGEMA with the CASTOR HAW 20/28 CG transport and storage cask and stored at Gorleben for at least 40 years.

The Gorleben storage facility started its operation in 1995 and a total of eight large transport and storage casks had been placed into storage by October 1997.

In March 1997, the first three transport and storage casks of the advanced design CASTOR V/19, containing 19 large PWR fuel assemblies each (1300 MW reactors), were also stored at Gorleben. This cask has been designed for higher burnups up to 60 GWd/t, as requested by the German utilities.

Practical experience has been gained during the licensing procedures and in the course of manufacture, handling and loading, transport and storage of the casks. This experience forms the basis for verification of the design calculations with the experimental data as well as for the optimization of future cask designs. Up to now, comparisons show that measured and calculated values are in close agreement.

Based on the CASTOR V/19 design, new cask types have been developed and licensed in Germany, such as the CASTOR V/52 accommodating 52 BWR fuel assemblies including shrouds (1300 MW reactors), the CASTOR V/21 accommodating 21 short PWR fuel assemblies (1300/900 MW reactors), and the CASTOR 440/84 accommodating 84 fuel assemblies (VVER440 MW reactors). The use of these casks is expected in the near future.

THE SHIPMENT TO THE GORLEBEN STORAGE FACILITY

The storage facility Gorleben started its active operation in 1995. A total of eight large transport and storage casks have been placed into storage by October 1997.

In Fig. 1 a view into the Gorleben storage facility is shown.

Fig. 1 - View into the Gorleben storage facility

On the left side one can see three casks loaded with 28 HLW canisters each (one TS28V-cask in the background and two CASTOR HAW 20/28 CG in front of it) can be seen. A total of five casks loaded with irradiated fuel assemblies are shown on the right side. In the background two casks of the older design, the CASTOR Ic with 16 BWR-fuel assemblies and the CASTOR IIa with 9 PWR fuel assemblies are placed. Both casks are developed for short decay times between 9 and 18 months and a moderate burnup up to 40 GWd/t. In front of these two casks, three casks of the type CASTOR V/19 can be seen.

The first two casks (CASTOR IIa in 1995 and TS 28 V in 1996) were brought to the storage facility in two single transports. The transports were disturbed by peaceful and radical demonstrators. Therefore, it was only possible to perfom the transport with extensive security measures.

The third storage campaign was performed as a convoy transport consisting of six casks coming from three different locations. Two CASTOR HAW 20/28 CG casks coming from La Hague/France, one CASTOR Ic from the German nuclear power plant Gundremmingen, and three CASTOR V/19's from the power plant Neckar, were combined into a convoy and were transported by rail to a transfer station in Dannenberg-Ost, located near the storage facility. There, the casks were transferred from the railroad waggon to a heavy-load truck, on which the casks were transported over a distance of approx. 20 km to the Gorleben storage facility. Fig. 2 shows a diagramme of the transport sequence.

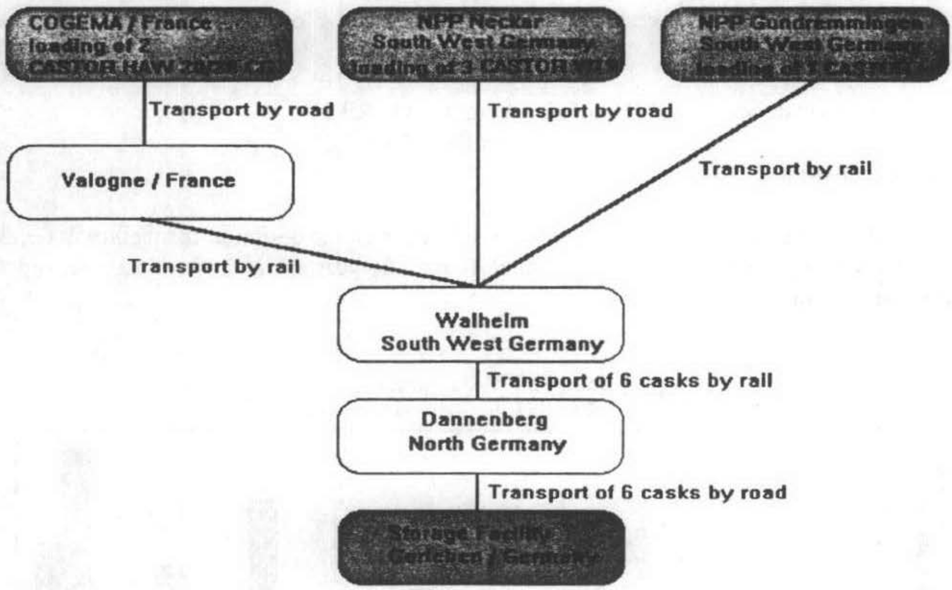

Fig. 2 - Transport of 6 casks to the storage facility

INVENTORY DATA OF THE STORED CASKS

The inventories of the stored casks are characterized by the total heat load of the casks and the measured average dose rate at the surface. In the following Fig. 3 the heat load of the casks is compared with the admissible values of each cask type. The highest level of utilization for the heat load is currently about 70-78 % of the total capacity for the HAW casks.

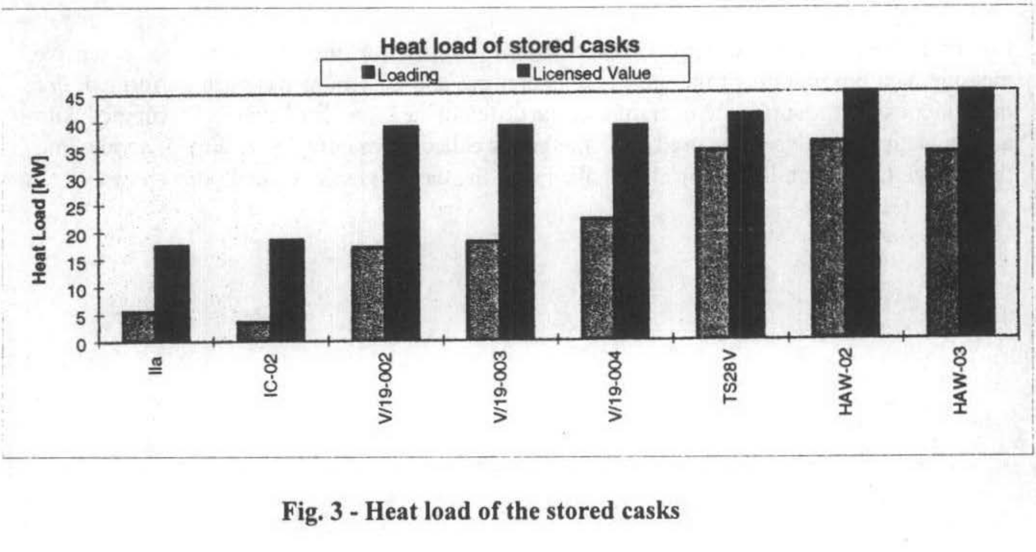

Fig. 3 - Heat load of the stored casks

For storage at a German storage facility, the following average dose rate limits at the surface are to be respected:

- neutron dose rate < 150 μSv/h according to ICRP 21
  < 250 μSv/h according to ICRP 60
- gamma dose rate < 100 μSv/h

The definition of these limits is site-specific and depends on the design of the facility in terms of shielding and capacity and the allowable dose rate per year at the fence of the site. Fig 4 shows the dose rates of the stored casks.

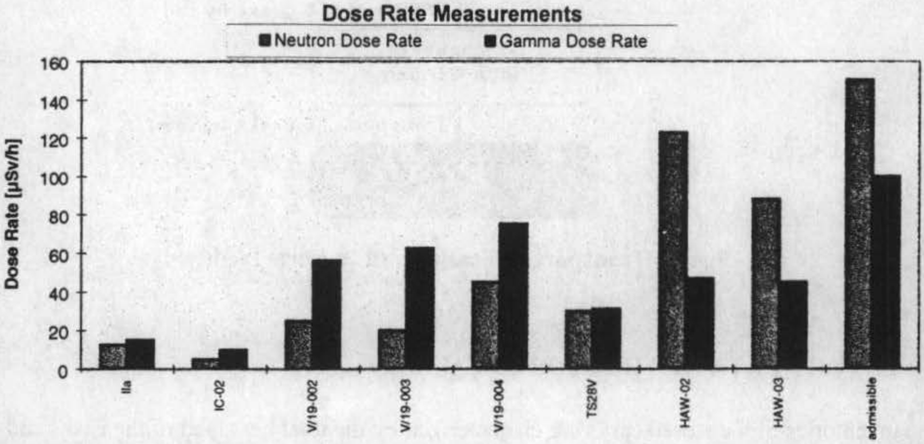

Fig. 4 - Dose rates of the stored casks

MEASUREMENTS OF THE SURFACE TEMPERATURES

For each type of cask which is stored at the facility for the first time, an extensive measurement programme of the outside temperatures and dose rates has been performed. For measurement of the surface temperature of the different casks, a visual method combined with a computational analysis was used. This method is called thermography. In Fig. 5, a view into the storage facility similar to Fig. 1 but taken with the thermographical method is shown.

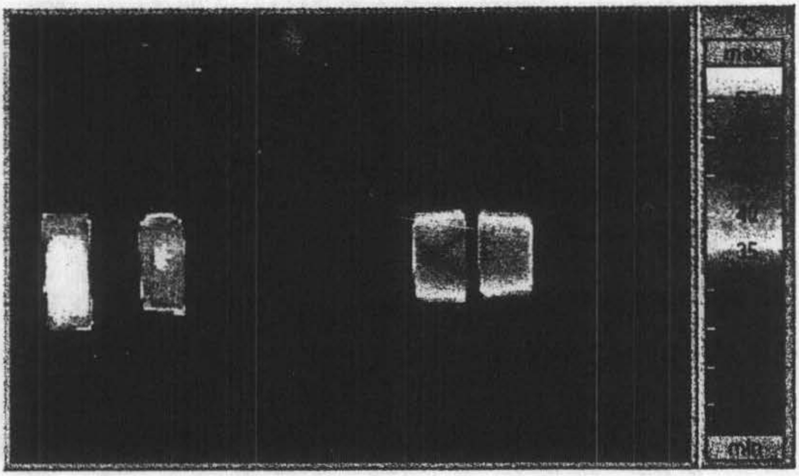

Fig. 5 - Thermographical view into the storage facility

For more details a closer look was taken at two CASTOR V/19 casks, which are standing on their storage positions close beside each other. The temperature distribution at the surface of both casks is shown in Fig. 6.

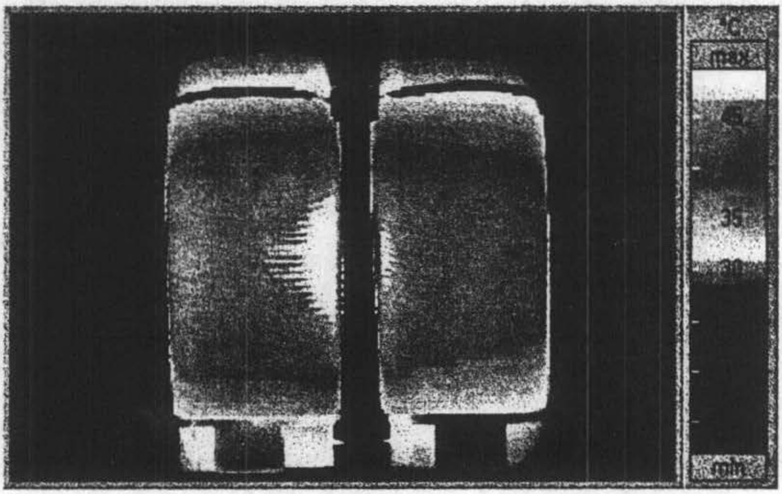

Fig. 6 - Thermographical view on two CASTOR V/19

The maximum temperature of about 50 °C at the mid-height of the cylindrical surface of the finned cask occured at that part where both casks are close together. This temperature is about 8 to 10 K higher, as at the opposite side where no other cask is stored. This so-called storage effect is very important to be considered, because it leads to the maximum storage temperature which is to be taken into account for the design. The temperature increase results from a reduced efficiency of the radiation heat transfer to the environment. This means that a storage cask has to be optimized for a high heat transfer by natural convection. Therefore most of the storage casks are finned.

In Fig. 7 the temperature distribution of a single CASTOR HAW 20/28 CG is shown.

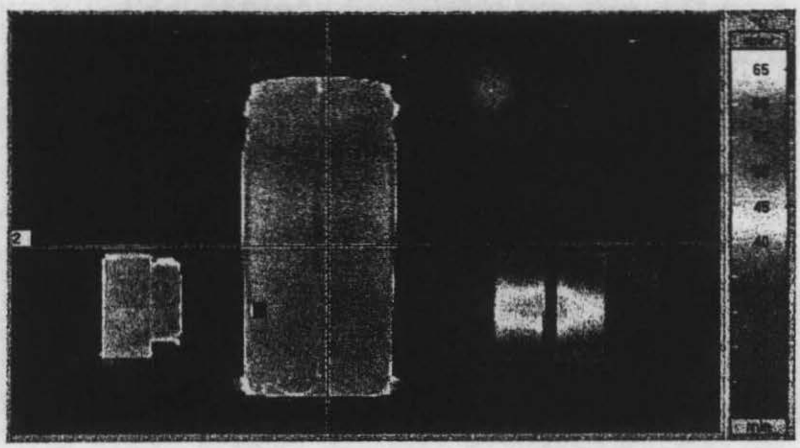

Fig. 7 - Thermographical view on a single CASTOR HAW 20/28 CG

The maximum temperature of 65 °C is slightly higher than that of the CASTOR V/19 because of the higher heat load of the cask. The temperature at the cylindrical part of the surface is much more homogenous with the HLW canisters as can be observed on casks loaded with fuel assemblies.

A comparison between measurement and calculated values shows that the measured values are slightly below the calculated ones.