EXPERIENCE OF HOT CELL OPERATION IN COMPARISON WITH UNDER WATER TREATMENT OF CORE COMPONENTS

R. Finkbeiner, G. Gestermann

GNS Gesellschaft für Nuklear-Service mbH,
Hollestr. 7 A, D- 45127 Essen, Germany

Abstract

A small amount of waste generated in nuclear power plants is produced in the reactor core as the near-core area through the activation of metallic parts by neutron flux.

These items often remain in the reactor core for many cycles, and must be replaced if their mechanical function or technical application is no longer guaranteed. Typical core components are

- Fuel assembly channels and channel attachments from BWR's
- Control assemblies from BWR's and PWR's

This waste normally is stored inside the reactor pool and the conditioning and treatment is performed with under water tools and different cutting equipment. GNS has complete modern equipment available to treat all the waste under water and has made more than 20 years of experience in more than 20 nuclear power plants.

In order to eliminate difficulties (e.g. long term blocking of the fuel element storage pool) GNS started in 1991 developing a system for treating activated core components outside the reactor pool.

This system consists of:

- a transport system with 6 Type B (U) containers

and

- a hot cell equipped with the necessary tools.

Since 1997 the facility is in operation with good results.

Transportation System

The most important step in using a hot cell for treatment of activated core components is a transport system.

In 1991 GNS began with the design and construction of a transportation and storage cask "MOSAIK 80T". The construction principle is very close to well established MOSAIK casks, but takes the dimensions of the core components and the different shielding requirements into consideration. In Fig. 1 a drawing of the MOSAIK 80 T is shown. At the moment GNS owns six of these MOSAIK 80 T casks which are equipped with baskets to load 66 fuel assembly channels. With pay-load the weight of the cask is approx. 80 Mg.

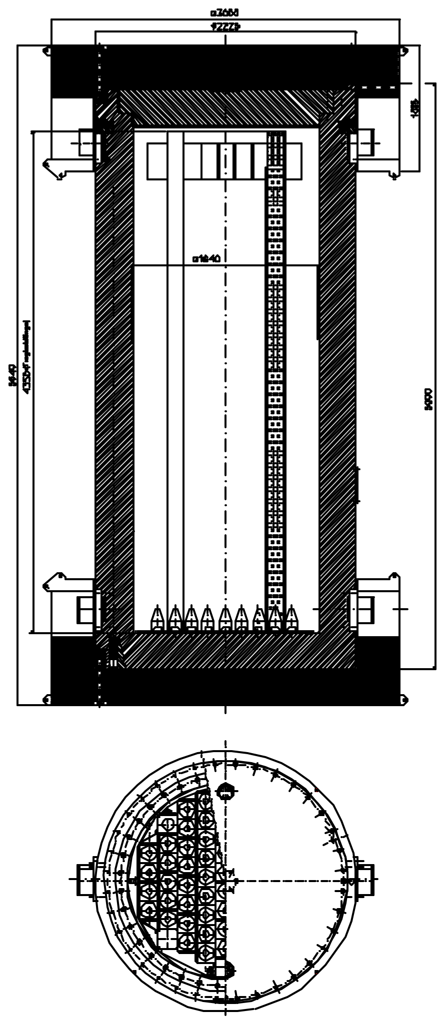

Fig. 1 MOSAIK 80 T with basket for 66 fuel assembly channels

The casks are licensed as a Type B(U) package for transportation and can be used for dry storage of uncut or pre-cut parts. During transportation the casks are equipped with shock absorbers.

At the end of 1992 the first 3 casks were loaded and placed into on-site storage at a power plant.

Hot cell design

The hot cell is built in a formally used storage building with large shielding walls on the site of the research centre in Karlsruhe. Due to this, the designers had to follow the existing constructions, buildings and transportation ways.

The actual design of the hot cell is shown in Fig. 2.

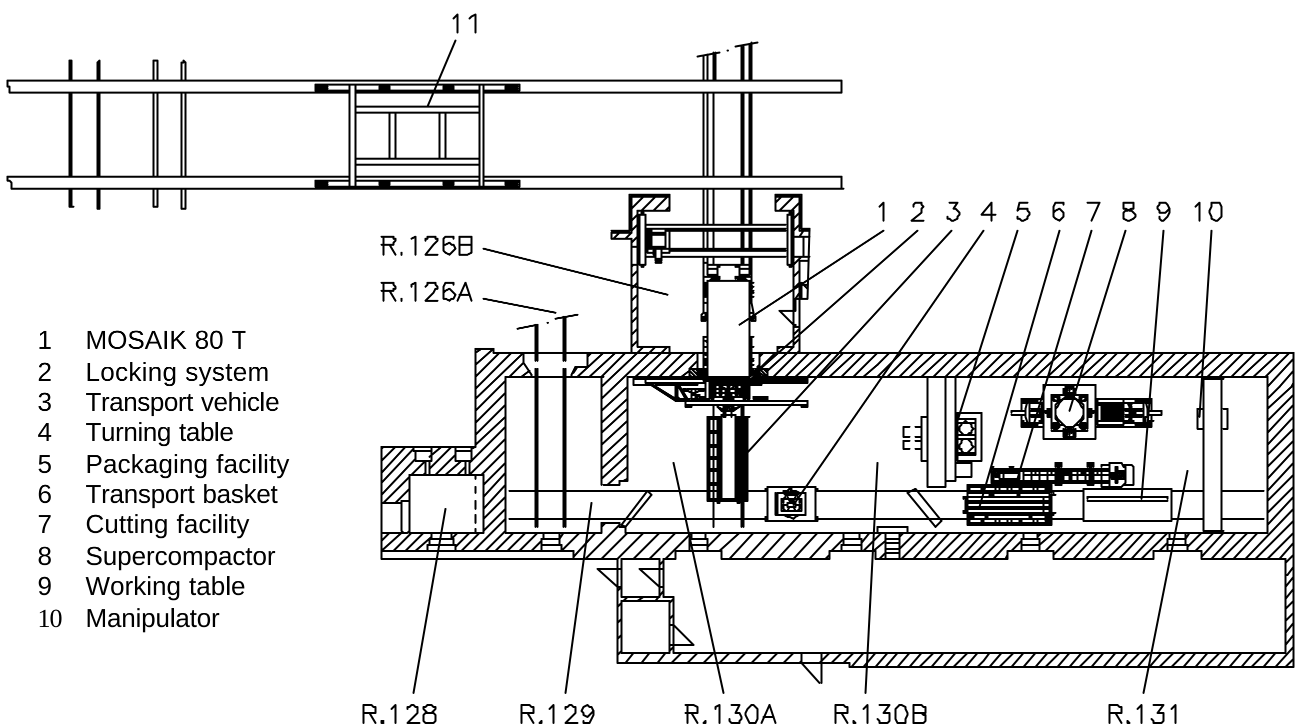

Fig. 2 Top view of the hot cell

To unload the activated core components out of the MOSAIK 80 T cask into the cell, a docking system was built. The transportation cask is docked in a horizontal position and a remote controlled lid removing system takes the shielding lid into a parking position.

With a manipulator in a next step the whole basket with content is pulled on a vehicle into the loading area of the cell. On this vehicle the basket can be turned and transported to the treatment area.

Equipment in the hot cell

The main tool inside the cell is a heavy power manipulator. With this manipulator all transports and movements of waste or tool can be done. In the same way, repairs or equipment change can be performed. To cut the activated components, there is a shear installed which is able to cut automatically.

An other important tool is the hot cell in a supercompactor with a force of 2000 Mg. With this the volume of the waste can be reduced by a factor 2-3. This supercompacted waste is normally packed into shielding containers. To get a good adaptation to the inner diameter of container, there are three different compacting chambers with the most commonly needed diameters available.

Other tools such as saws or thermal cutting equipment is available.

Experience of under water treatment

For the treatment of activated core components under water, GNS has more then twenty years experience and all the equipment that is necessary to carry out this treatment available. The main units for the under water conditioning are:

- Universal hydraulic shears (UHS)
  for cutting of rod-shaped core components with small amounts of crud and no gas release during cutting

- Underwater cutting unit (UWS)
  for cutting of absorber elements and instrumentation lances with gas release

- Fuel channel cutting facility (BZ)
  for pre-pressing and cutting of BWR fuel channels

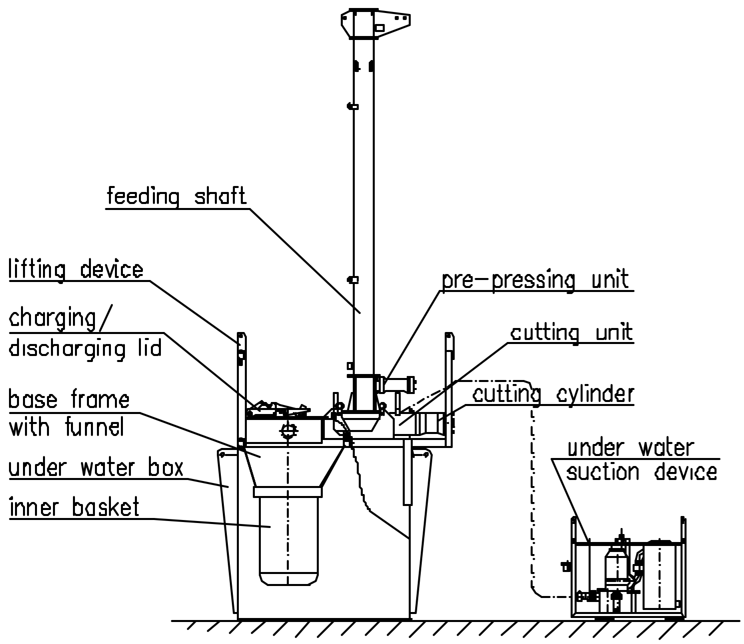

Fig. 3 Fuel channel cutting facility (BZ)

To compare the underwater cutting with the hot cell treatment only the conditioning of the BWR fuel channels are taken into consideration.

Till 1999 GNS has treated in total 2880 fuel assembly channels under water in six German BWR power plants. Most of them are cut with the BZ-facility.

The cut parts are loaded under water into cast iron casks of the type MOSAIK VI with an additional inner lead shielding between 2 and 7 cm. In total 307 casks have been filled. This means the average loading of a cask is 9.4 fuel channels.

In practice fuel channel attachments are packed in addition by hand into some casks to optimise the loading factor.

Experience with the hot cell operation and the existing transportation system

1992, the first at 3 MOSAIK 80 T casks were loaded with a total of 198 fuel channels and stored onsite the power plant. The loading procedure can be compared with the loading of spent fuel casks. The loading and preparation of the casks for storage and transportation, inclusive drying of the casks content, takes approx. 1 week.

The storage and the subsequent transportation of the casks after 7 years of storage does not create any problems.

The locking and reloading procedure of the casks with the remote control equipment works safety and quickly.

The pre-compaction and cutting of the fuel channels is done in the automatic operating cutting facility with an cutting length of 5 cm. The cut parts are loaded by conveyor belt into an 180 l drum. This drum is finally supercompacted by a compactor with 2000 Mp of force.

During the first time of conditioning fuel channels in this way it was found, that the volume reduction was not as good as we expected. After installing a vibration unit under the drum and running it during loading some times, the volume reduction became much better.

Till now 12 MOSAIK 80 T casks loaded with fuel element channels have been transported to the hot cell. This means in total 792 channels have been cut and supercompacted inside the cell. With the supercompacted pellets, a total of 43 shielding containers (MOSAIK VI) with an inner lead shielding layer of 2 or 4 cm have been loaded.

This corresponds an average loading of 18.4 fuel channels per container.

In practise the loading with using the vibrator was much better and it is possible to load up to 22 fuel channels into one container.

Conclusions

Both ways of conditioning activated core components either the under water treatment or the hot cell cutting with additional supercompaction can be used without technical problems.

The main advantage of the hot cell treatment is the safe and very quick stay of equipment and personnel at the fuel storage pool inside the power plant and the excellent volume reduction of the waste product. Beside this, the radiation exposure of the involved personnel is clearly lower.

To make a decision about which is the most effective way, all the circumstances inside the nuclear power plant and the possibilities of interim and final storage of the waste products have to be taken into consideration.