Remote Dismantling and Packaging of the RPV and Thermal Shield at the Obrigheim NPP – 16073

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ABSTRACT

The Obrigheim Nuclear Power Plant (KWO) is located in the Federal State of Baden-Württemberg in Germany and was operated by the EnKK-KWO. The Nuclear Power Plant – a light water pressurized water reactor with 357 MW of electrical power – was operated from 1968 to 2005. In June 2009 the Energiewerke Nord GmbH (EWN) was charged with the dismantling planning and dismantling of the reactor.

According to the German nuclear and radiation protection law, several licenses will be required for the realisation of this task. This also applies to the disposal of the waste produced by dismantling, which must finally be stored in the German final repository for low and medium-radioactive waste (underground repository "Konrad").

In spring 2010 EWN completed all application documents for the dismantling of the reactor pressure vessel (RPV) and the RPV internals and EnKK-KWO delivered them to the responsible Environmental Ministry of Baden-Württemberg. Since then it has been worked intensively on the design, construction and manufacturing of the facilities for dismantling. With a separate notification of amendment, it was applied for the license to install and commission the facilities for the dismantling of the RPV and the RPV internals at the Environmental Ministry of Baden-Württemberg in October 2010. This notification of amendment was confirmed in summer 2012.
In September 2011 the work process and test plan and the technical information about the campaign for the removal of the radioactive waste resulting from the RPV with internals, peripheral components and secondary waste with the aim of final disposal in the Federal Repository "Konrad" was submitted to the Federal Office for Radiation Protection. The evaluation and assessment of the work process and test plan was concluded in August 2013, when it was audited by TÜV Nord EnSys without any further measures and indications. On September 10 the work process and test plan was released by the Federal Office for radiation protection.

The dismantling of the RPV internals upper core and lower core structure started in September 2013 in the wet cutting area in room 01.106/306 and were finished in October 2014.

In the presentation "Dismantling of the Obrigheim NPP Reactor and Waste Management" held on the WM Symposia in Phoenix, 2014, an overview about the remote cutting and packaging of the upper and lower core structure was given. In today's presentation the subsequent dismantling activities will be outlined and evaluated.

The presentation will start with the short description of the basic frame conditions for the nuclear licensing procedure, important procedural principles, and necessary plant-specific conditions.
After the remote cutting and packing of the reactor internals of the upper and lower core structure was completed, the wet cutting area "reactor room 01.106/306" was cleaned and the reactor room rebuilt into a cutting area for peripheral components. After the peripheral components were dismantled, all preconditions were set to lift the RPV from its mounting position and to arrange it in the upper reactor room 01.306.

After these activities were completed, the lifting of the RPV was prepared and the cutting area "Dismantling of the RPV insulation in the reactor room 01.106/306" was set up. To carry out this task, a strand jack unit with connection block was installed on the bridge of the reactor building crane. The opening created by the dismantling of the pool plate was closed with a flap door. The manipulators used for the wet cutting of the RPV internals were also used for the remote dismantling of the RPV insulation and mounted in the cutting area. The remote facilities were handled from a control centre and/or control stand.

The air-technical housing which has already been used for the remote dismantling of the RPV internals was designed for the dismantling of the RPV insulation and was extended for this dismantling scope with appropriate ventilation systems.

A special feature is the fixation of the RPV insulation at the RPV corpus. The RPV insulation consists of insulation wool, wire mesh and metal-sheet insulation. This "Sandwich Construction" is detached with a steel corset at the RPV corpus and partly tightened. The insulation of the RPV bottom dome is tightened at the supporting frame. Due to the activation of the material in the core area and the resulting high ambient dose rate the RPV insulation can only be dismantled remotely. Additionally, as asbestos fibers are expected to be found in the insulation the dismantling has to be performed according to the Technical Rules for hazardous substances.

The demolition, restoration or maintenance works have to be performed remotely according to the Technical Rules for hazardous substances when the RPV is located in the cutting area. But in case of dismantling of a power reactor no such experience can be found.

Beginning with the explanation of the technical, radiological and substantial boundary conditions this presentation will not only impart knowledge about the dismantling of the RPV insulation but also about the remote controlled packaging of the metal sheet insulation and the manual conditioning of the RPV insulation. Subsequently, reports on the remotely controlled cutting and packaging of the RDB are given. Here is particularly interesting that cutting methods have been used and how the activity determination of the segments was carried out.

On the basis of the evaluation of the realisation the subsequent dismantling activities will be lined out.

In parallel to the dismantling tasks, the waste package documentation for the final repository was issued, checked and confirmed for the containers loaded with parts of the RDB internals. The most important stages are exemplified in this presentation.

INTRODUCTION

The Obrigheim Nuclear Power Plant (KWO) is located in the Federal State of Baden-Württemberg in Germany and was operated by the EnKK-KWO. The Nuclear Power Plant – a light water pressurized water reactor – was operated from 1968 on. In the last stage of completion the reactor had 357 MW of electrical power. As one of the first pressurized water reactors in Germany, during the operation phase of 37 years more than 86800 GWh electrical power had been supplied. In June 2005 the NPP was shut down finally and is being dismantled at the moment.

In June 2009 the Energiewerke Nord GmbH (EWN) was charged with the dismantling planning and dismantling of the reactor. This also comprises the documentation and to the disposal of the waste produced by dismantling, which must finally be stored in the German final repository for low and medium-radioactive waste (underground repository Konrad).

From September 2013 till October 2014 the most activated RPV internals upper core and lower core structure were dismantled in the wet cutting area and afterwards packed into casks. The subsequent dismantling of the peripheral components as precondition for the lifting of the RPV from its mounting position has been finished till the end of March 2015. In April 2015 the RPV has been lifted with a strand jack unit to the dry cutting area above the reactor pit. The RPV Insulation has been remotely removed and packed until July 2015 according to the Technical Rules for hazardous substances within an air-technical housing.

TRANSPORT OF THE RPV TO THE WET CUTTING AREA ROOM 01.202

For the further remote segmentation and packing of the RPV it was necessary to transport the RPV from its mounting position to the wet cutting area "Spent fuel element storage pond" (room 01.202) (see Fig. 1). The RPV has been transported with the strand jack unit with connection block which has already been used during the removal of the RPV insulation.

Preparatory Works

With the clearance of the asbestos removal area at the reactor pool and the reactor cavity the air-technical housings in the rooms surrounding the RPV could be removed. In parallel the wet cutting area "Spent fuel element storage pond" had been prepared for the dismantling of the RPV and the Thermal Shield. Therefore inter alia the packing manipulator, the device carrier system, the turntable with fixing elements, the water cleaning facility, the camera control system and the thermal cutting devices for the subsequent cutting of the RPV have been mounted (see Fig. 2). Following the equipment had been commissioned and tested with complex functional tests.

With the reactor building crane at Obrigheim NPP a maximum load of 100 Mg can be lifted. Due to this reason a strand jack unit with connection block was installed on the bridge of the reactor building crane (see Fig. 3). Right before the transport the strand jack unit with connection block was positioned centric above the RPV whilst the crane trolley was positioned on the edge of the crane bridge.

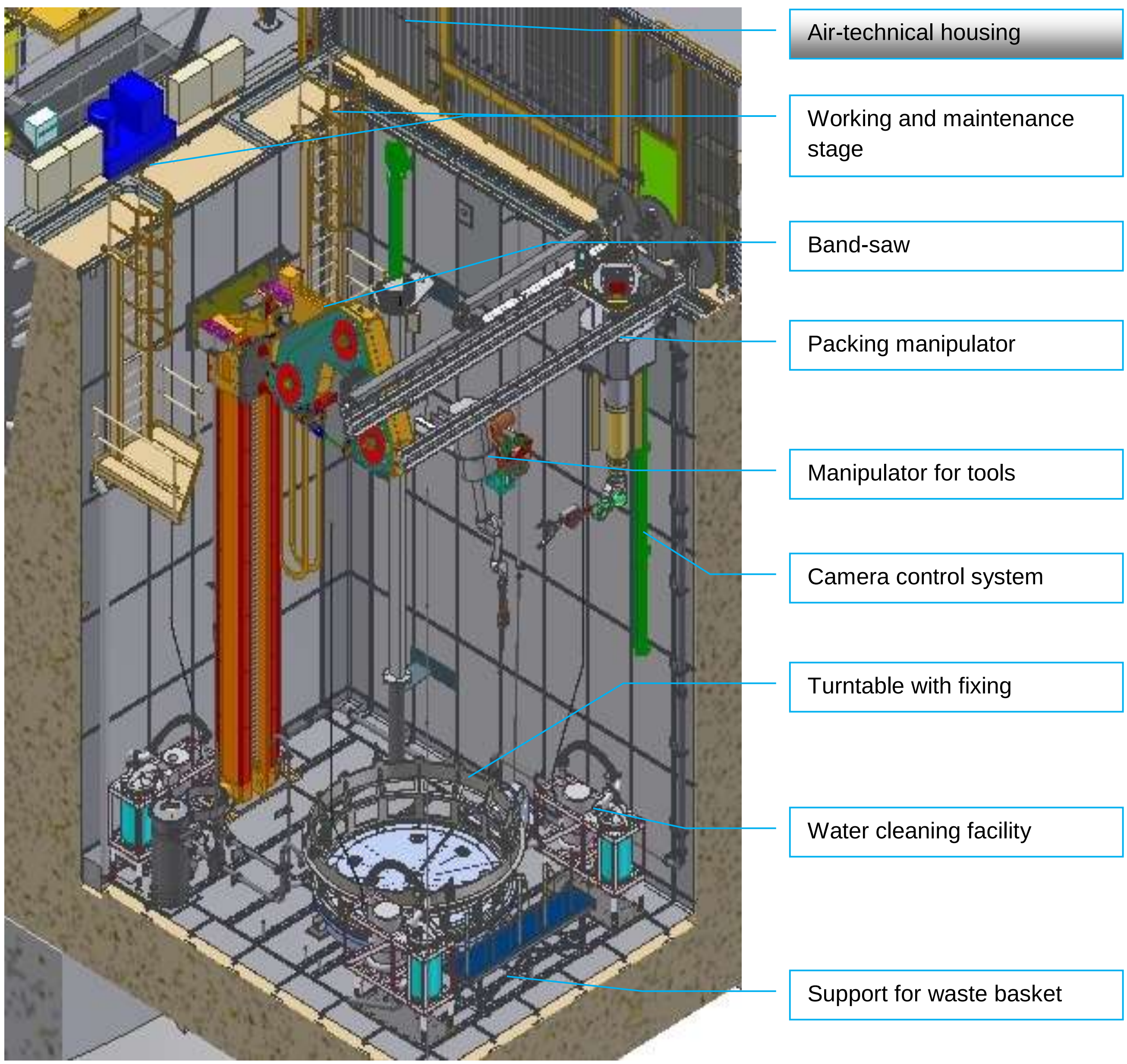

Fig. 1. Wet cutting area room 01.202 - Overview representation

Fig. 2. Wet cutting area room 01.202 with dismantling equipment before lifting the RPV

Now the connection block was let down on a level with the RPV and attached to the lifting hook of the RPV cover plate. The cover plate is tightly screwed to the RPV flange and is used as load handling device for the transport. After the partly filling of the wet cutting area with water the preparatory works for the transport had been finished.

Transport Execution

Mid-august 2015 the reactor had been lifted approx. 17 m out of the reactor pit with the strand jack. This procedure took several hours. This height was necessary to assure that the reactor bottom dome could be moved safely above the spatial separation between reactor room and spent fuel element storage pond (see Fig. 4).

Fig. 3. Strand jack with connection block on the bridge of the reactor building crane

Before the RPV had been set down on the turntable the load of 186 Mg had been moved 11 m horizontally with the reactor building crane towards the wet cutting area room 01.202. The fixing elements of the turntable were designed in a way to safely hold the RPV frame. In this context it was important to consider that due to the heavy weight of the RPV only a part load could be set down on the turntable with fixing elements. For this reason, the RPV with its cover plate remained attached to the strand jack for the subsequent thermal cutting of the flange and nozzle area.

SEPARATION OF THE FLANGE AND NOZZLE AREA FROM THE RPV

After the successful transport of the RPV from room 01.306 to room 01.202 it was planned to cut the flange and nozzle area from the cylindrical part of the RPV.
The flange and nozzle area had been supposed to get cut and packed at a separate dry cutting area.,

Fig. 4. RPV above the wet cutting area right before the settling

Preparations

In advance of the RPV transport trial cuts on test samples had been performed with the autogenous cutting device in room 01.202. Special attention had been drawn on material thicknesses and material composition comparable to those parameters existing at Obrigheim NPP. It was foreseen to position the ignited autogenous cutting device with the device carrier system in a defined distance to the RPV, to turn the turntable and to generate a kerf. Therefore, the exact paths of the packing manipulator and the device carrier system had to be determined and documented. Furthermore, the exact turning speed of the turntable had to be defined and the synchronisation of the strand jack´s connection block had to be tested.

The Autogenous Cut

Hereinafter the RPV had been set down with a defined part load on the turntable. Afterwards the air-technical housing had been closed to perform the separating cut remotely under air-technical sealing. Therefore, the autogenous burner was ignited with an igniting flame. Then the device carrier system arm had been moved towards the exact position determined by coordinates right above the water-level near the RPV.

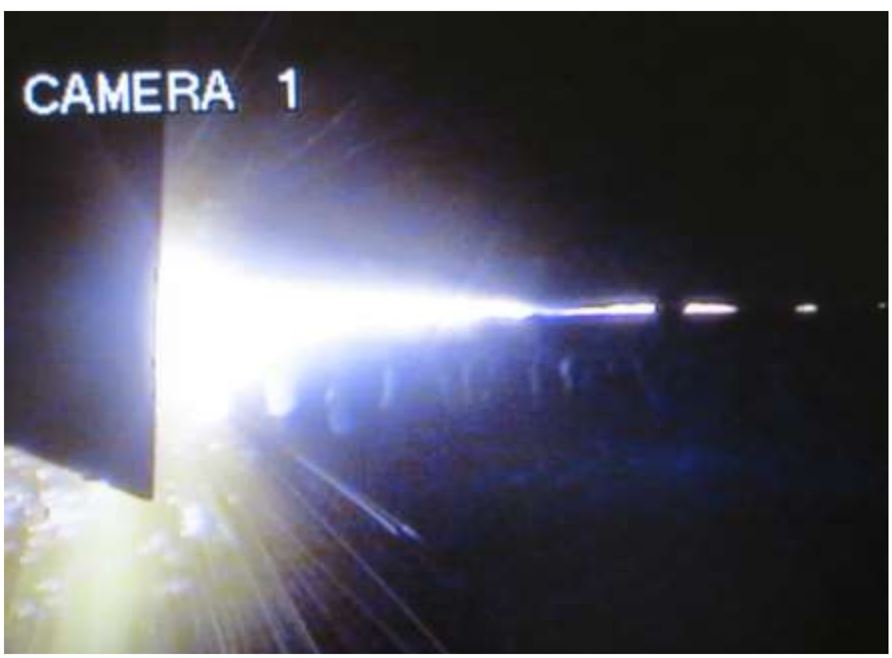

Fig. 5. Kerf at the RPV, heat protection metal sheet on the burner

At this determined position one of four drillings had been made in the forefront, which functions as the starting point for the burner flame. After the thermal output had been increased, the material started to melt and a kerf started to emerge due to the rotation of the turntable (see Fig. 5).

Fig. 6. Cut of the RPV, in the foreground the burner

Retaining the rotation and the cutting parameters a horizontal full circle had been cut within 120 min and without interruptions. Subsequent the manipulator with the burner was slewed away and the flange and nozzle area of the cylindrical part of the RPV was lifted (see Fig. 6) and transported to the cutting area room 01.412 (see Fig. 7)

Fig. 7. Transport of the RPV flange and nozzle area to the cutting area room

01.412 **CUTTING AND PACKAGING OF THE RPV FLANGE AND NOZZLE AREA**

Then the flange and nozzle area of the RPV had been transported to the cutting area room 01.412. There the component had been mainly cut with the wire-saw and packed afterwards (see Fig. 8). The flange and nozzle area had been cut with vertical sections into 12 packing size segments. Two segments (mass approx. 5 Mg) had been packed into one Konrad-Container Type IV.

Fig. 8. Cutting of the RPV flange and nozzle area with the wire saw

CUTTING AND PACKAGING OF THE THERMAL SHIELD AND THE CORE STRUCTURE OF THE RPV

The cylindrical part of the RPV with the thermal shield at the core structure had been cut and packed remotely in the wet cutting area room 01.202 due to radiological reasons (Fig. 9). Both components were cut from top to bottom.

At first segments in two ring levels of the thermal shield had been cut and packed using the plasma torch (Fig. 10) and the CAMC device. Afterwards the first ring level of the cylindrical part will be cut with the autogenous burner and the band-saw to packing size and packed.

The cutting and packing of the rings of the thermal shield and the RPV is alternately then carried out.

In summary 5 rings of the thermal shield and 6 rings of the RPV were necessary.

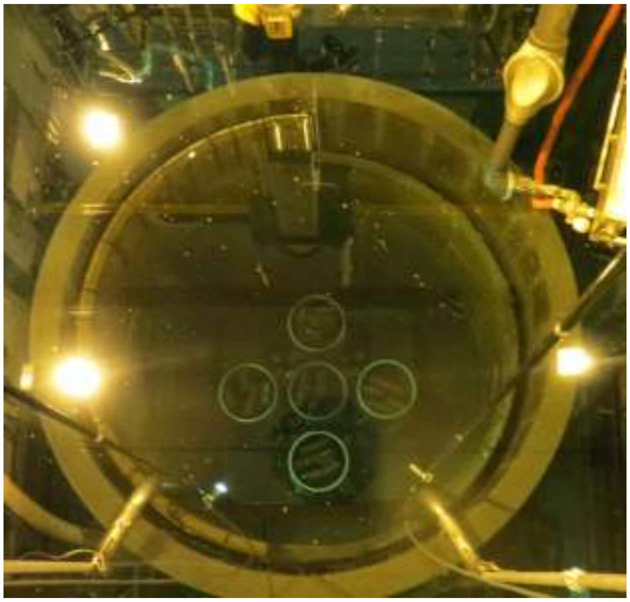

Fig. 9. RPV (outside) with thermal shield

Fig. 10 Plasma torch during a horizontal cut

CONCLUSIONS

In total EWN disposed of 6 RPV, 25 RPV internals and 5 annular water tanks of the reactors from the nuclear power plant sites in Greifswald and Rheinsberg. Two strategies have been realised – disposal as a large component with shielded transport of the reactor components to the interim storage facility with subsequent decay storage for later conditioning as well as the remote dismantling and packing of the reactor components.

The lessons of experience from these activities have proved to be a valuable prerequisite for the planning, manufacturing, installation and commissioning of the equipment for remote dismantling in order to comply with the challenges of the high safety standards in Germany.

It has been shown that an economic dismantling of the reactors is possible despite high safety and radiation protection requirements to meet the internationally valid protection aims.

The main challenge of the KWO reactor dismantling project is the limited space available due to the compact containment design. All handling processes have to be planned on a very detailed level. The advanced development of the nowadays available planning software allows a detailed three dimensional presentation of the original environment. Thus, all processes can be tested with a model.

The transport of the RPV from its mounting position to the wet cutting area room 01.202 was an important project milestone in the dismantling of the Obrigheim reactor. Not only especially due to the fact that all necessary tasks for the transport and the subsequent cutting of the flange and nozzle area from the RPV had to be performed remotely. But furthermore due to the fact that all operations, including possible interventions had to be considered and tested in the forefront, the transport of the RPV has a high significance in the field of engineering services.

The used thermal cutting technologies are mostly industrial standard. The necessary special experiences resulted from the dismantling of large components during the decommissioning at the German NPPs Greifswald and Rheinsberg.

But some techniques, for example the remote horizontal cut from a starting point with the autogenous burner had to be additionally tested and compiled in a workshop.

The repeated use of equipment which has been successfully applied in operation and the application of practically tested handling processes will minimize potential problems.

Finally, the gained experiences, particular those for activated components with high wall thicknesses can be widely used for future decommissioning projects in Germany and abroad.