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Remotely Controlled Dismantling of HLLW-Storage Tanks: First Application of the Tools and Machinery in Hot Operation – Paper 11278

Joachim Dux, Werner Lutz, Klaus Hendrich et. al.

WAK Rückbau- und Entsorgungs- GmbH, P.O.Box 12 63,
76339 Eggenstein-Leopoldshafen, Germany

ABSTRACT

The German pilot reprocessing plant WAK was shut down in 1990 after reprocessing about 200 Mg of nuclear fuels and is decided to be dismantled completely to the green field until year 2023. During the years 1994 until 2010 approximately 2,000 Mg of partly highly contaminated process equipment and 1,500 Mg of concrete structures corresponding to 99% of the radioactive inventory of 5E14 Bq of the WAK reprocessing building have already been dismantled.

In the decommissioning project of the Karlsruhe reprocessing plant (StiWAK), vitrification of the high level radioactive liquid waste concentrates (HLLW) represented a major milestone. From September 2009 to June 2010, about 55 m³ HLLW with a total β/γ-activity of 8.0E+17 Bq were vitrified at the Karlsruhe vitrification facility (VEK) and filled into 123 canisters. HLLW vitrifcation is followed by an extensive rinsing and shutdown program, by means of which the process installations of VEK and the units for the storage and evaporation of high-active fission product solutions (LAVA) are specifically prepared for dismantling. In late 2010, VEK operation will be completed by the shutdown of the vitrification melter.

In parallel, dismantling activities of step 5 of the StiWAK project started with the disassembly of the plant areas for the storage of intermedium-level radioactive liquid waste (ILLW) from reprocessing operation at the HWL (main waste storage building). Step 5 covers all activities up to the revocation of the controlled areas at HWL, LAVA, and VEK, including the dismantling of the remaining infrastructure facilities on the site. Special challenges of step 5 are the disassembly of the emptied and highly contaminated HLLW tanks at HWL and LAVA and the remote dismantling of the VEK process installations. It is not only necessary to plan technical procedures and dismantling steps under the given radiological boundary conditions, but also to qualify a concept for the management and disposal of the residues and contaminations remaining in the storage units.

PREPARATION OF DISMANTLING OF THE HLLW STORAGE FACILITIES: RADIOLOGICAL BOUNDARY CONDITIONS AND WASTE MANAGEMENT CONCEPT

The two tanks used for HLLW storage at LAVA until vitrification have a volume of 75 m³ each. During the storage period, the HLLW had been distributed equally to both tanks at homogenized concentration. For the preparation and planning of the rinsing program in these tanks at the end

of the storage period and as a part of the shutdown program of the VEK, dose rate measurements of the first emptied tank were performed with BeO dosemeters via the sampling systems to determine the remaining activity inventory. First, dose rates of up to 600 Gy/h were measured in the bottom section of the tanks (s. also Fig. 1). Calculation for a known nuclide composition yields a total activity of about 5E+15 Bq.

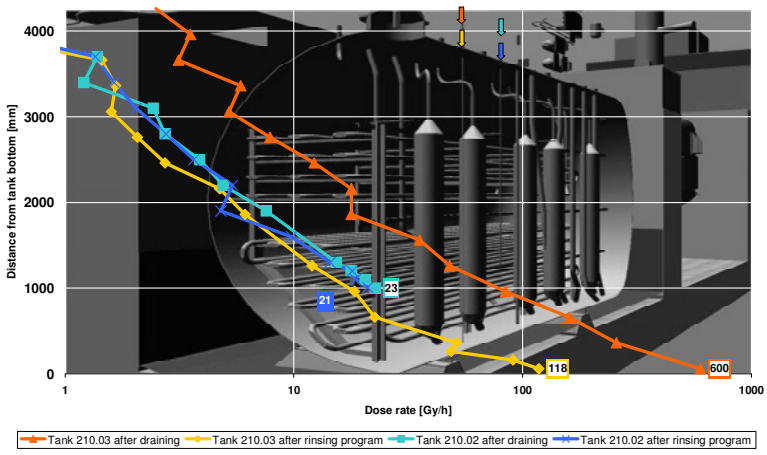

Fig. 1. Dose rate profile in the emptied HLLW tank

It was proved by first rinsing tests that dried HLLW residues are responsible for these residual activities and that no appreciable solid depositions exist in the tank. In the meantime, further rinsing measures have been performed in the tank under the rinsing and shutdown program of the VEK and the remaining contamination in the tank has been reduced by more than 90%. Presently, a remaining activity of about 1.0 E+14 Bq is assumed and taken as a boundary condition for tank dismantling. With a known mass-specific activity (determined by HLLW analyses during vitrification), this corresponds to a solid quantity still remaining in the tank of about 20 kg.

The two HLLW storage tanks at HWL (s. Fig. 2), which were reversibly taken out of operation in 1987, had been used for different purposes during operation. One tank had not been applied for HLLW storage, but served as a spare tank. The second tank had been used for the storage of the fission product solution for many years. It still contains about 100 kg solids in the bottom section with a total activity of about 4.6 E+15 Bq.

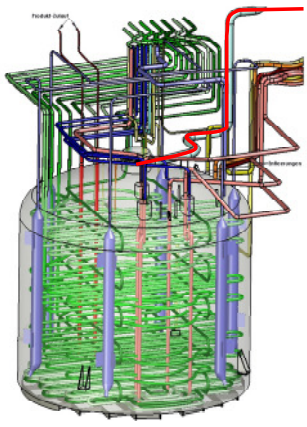

Fig. 2. HLLW tank at HWL

During the licensing procedure for the dismantling of the HLLW tanks at HWL and LAVA, a disposal concept was developed on the basis of the current knowledge (measurement of the dose rate in the tank, determination of residual activity, determination of the solid mass), according to which the solid shall be disposed of at the German final repository KONRAD. This will require conditioning of about 30 accident-proof packages of a specific waste cask class suitable for final disposal. At the repository, axial dilution will be required due to the thermal impact. WAK GmbH presently has a sufficient number of KONRAD-suited packages at the storage facilities of HDB to provide for this dilution volume.

The application for a license for the disassembly of the HLLW tanks has already been reviewed by an expert, the license is expected to be granted in 2010.

DISMANTLING OF THE ILLW STORAGE SYSTEMS: A SURVEY

Parallel to VEK operation and the preparations for dismantling the HLLW storage facilities, the ILLW tanks at HWL are presently being dismantled. In the dismantling concept for the HLLW systems of WAK, dismantling of these tanks (two tanks of 45 m³ each, one tank of 30 m³, two tanks of 5 m³ volume each) is the prerequisite for dismantling the HLLW tanks due to their spatial arrangement. During operation, the ILLW tanks had been located in thick-walled concrete cells without any openings and possibilities of access. For horizontal access, the so-called southern extension building of HWL was constructed. It accommodates the complete infrastructure for the control of the remote handling systems, for bringing in the machines, tools, waste drums, materials, etc., and for bringing out the filled waste drums.

Fig. 3. Carrier system with manipulator

The dose rate of up to 100 mSv/h on the tanks requires the use of appropriate remote handling systems for dismantling. The most important system used is a manipulator carrier system (MCS) based on a small excavator. If necessary, various tools, devices, and manipulator systems can be coupled electrically and hydraulically to the MCS (s. Fig. 3).

So far, these devices and tools have been used to disassemble the two small tanks in whole pieces, to bring them out, and to transfer them to HDB for further dismantling. The large tanks, two of which have already been disassembled, are dismantled directly and brought out of the dismantling area in 200 l drums or in a transport package that may also contain larger parts. Dismantling of the ILLW tanks will presumably be completed in the first half of 2011. Then, the room will be decontaminated largely for access by dismantling staff and in order to install additional systems (remote handling systems, ventilation systems, maintenance systems, etc.) required for the dismantling of the HLLW tanks.

OTHER REMOTE DISMANTLING ACTIVITIES IN STEP 5: AN OUTLOOK

Apart from the above dismantling activities, some of which are being executed already, step 5 also covers the remote dismantling of other plant sections in the HLLW facilities.

These are installations in other cells of the LAVA HLLW storage area, which were used for the transfer of HLLW from the storage tanks to VEK during vitrification. Their dose rate does not allow for any manual dismantling. These cells will have to be accessed vertically via the crane hall located above. There, extensive new installations of lock systems, lifting gears, and remote handling technology will be required (s. Fig. 4).

The application for a license for this work is presently being reviewed.

Planning of a concept for VEK dismantling after operation has also started. The focus currently is on the optimization of the dismantling sequences, the optimization of the transfer paths, and the specification of the management and disposal strategy for large components, such as the melter. Due to the expected contamination level of the plant components, the HLLW transfer cell, the melter cell, and other offgas treatment systems will be dismantled remotely.

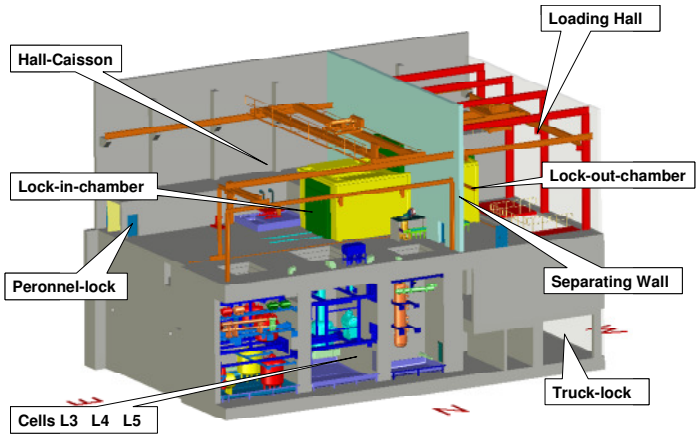

Fig. 4. Dismantling of other LAVA cells

SUMMARY

Removal of the HLLW systems at WAK upon the completion of HLLW vitrification at VEK represents a great challenge as far as the planning and execution of dismantling and the management and disposal of the radioactive wastes are concerned. For most of the problems to be solved, solution approaches exist or have already been implemented technically. These are:

- The measures to be taken prior to dismantling of the HLLW systems are being implemented already (construction of the southern extension building of HWL completed, dismantling of the ILLW storage tanks in the advanced stage).
- The applications for licenses for dismantling the HLLW storage tanks have been submitted and reviewed by the expert. The licenses are expected to be granted still in 2010. Together with the other WAK dismantling activities (extensive shutdowns after the completion of vitrification, new evaluation of safety-relevant installations, etc.), this will ensure continuous proceeding of dismantling.
- The systems and tools for remote dismantling of the HLLW storage tanks were tested in a specially set-up test field and applied for dismantling the ILLW storage tanks already.
- License applications for the dismantling of other HLLW facilities, including the VEK, are in preparation. The time planning is such that from today's point of view, the review and approval periods will not cause any delays.