Concept for Dismantling the Hllw Treatment Facility on the Former Wak Reprocessing Site

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ABSTRACT

The German pilot reprocessing plant WAK was operated until 1990 and processed about 200 tons of nuclear fuels from test and power reactors. In late 1991, the Federal Republic of Germany, the State of Baden-Württemberg, and the utilities decided to shut down the WAK and to dismantle it completely to the green field.

In the years 2000/2001, remote-controlled dismantling of the process cells in the reprocessing building was completed. Part of the building has already been subjected to release measurement and released from the obligations under the German Atomic Energy Act.

However, a major prerequisite for the complete dismantling of the WAK is the management of the 60 m³ high-level liquid waste (HLLW) with an activity of 8.0 E 17 Bq resulting from reprocessing. For this purpose, the Karlsruhe vitrification plant (VEK) was constructed and is now under commissioning /1/. Hot operation is foreseen for the years 2007/2008.

Following vitrification operation, dismantling of the four HLLW tanks in the storage building will be a particularly challenging task in terms of radiology. The HLLW tanks are located in thick-walled concrete cells that require remote-controlled horizontal access. For this purpose, a new access building, the southern extension, was built. It serves to bring in and operate the remote handling tools and allows for the contamination-safe removal and measurement of the MAW drums. In contrast to the crane in the process building, the manipulator carrier system used here is an 8 Mg excavator. All tools, including the wall cutter, chisel, cutting disk, scissors, and the electric master-slave manipulator (EMSM), can be docked to this excavator.

The VEK installations shall be dismantled parallel to the HLLW storage tanks. Due to the dose rates expected after operation, two dismantling areas have to be distinguished in the VEK: The core area with the HLLW transfer cell, melter cell, and exhaust gas cell requires remote dismantling. All remaining cells and rooms may presumably be dismantled manually.

INTRODUCTION

From 1967 to 1970, the Karlsruhe reprocessing plant (WAK), see Fig. 1, was built by the Forschungszentrum Karlsruhe on behalf of the Federal Republic of Germany. In 1971, operation of the plant was started by the WAK Betriebsgesellschaft mbH (WAK operation company). By the end of 1990, about 200 tons of nuclear fuels from experimental and power reactors were reprocessed. On June 30, 1991, production operation of the WAK was finally stopped.

The technical objective of the decommissioning project is the “green field”. To reach this objective, the plant shall be dismantled completely in six steps, the radioactive waste arising shall be disposed of, and the premises recultivated. Plant dismantling is managed by the newly founded company WAK Rückbau- und Entsorgungs-GmbH (WAK dismantling and disposal company).

Compared to other nuclear decommissioning projects, WAK is characterized by two special features: About 60 m^3 of high-level liquid waste (HLLW) with a radioactivity inventory of about 8.0 E 17 Bq are still stored there in two storage tanks. Hence, the operation expenditure required for these storage areas is very high. For HLLW vitrifica-

tion, the Karlsruhe vitrification plant (VEK) /1/ was built. It will be commissioned soon. It is planned to produce about 130 glass canisters in 2007/2008.

In addition, the rooms and facilities of the WAK are contaminated with α, β, and γ activity due to reprocessing operation. Handling of these activities in all dismantling and disposal areas will require special measures and a high expenditure until the plant can be released from the obligations under the German Atomic Energy Act.

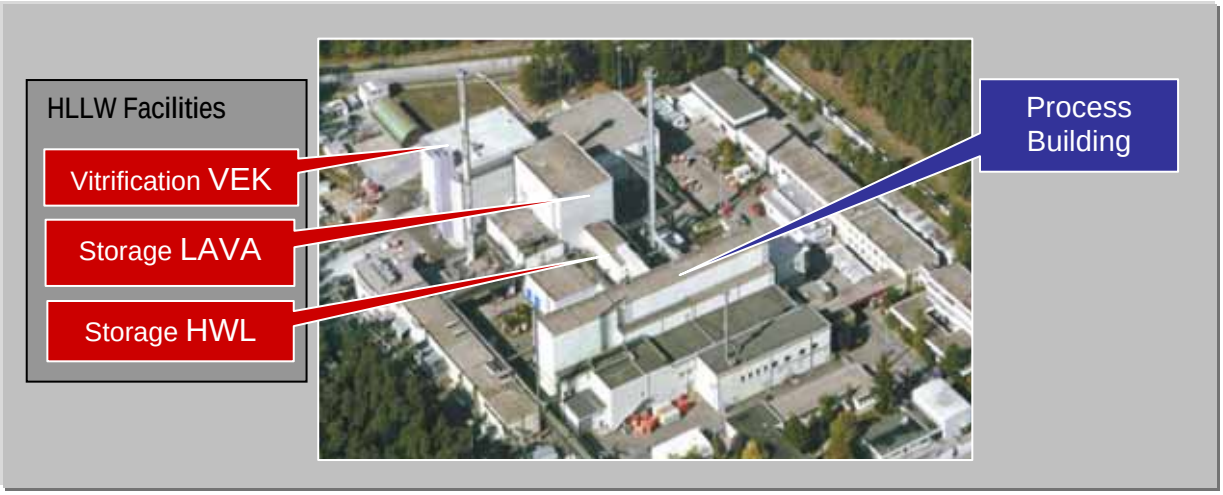

Fig. 1: Aerial view of the WAK

LICENSING

For the dismantling of the process building, including the elimination of the controlled area, all licenses have been granted. Two decommissioning licenses have been granted for dismantling the HLLW facilities. They cover the erection of the HWL southern extension building (dismantling step 5.1) and remote dismantling of the MAW tanks (dismantling step 5.2). Licensing of dismantling step 5.1 also comprised a review of the complete technical concept for the dismantling of all HLLW storage areas, including VEK.

The VEK was built under three partial construction licenses. Civil work started in 2000. The first partial operation license for inactive compound operation was granted on Dec. 20, 2005. Additional licensing documents for “hot operation” are presently in an advanced state of review. The second partial operation license for hot operation is expected to be granted in the first quarter of 2007.

STATUS OF OPERATION

Process Building

The reprocessing technical installations were removed completely from the process building. For reasons of safety, however, the ventilation system, 12 bar steam and pressurized air supply systems, communication and fire alarm facilities, electrotechnical supply facilities, and wastewater treatment units are still operated to the extent required. Facilities and workplaces requiring a high personal monitoring expenditure, such as the emission measurement system, radiation protection workplaces, the central control room and switches of the ventilation system, have been taken out from the process building.

Surface contaminations of the process building structures have already been removed in nearly all cells and adjacent rooms. In all cell and room areas of the process building, detailed recording of the radiological state of the building structures is being continued.

LAVA / HWL Storage Areas

In the two LAVA storage tanks, about 60 m^3 of HLLW with a radioactivity inventory of about 8.0 E 17 Bq and a thermal output of about 70 kW are stored under constant cooling and circulation. As reprocessing operation was stopped, no new HLLW is generated.

The operation systems for HLLW storage in LAVA and the auxiliary facilities required for this purpose, such as exhaust gas cleaning, ventilation, media supply, radiation protection and stack monitoring, and communication systems, are in normal operation. The cell block and LAVA storage tanks are designed to withstand airplane crashes and earthquakes.

The HWL main waste store is in a deregulated state of operation and must be kept as a spare HLLW store until the end of vitrification.

Infrastructure Facilities

All systems for

- Media supply: Steam, water, pressurized air
- Power supply and communication
- Wastewater treatment, and others

are in the normal state of operation. These systems are safety-relevant for the reliable enclosure of the HLLW.

For future VEK operation, the normal and emergency power supply networks as well as the media supply system (cooling water, pressurized air, steam) were backfitted and modified extensively.

VEK Vitrification Plant

Construction of the vitrification plant has been completed largely. The media systems of the VEK have been connected to the WAK systems. At the moment, remaining functional tests are being carried out and all VEK systems are prepared for operation. This phase will be followed by commissioning and cold operation. As soon as the second operation license will have been granted, the HLLW and MAW lines will be connected (duration about 2 months), such that hot operation will presumably start in mid-2007.

DISMANTLING OF THE HLLW AREAS

Survey

Dismantling of the HLLW areas is the 5^{th} decommissioning step of the WAK and, hence, the penultimate step before reaching the green field objective. It covers all dismantling activities up to the elimination of the controlled areas in the HLLW storage facilities LAVA and HWL and the vitrification plant (VEK), including the dismantling of the remaining infrastructure facilities. Following step 5, conventional demolition of the building will take place under step 6.

Activities in phase 5 are divided into 10 dismantling steps:

Dismantling step 5.1:	Construction of the southern HWL extension building
Dismantling step 5.2:	Remote dismantling of the MAW tanks in HWL
Dismantling step 5.3:	Remote dismantling of the 4 HLLW tanks
Dismantling step 5.4:	Dismantling of the HA laboratory and remote dismantling of the LAVA cells L3-L5
Dismantling step 5.5:	Remaining manual dismantling in the HWL, decontamination, and release measurement of the building
Dismantling step 5.6:	Remaining manual dismantling in LAVA, decontamination, and release measurement of the building
Dismantling step 5.7:	Dismantling of the ELMA pipe duct

Dismantling step 5.8: Remote dismantling of the VEK process technology
Dismantling step 5.9: Remaining manual dismantling of the VEK, decontamination, and release measurement of the building
Dismantling step 5.10: Dismantling of the remaining infrastructure

The dismantling steps 5.1 and 5.2 (see Fig. 2) do not depend on the completion of vitrification operation. All remaining dismantling activities may only be carried out after the vitrification of the HLLW.

Construction of the Southern HWL Extension Building

The southern extension building is required to bring into the HWL the tools needed for dismantling the MAW and HLLW tanks (new access) and to remove the waste in a contamination-safe manner for packing into shielding casks. At the same time, the southern HWL extension building accommodates the control board for remote handling work.

The southern extension building is completed. Major components, such as the double-lid lock, drum measurement system, shielding gates, and crane systems have been installed and checked for functioning. By mid-2007, the lacking facilities (radiation protection instruments, video monitoring system, I&C) shall be completed. Commissioning, however, will only start when the southern extension building will have been connected with room 6 of HWL and when the ventilation system will be in operation.

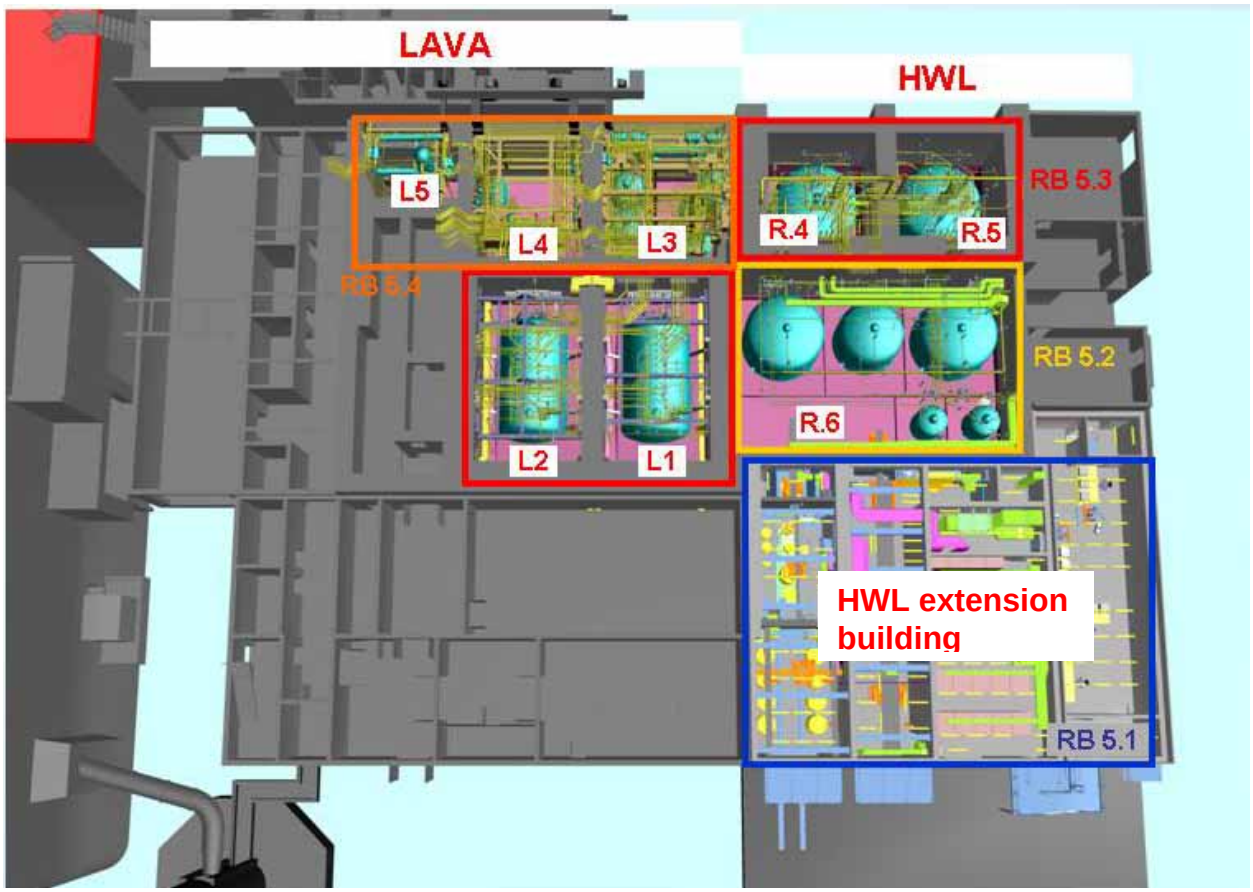

Fig. 2: Cross section of the dismantling areas 5.1 - 5.4 in HWL and LAVA

Remote Dismantling of the MAW Tanks in the HWL

As a first step, it is planned to dismantle the MAW tanks in HWL room 6 (dismantling step 5.2, see Fig. 2). Contrary to all other activities under step 5, this dismantling work does not depend on the end of vitrification operation, but may be carried out parallel to VEK operation. The respective license has already been granted. After the dismantling of the MAW tanks, room 6 will be turned into a remote handling platform, from which the HLLW tanks will be dismantled. At the same time, room 6 will be used as an intervention area for manual tool repair. Consequently, shielding gates will be installed in front of the wall areas that will then be broken to gain access to the HLLW tanks in R4 and L1.

Room 6 accommodates five MAW tanks with the following volumes: Twice 45 m³, once 30 m³, and twice 12 m³. The tanks were discharged completely and are dry in the meantime. Three years ago, the radiological conditions in room 6 were recorded with a gamma camera. Measurement revealed that two of the base tubs of the tanks are contaminated and that the average dose rate of the tanks in the lower area amounts to 2 to 10 mSv/h (with a maximum of 100 mSv/h in the upper third of one tank). As the limit for manual dismantling in WAK is 0.5 mSv/h, it was decided to have the MAW tanks dismantled remotely.

Prior to dismantling, the remote handling tools (see Fig. 3) have to be subjected to final tests. For this purpose, a remote handling test rig was installed in the former spare store ELMA after release measurement. The tests, including training of the staff, will be carried out until late 2007, such that dismantling of the MAW tanks and access to the HWL may start in 2008. Dismantling of the tanks will take about half a year. Including preparatory and reconstruction work in room 6, about 1.5 years will be needed.

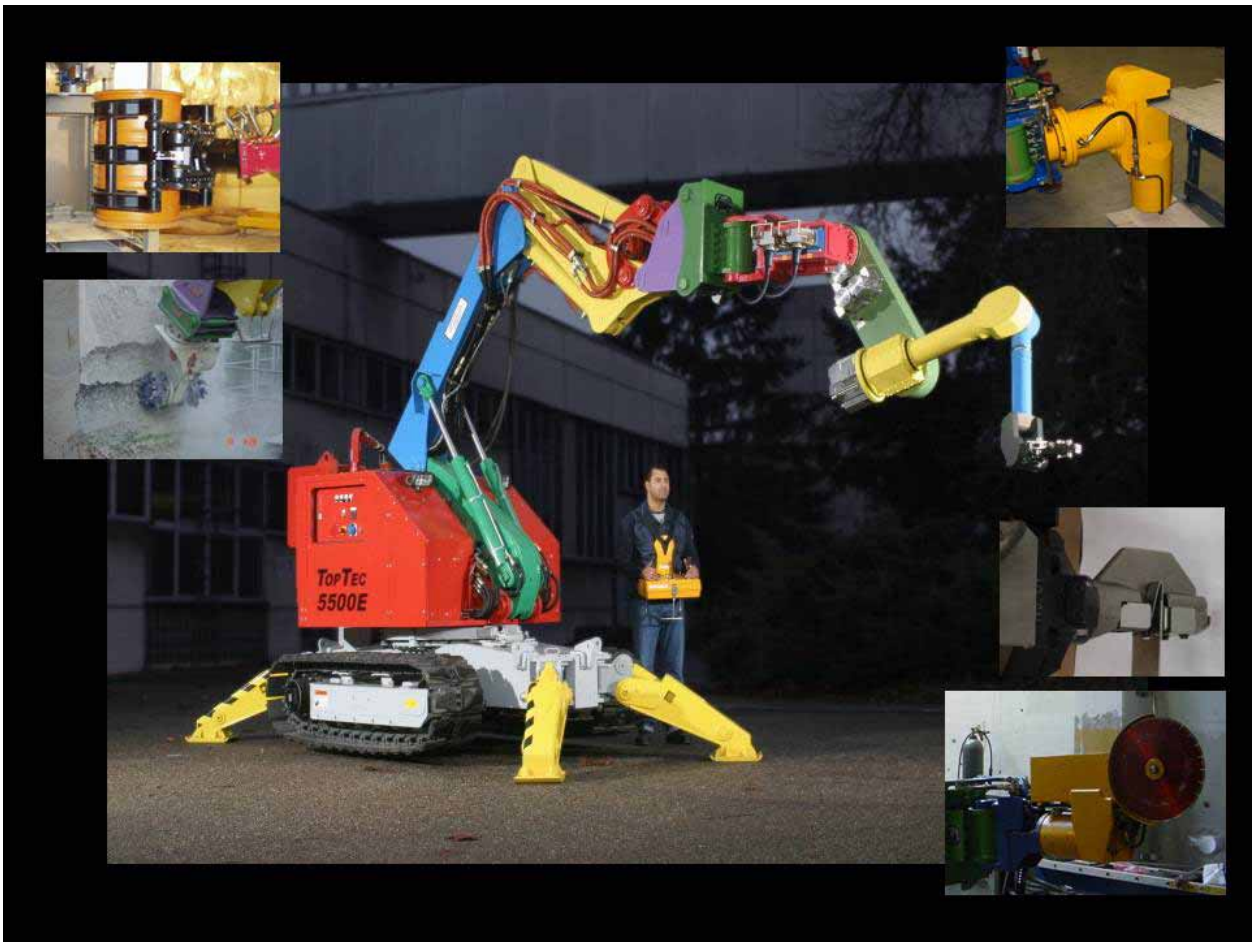

Fig. 3: Remote handling tools for dismantling the MAW and HLLW tanks

Remote Dismantling of the Four HLLW Tanks

The most challenging task will be the dismantling of the HLLW tanks after vitrification operation. This is due to the high residual contamination of the tanks and their inaccessibility behind thick concrete walls. Two empty HLLW tanks are located in the old storage building HWL (see Fig. 4) and two in the new storage area LAVA. Here, the HLLW (2 x 30 m^3) is stored at the moment. Both types of tanks are equipped with coiled cooling pipes and pulsators for constant cooling and circulation of the concentrate. The data of the tanks are summarized in Table 1.

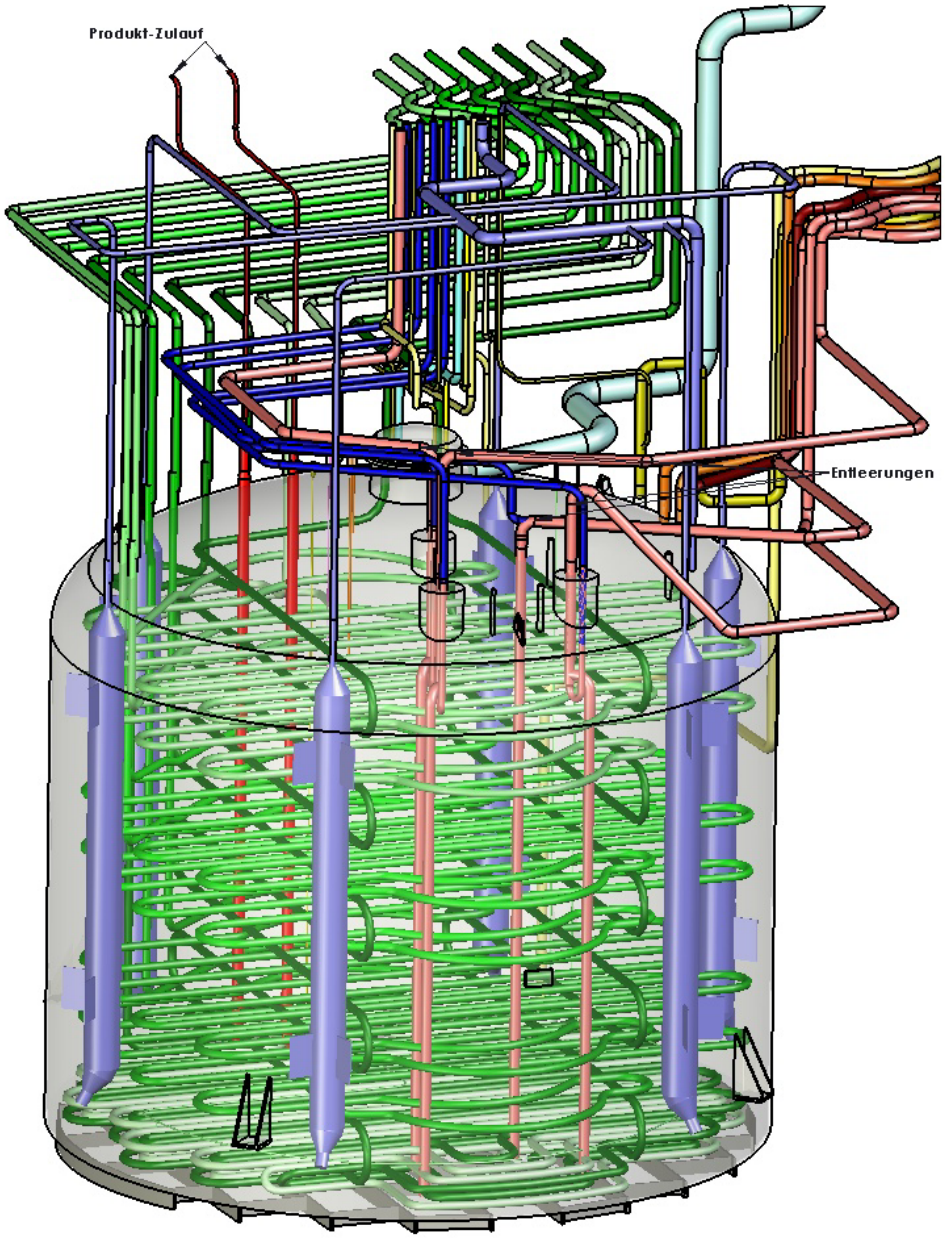

Fig. 4: 3D representation of an HLLW tank in HWL

Tab. 1: Data of the four HLLW tanks

	HWL		LAVA	
Designation of component	**81.31**	**81.21**	**210.02**	**210.03**
Construction	Cylindrical, vertical	Cylindrical, vertical	Cylindrical, horizontal	Cylindrical, horizontal
Volume	75 m³	75 m³	80 m³	80 m³
Diameter	5 m	5 m	4 m	4 m
Height / length	4.5 m	4.5 m	7.2 m	7.2 m
Wall thickness	10 mm	10 mm	12 mm	12 mm
Construction weight	16 Mg	16 Mg	18 Mg	18 Mg
Dose rate	< 0.3 mSv/h (maximum value measured outside of the tank in August 2006)	5,100 mSv/h (maximum value measured outside of the tank in August 2006)	1,500,000 mSv/h (filled) 1,000 mSv/h (estimated after discharge)	1,500,000 mSv/h (filled) 1,000 mSv/h (estimated after discharge)
Activity	< E 10 Bq	2.5 E 15 Bq	1 E 13 Bq (estimated)	1 E 13 Bq (estimated)
Remark	The tank was never used as a storage tank for HLLW	The tank was used as a storage tank until 1987	Current storage tank of 30 m³ HLLW	Current storage tank of 30 m³ HLLW

According to the concept, it is envisaged to remotely and successively dismantle the tanks on site down to drum size. For this purpose, the wall between room 6 and room 4 will be broken through by means of an excavator and a concrete miller (see Fig. 2). Then, tank 81.31 will be dismantled (due to the small dose rate, this will be done manually with machine support). After this, the wall to room 5 will be broken remotely for the remote dismantling of the tank 81.21. The tanks in LAVA will be dismantled in the same way. Here, the difficulty consists in the fact that these tanks are fixed to the cell walls with massive steel constructions for protection against earthquakes. This additionally limits their accessibility.

Considerations with Respect to the Decontamination of the HLLW Tanks

According to recent studies, dismantling of the tanks is no technical problem. The wastes arising, however, in particular those from tank 81.21, will not comply with the storage requirements for the planned German repository KONRAD. To reduce activity, decontamination tests were carried out on the laboratory scale. The result was more than satisfactory, such that further proceeding will be changed as follows:

The HLLW tanks are planned to be decontaminated prior to dismantling, such that contamination will be removed from the coiled cooling pipes at least. Next year, a test will be carried out on the tank 81.21 with the highest contamination. If this test will be successful, it is planned to rinse the tank parallel to VEK operation. The rinsing solution will then be vitrified subsequent to HLLW vitrification. The current HLLW storage tanks will be measured after discharge and also cleaned by rinsing, if necessary. Then, the rinsing solution will also be vitrified.

It is aimed at vitrifying the high soluble residual activities such that they can be subjected to disposal. The remaining tanks can then be conditioned as envisaged by the concept and will comply with the storage requirements of the planned KONRAD repository.

Successful decontamination would mean a significant risk reduction as regards waste disposal and reduce the risk potential in the plant. As a result, the risk of contaminating cell walls and tools during later dismantling work would be smaller (saving of time and costs). However, this goes at the expense of a longer operation time of the vitrification plant by about half a year.

Dismantling of the VEK Vitrification Plant

Following the vitrification of the HLLW /1/ and, if necessary, of the rinsing solutions, the VEK /1/ shall be dismantled. Due to the expected radiological situation, dismantling of the VEK will be divided into two dismantling steps. Within dismantling step 5.8, the transfer cell V1, the melter cell V2, and the exhaust gas cleaning cells V5, V6 and V8 will be dismantled remotely. The plant components remaining until the elimination of the controlled area may presumably be dismantled manually (dismantling step 5.9).

The manipulators that have already been installed in the cells V2 to V4 and V6 during the construction period will be applied for remote dismantling. The systems for taking up a manipulator in the ceiling area exist in cell V1. Cell V5 first will have to be accessed horizontally (e.g. with an excavator).

Dismantling of the HA Laboratory and Remote Disassembly of the LAVA Cells L3 to L5

Upon the completion of vitrification, the transfer cells between LAVA and VEK will have to be dismantled in addition to the HLLW tanks and the vitrification plant. Due to the dose rate expected (about 100 mSv/h), remote dismantling is planned.

The cells L3 – L5 (see Fig. 2) will not be accessed horizontally as in case of the HLLW tanks, but vertically via the cell hall. Again, the master-slave manipulator EMSM3 will be applied. Now, it will not be fixed to an excavator, but to a crane.

Prior to the start of dismantling, the HA laboratory will have to be extended in the cell hall, as it covers a large part of the cell L3 and inhibits the planned construction of the caissons above the cells.

SCHEDULE

In 2007, it is planned to test and procure the remaining remote handling tools for the dismantling of the MAW and HLLW tanks, to visually inspect the tank 81.21 as well as to carry out a decontamination test for cleaning the coiled cooling pipes. At the same time, the vitrification plant is supposed to start hot operation in mid-2007, if the license will be granted (until late 2008).

From 2008, the MAW tanks in room 6 of the HWL shall be dismantled. Then, dismantling of the HLLW tanks in the HWL will be started, provided that vitrification will have been completed. At the same time, dismantling of VEK will start directly after vitrification. As soon as remote handling will have been completed in the VEK, the LAVA cells L3 – L5 will be dismantled remotely. All remote dismantling activities are planned to be completed by late 2014.

Upon the completion of remote handling, the remaining manual dismantling work, decontamination work, and release measurements will be carried out in the LAVA, HWL, and VEK facilities. These activities will presumably be completed by late 2018.

After this, dismantling step 6 will cover the conventional demolition of all building structures on the WAK site. Demolition of the process building and the VEK may start in 2016/17 already, the buildings LAVA and HWL may be demolished from early 2019 only. The project is supposed to be completed by 2019.

References

/1/ W. Grünewald, G. Roth, W. Tobie, S. Weisenburger, J. Fleisch, M. Weishaupt
”Commissioning and Cold Test Operation of the German HLLW Vitrification Plant VEK”, WM 07 Conference, Tucson