Progress Achieved in the Decommissioning of the Process Building of the Karlsruhe Reprocessing Plant

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ABSTRACT

Since years, the former process building of the Karlsruhe reprocessing plant (WAK) has been dismantled manually exclusively. Various dismantling techniques have been developed and optimised constantly based on the experience gained. Today, performance characteristics can be given for all techniques applied. Based on these figures and on a detailed characterisation and acquisition of all dismantling activities to be performed, costs of the work capacities required can be estimated and the schedule can be planned reliably. Using these figures, it also appears possible to reliably calculate the decommissioning costs, capacities, and schedules of other alpha-contaminated facilities.

INTRODUCTION

The Karlsruhe Reprocessing Plant (WAK) has been under decommissioning since 1991, with two dismantling paths being pursued in parallel. Path 1 consists in the decommissioning of the process building, while path 2 covers the decommissioning of the HAWC storage facilities as well as of the vitrification facility (VEK). Decommissioning of the process building has advanced significantly. The deregulation phase, dismantling of peripheral devices, and remote dismantling of highly contaminated and strongly radiating process equipment have been completed. Until the planned release measurement of the entire building in 2017, numerous dismantling and fine decontamination activities are and will be performed directly by the staff deployed on site. Hereinafter, it will be reported about the techniques that are/will be used for this purpose. Decommissioning of the HAWC storage facilities and of the vitrification facility will start upon the completion of vitrification in about 2011. It will be reported elsewhere about the vitrification operation performed so far.

RADIOLOGICAL BOUNDARY CONDITIONS

Upon the disassembly of the strongly radiating and highly contaminated components, the remaining facilities were dismantled. Decontamination of the building structures started to comply with the release limits of 0.5 Bq α/cm^2 and 5 Bq β/cm^2 (penetrated activity), respectively, depending on the nuclide vector. The limit given in the license for the direct deployment of staff on site is 0.5 mSv/h. In practice, radiation usually is far below this value that more or less exclusively refers to direct radiation. Due to the α contamination of the entire plant and the high radiological effect of α radiation, specific measures have to be taken to protect the personnel. Depending on the existing contamination level, varying protective clothes have to be worn. In addition, a ventilation-related barrier and lock system is applied. Contamination in the whole plant is monitored by a number of dust collectors and online measurement instruments. To protect the staff, conventional protection systems are installed in addition. Recurrent trainings and instruction sessions are organized. During the nearly 100,000 dismantling activities so far, only 3 cases of incorporation (2 inhalations, 1 incorporation via a wound) occurred. This confirms the success of the dismantling and radiation protection concept.

CURRENT STATUS OF DISMANTLING OF THE PROCESS BUILDING

The process building has the following dimensions: L = 103 m, W = 55 m, H = 23 m. It has 150 rooms, of these, 10 process cells with walls of up to 1.5 m in thickness.
Until October 30, 2009, 1,040 tons of building rubble, 1,700 tons of steel, 230 tons of cables, 1,200 m² of liner, 7,700 dowels, and 230 wall feedthroughs had been removed. 5,500 m² of surfaces had been shaved. 4.7 E 14 Bq of activity had been removed from the building. Future dismantling will focus on the removal of the wall feedthroughs, the shaving of surfaces, and the mortising of hot spots in order to reach the release limits.

TECHNIQUES APPLIED

Removal of Feedthroughs

Contaminated pipe feedthroughs, the ends of which are closed by welding to prevent contamination from spreading, are cut out of the wall as a block by a dry rope saw technique. The capacity of dry rope sawing is 0.25 m²/h, including fitting times. In total, 300 pipe feedthroughs existed, of which 230 have been removed so far.
Apart from pipe feedthroughs, cable and other feedthroughs exist, which are not cut out, but mortised. During this work, the asbestos problem has to be taken into account. In total, 1,140 feedthroughs existed, of which 200 have been removed so far.

Fig. 1. Photographs of Removal of Feedthroughs

Removal of Contaminated Building Joints

If building joints cannot be decontaminated due to their structure or if the joint material cannot be removed due to the high activity penetration depth, the contaminated construction elements are removed by dry rope sawing or by large-area mortising. In both cases, the static stability of the building has to be analysed first. 4 building joint areas of 60 m² in total will have to be removed, with static replacement measures (support constructions) being required in individual cases.

Fig. 2. Removal of Contaminated Building Joints

Removal of Dowels

Dowels are removed either by using a striking weight or hydraulic pulling device or by mortising. The latter technique has proved to be adequate and is nearly exclusively used at the Karlsruhe Reprocessing Plant. The average performance of a team of two workers is 20 dowels per day. In total, 14,000 dowels existed, of which 7,700 have been removed so far.

Removal of Cast-in Channels

Cast-in channels are removed by mortising. So far, 460 m of the 1,850 m of cast-in channels installed have been removed. The capacity amounts to 10 m per day.

Removal of Liners

Fig. 3. Removal of Liners, Cut-off grinding

Various methods were tested.

Laser cutting may be very elegant, but turned out to require too high an expenditure for use at the WAK. Plasma cutting turned out to be hardly practicable due to smoke development and flying sparks.
Cut-off grinding was found to be suitable. This technique was used for removing most of the liner surfaces. Of the total of 1.450 m², 1.200 m² have been removed so far. A team of two workers can remove about 0.5 to 1 m² daily.

Removal of Asbestos-containing Feedthroughs

Fig. 4. Asbestos-containing Feedthroughs, Sampling

About 300 cable and pipe feedthroughs are located all over the building. They were sealed with asbestos-containing material for fire protection purposes. For small-area removal, the glove bag technique is applied, large-area removal of these feedthroughs is accomplished by a double-chamber lock technique. The average time needed for the removal of an asbestos feedthrough in the controlled area, including fitting times, is 3 h for the glove bag technique and up to 2 weeks for large-area removal.

Determination of the Depth of Penetration of Contamination into the Building Structure

Fig. 5. Determination of Penetration

If hot spots are found, their dimensions are determined using a radiation measurement device. At the point of highest radiation, the penetration depth of activity is determined using a hollow drill and an attached cyclone separator. So far, about 500 depth profiles have been recorded. A complete depth profile consists of 10 drillings at 3 decreasing diameters each. Per day, 3 complete depth profiles can be generated.

Removal of Hot Spots

Fig. 6. Removed Hot Spot

The reprocessing plant was a chemical facility, during the operation of which liquids were released, which caused a contamination of large surface areas. Following the removal of contaminated wall, ceiling, and floor areas in the process cells and service rooms by shaving/grinding, locally confined spots of activity penetrated into the building structure remained, so-called hot spots.
These hot spots are removed by mortising using an electrically driven chisel under

constant radiological monitoring. Presently, these fine decontamination activities are having a share of 30 – 40% in dismantling work.

Determination of the PCB Concentration in the Coatings and Building Structure

To decide whether the building rubble arising from the demolition of the building has to be disposed of as conventional rubble or transferred to a special dump for hazardous waste (costs), samples were taken at relevant points and a PCB concentration map was drawn up. The sampling technique corresponded to the technique used for determining radioactive contamination of the coatings and building structure.

Removal of Coatings

The contaminated surfaces were coated by emulsion paint, varnishes, epoxy resin, glass fibres, etc. Depending on the coating, angular grinders with diamond-coated cup disks or electric shavers are applied.

Fixation of Surface Contamination

Contaminated wall and ceiling areas are subjected to spraying with a polymer dispersion. In this way, contamination particles are fixed and the air is prevented from being contaminated by aerosols released.

Shaving of Surfaces

Fig. 7. Wall Shaver

As a rule, contaminated surfaces are removed down to a depth of 2 – 3 mm.
Structured surfaces are removed by an angular grinder with the respective diamond disks and connected vacuum cleaners. The daily (6 h) capacity of a team of two workers is about 2 m².
Large smooth walls or ceilings are removed by a mechanical wall shaver that is attached to a forklift or a modular rack. It reaches daily capacities of up to 20 m². So far, about 5,500 m² have been shaved off and subjected to release measurement. These areas included areas of highest contamination in the cells and the surrounding service rooms.

Measurement by in-situ-γ-Spectrometry

Fig. 8. In-situ- γ-Spectrometry

In-situ-γ-spectrometry is applied to verify that the activity values are far below the release limits. The average time needed is 0.7 h/m² (including fitting times).

OUTLOOK

So far, 1,700 tons of process-related equipment and machines have been dismantled. 200 tons still remain to be removed. 230 saw blocks have been cut out, another 130 still remain to be removed. 1,200 m² of steel liner have been dismantled, about 250 m² still remain to be removed. Of the 14,000 dowels, 7,700 have been removed. 230 tons of electric cables have been removed, about 100 tons still remain to be taken out. About 5,500 m² surfaces have been shaved, with the release limits being reached. Another about 38,000 m² still remain to be shaved and subjected to release measurements.

As no technical problems are expected to occur during future work, we are confident that the process building will have been subjected to release measurement by 2017 with the present dismantling team force (30 workers). Then, conventional demolition will start.