Requalification of historical intermediate level waste (ILW) for the repository KONRAD on basis of non destructive assay (NDA) and re-evaluated nuclide vectors

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Abstract
The storage facility for ILW of the HDB contains a large number of historical waste products in 200-l drum geometry, which were produced in the 1970ies to the 1990ies. In the next years more ILW will be treated and stored at HDB, exceeding the storage capacity of the ILW store. All waste products produced at HDB are treated according to the acceptance criteria of the repository KONRAD and are planned to final storage in this repository. In order to qualify the waste materials for final storage in KONRAD and to remove parts of the inventory from the storage chambers this project was started.

The main issues of the project, which will be accompanied by the regulator, are product control measures like gas chromatographic analyses of remotely sampled gas syringes and non destructive assay techniques like γ-spectrometry and neutron-analytics. The product control is followed by declaration on the basis of re-evaluated nuclide vectors and a repackaging of the drums in licensed containers. The packaging concept includes a 400-l drum as qualified over-pack, because several of the historical drums cannot be qualified as IP-II or type A package. The annual space between the two drums is filled with quartz sand for stability and additional shielding. The drum set is afterwards inserted into a qualified UBA-container provided by GNS. In the case that the product control measures and the reassessment of the declarations result in a violation of the activity limits of the relevant acceptance criteria for KONRAD, the respective drum has to be physically requalified after correspondence with the surveillance authorities.

This program will be applied to a fraction of approx. 400 canisters, which were selected on the basis of several quality aspects like dose rate below 100 mSv/h, nuclide inventory below 100 A2 according to paragraph 201 of TS-R-1 and well-known waste composition. In the future more waste products will be treated in the same way, if approved containers exist for the inventory.

Introduction

The Central Decontamination Department (HDB) of the Wiederaufarbeitungsanlage Karlsruhe (WAK GmbH) specializes in handling radioactive wastes and residues, from decontamination and recycling to conditioning for final storage. For this purpose a variety of methods for the treatment and conditioning of wastes with low and intermediate activities are available, for example decontamination, compaction, incineration, evaporation and cementation. The product control measures are performed by a multi-purpose radiochemical laboratory for the analyses of radioactive samples and a variety of NDA-drum measurement systems. For the storage of treated waste material several facilities for LLW and ILW waste products are available.

The HDB was founded in the 1960ies to decontaminate materials and instruments used in the nuclear installations of the Karlsruhe site and to dispose of the radioactive waste arising from nuclear research and the operation of the research reactors and the reprocessing plant present on the site.
With time the tasks changed from treatment of operation waste to decommissioning and waste occurring from the demolition of the nuclear facilities.
The HDB treats radioactive waste according to the valid acceptance criteria of the repository KONRAD. These acceptance criteria were first issued in 1995 and revised in 2010. Prior to 1995 the waste was treated using methods approved by the regulatory authorities according to the state of technology. Due to the amount of waste produced at the Karlsruhe site and for reasons of security the raw waste had always to be treated efficiently to avoid large amounts of untreated waste on site.

Description of the project

The storage facility of the HDB for ILW contains a large number of historical waste products, which were produced in the 1970ies to the 1990ies. Because the maximum capacity of the storage facility is almost used and storage capacity will be needed in the future, a project was started with the aim to transfer the waste into another storage by repacking in licensed shielded containers after verifying the existing documentation and declaration and performing qualified product control measures via NDA-γ-spectrometry and –neutron-analytics. This storage is only licensed to waste packages meeting the acceptance criteria for the repository KONRAD issued in 2010. The data recorded for the declaration and treatment of the historical waste products are not sufficient for the acceptance criteria of this repository. For this reason the requalification scheme was established. This scheme comprises a reevaluation of the original declaration, information on the nuclide vectors of the waste producer, revisiting the treatment process at HDB and recent analytical data from non destructive assay techniques resulting in a complete declaration and documentation (see figure1).

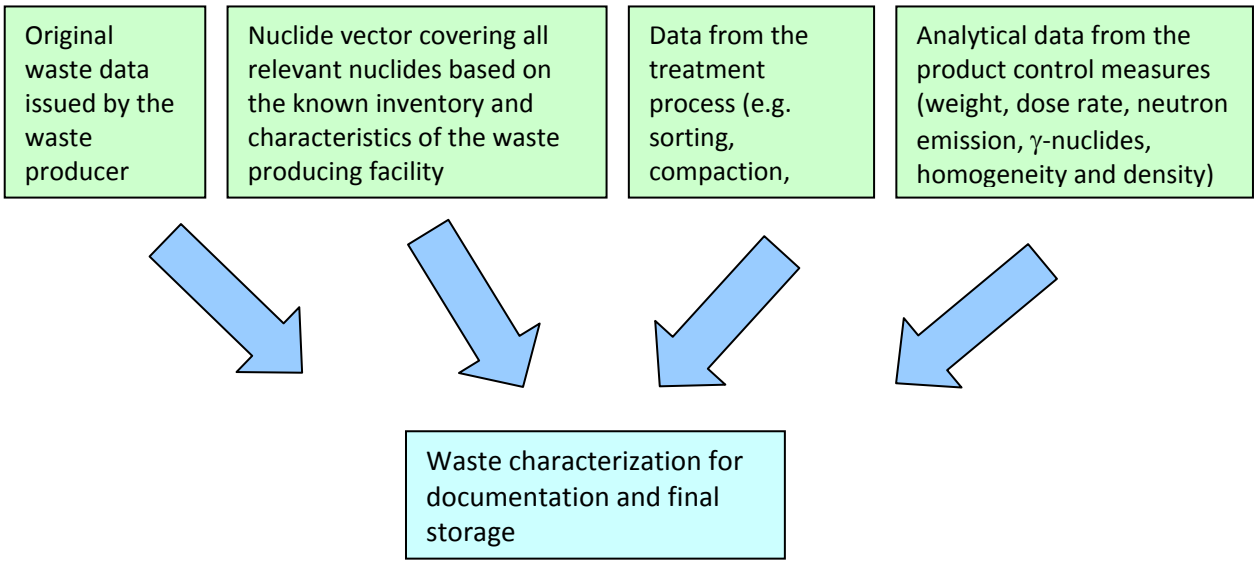

Figure 1: Flow sheet for re-evaluation and qualification of declaration

The waste products in question are predominantly solid and liquid waste materials which were solidified with concrete. The origin of the waste is the former pilot reprocessing plant WAK, the pilot fast breeder reactor KNK, material testing waste from nuclear fuel for several reactor types, essay nuclear fuel samples, etc..

The waste products planned to be removed from the storage facility were chosen on the basis of dose rate (the maximum shielding of the packaging concept is in the range of 100 mSv/h), reliable data of origin, way of treatment and nuclide inventory below 100 A2 according to paragraph 201 of TS-R-1 and well-known waste composition. The challenge of these measures is that all actions have to be performed remote controlled in a hot cell due to the intense dose rate of the waste canisters.

Existing documentation

All waste products are documented with an electronic declaration and documentation in the database system KADABRA as well as the original raw waste declaration on the report filed by the waste producer. The very old products were produced without a quality control plan verified by the authorities. For these waste materials the entire treatment history has to be documented in detail.

The waste products will be transferred to the German repository KONRAD in the future, so they have to meet the acceptance criteria of the repository. For historical waste products, which were produced without a quality control plan and without qualified treatment methods, the compliance with the criteria has to be proved on the basis of documentation and analyses.

The first acceptance criteria for KONRAD were issued in 1995, the current revision dates from 2010. The waste materials which were produced prior to 1995 were treated on the basis of the state of technology, but the documentation was obviously far less detailed than today. So only the major nuclides and the masses of U and Pu were declared. Because the original nuclide vectors contained insufficient data for a complete declaration, detailed studies of the materials handled in the facilities of the waste producers were created on the basis of reports and burn-up calculations of the treated materials. On the basis of these studies new nuclide vectors were created and submitted to the supervising authorities for approval.

To achieve a complete declaration of all nuclides specified in the acceptance criteria, concept reports for all relevant waste producers were filed defining one or several nuclide vectors. They were derived from the known field of study or, in the case of the WAK, from burn-up-calculations of the reprocessed nuclear fuel, which resulted in the radioactive inventory of the plant. These reports were submitted to the regulator prior to this campaign.

The waste products will be requalified and repacked in batches according to quality control plans approved by the regulatory authorities. These quality control plans comprise all relevant steps of treatment and quality control.

For the first batch rather new waste products from the reactor tank of the pilot fast breeder reactor KNK were chosen. Here the documentation was very good, the waste was treated according to a qualified method and the treatment method was immobilization of the metallic materials of the reactor tank in 200 l drums with inactive concrete. These well documented materials will be used to test the established process.

In the preparation phase of the batch all existing information was collected and submitted to the regulator for approval. The information contained details on the waste materials, the dose rate, the contamination and the nuclide vector applied, including the report describing the activation calculation and the way of declaration. The next batches will contain materials from the former multi purpose reactor MZFR and from the pilot reprocessing plant WAK. Here waste materials from the decommissioning phase as well as from the phase of operation will be removed from the storage.

Quality control by non destructive assay (NDA)

The product control measures to confirm the declaration and quality of treatment will be performed in a handling cell adjacent to the storage facility. The installations present are a γ-scanner, a dose meter and a passive neutron monitor. The NDA facilities are in the process of being accredited according to ISO 17025 to prove that only qualified methods are applied. The g-scanner works with a revolver collimator allowing variable collimation for optimum count-rate, dead-time and surface coverage. The analysis times for typical ILW-products are in the range of 30 to 60 minutes.

At present only a passive total neutron counting system is used, but because of unknown amounts of nuclides with high neutron emission rates like Cm-244, a new active neutron counter will be installed. The new neutron counting system must take all the special circumstances of the location into account, e.g. entire remote control of the drum, high gamma-background in the hot cell. It's necessary to distinguish gamma caused influence on the count rate from the count rate derived from the neutron source. Modern multiplicity neutron counting techniques, which are offered by several

companies, have little prospect of success because the results will be disturbed by random coincident events caused by the expected high count rate.

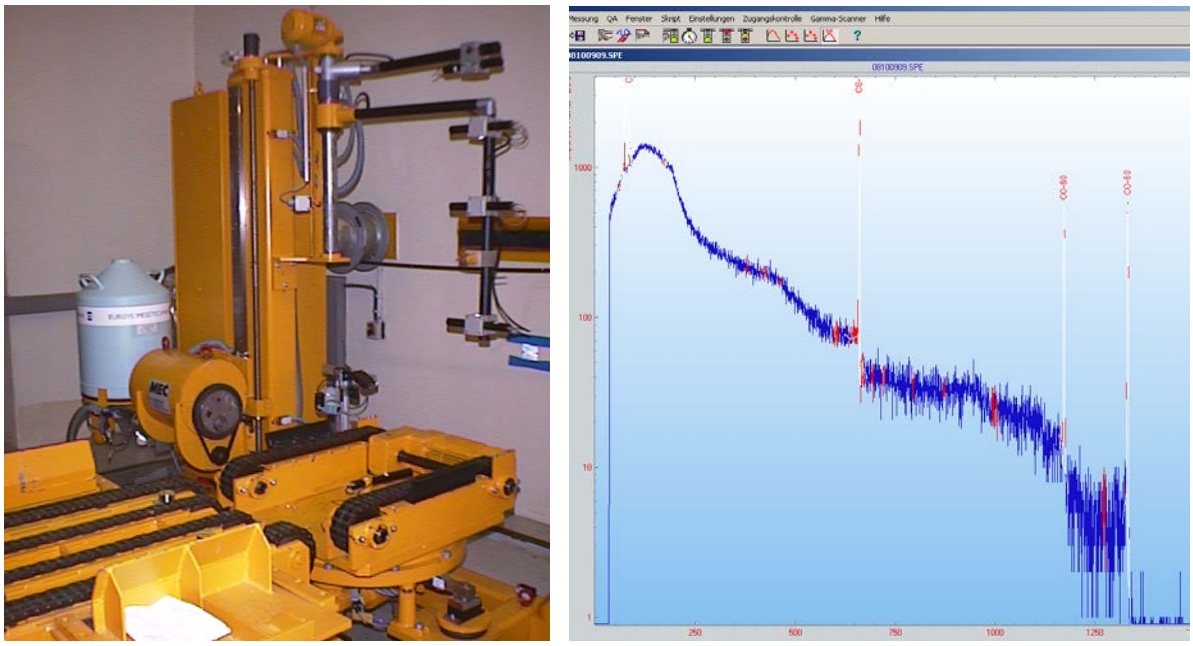

Figure 2: γ-Scanner for ILW and typical spectrum

In the case that the product control measures and the reassessment of the declarations result in a violation of the activity limits of the relevant acceptance criteria for KONRAD, the respective drum has to be physically requalified after correspondence with the surveillance authorities.

The gas analyses are required according the acceptance criteria of the repository KONRAD. Due to their age and the treatment process the canisters are supposed to be chemically stable. To prove this a certain percentage of canisters have to be analyzed for the composition of the gas phase (in the canister) by gas chromatographic analyzes of remotely sampled gas syringes.
The gas analyses are performed in a low level laboratory after remote-controlled sampling via syringes through the venting filters (see figure 3). The gases analyzed are hydrogen, methane, ethane, ethane, nitrogen, oxygen, carbon dioxide and carbon monoxide. The analyzes are performed as a two step process to first analyze the start conditions and after a defined time analyze the final amount and the resulting rate of gas production.

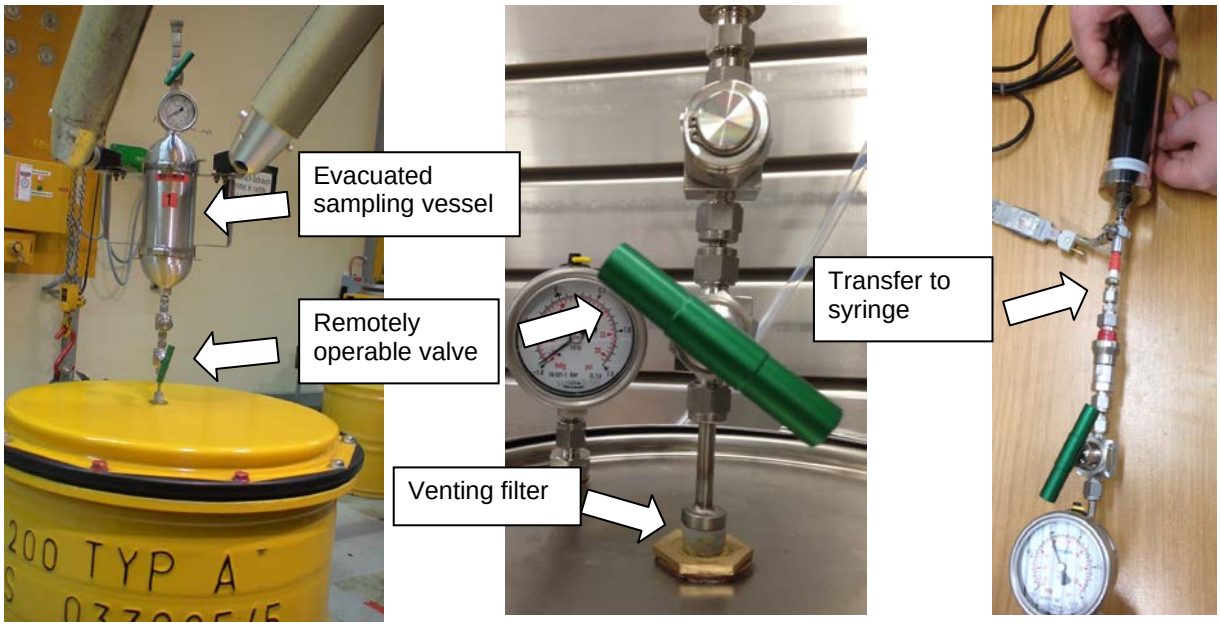

Figure 3
Test of the sampling device for remote-controlled sampling. The evacuated gas sampling pipe is lowered onto the venting filter. The syringe for the injection of the sample into the gas chromatograph is adapted to the clean side of the pipe after sampling.

Packing concept

The packing concept for the drums includes over-packing in a qualified 400 l -drum, with the annular space filled with compacted sand for stabilization and additional shielding. These drums are inserted in UBA-containers (cased concrete containers) provided by GNS (see figure 4).

Figure 4
Concept of overpacking into a qualified container, which is the UBA provided by GNS. A 200 l-drum is inserted into a qualified 400 l-drum and the annual space is backfilled with quartz sand. This drum set is afterwards inserted into the UBA container.

This over-packing concept allows the canisters to be removed from the storage for ILW-waste and to be stored in the storage licensed for containers destined for the repository KONRAD. The 200-l drum is stabilized within the 400-l drum by metal spacers. The quartz sand is inserted using a funnel with feed control (see figure 4). The sand is filled in several steps followed by steps of compaction to achieve a compact and stable sand layer in the annular space. After complete backfilling, the 400-l

drum is closed and the amount of sand is determined by weighing. The set of the two drums is afterwards inserted into the UBA-container also stabilized by metal spacers. First inactive tests show, that the backfilling and over-packing can be operated remote controlled in the planned manner.
The product control measures will start in 2015. The first transfer into UBA and removal from the ILW storage will take place subsequently.

Conclusions

Detailed requalification and product control measures for historical ILW products present at HDB will result in products qualified for the repository KONRAD and allow their removal from the present storage facility.

References

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