

**Optimized Qualification of Legacy Waste for the Repository Konrad –
16629**

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ABSTRACT

The repository Konrad in Germany is planned for the acceptance of low level waste and intermediate level waste.

The Wiederaufarbeitungsanlage Karlsruhe (WAK GmbH) has the assignment to decommission and dispose of the nuclear facilities on the site of the Karlsruhe Institute of Technology (KIT). The entire inventory of these installations as well as the existing waste materials stored in the interim storage of the HDB are planned to be sent to the repository Konrad and are therefore treated according to the respective acceptance criteria. These acceptance criteria were defined on the basis of safety considerations and first published as a draft in 1995. After full legal recognition in 2007 the acceptance criteria were revised in 2010 and 2014.

All legacy waste treated prior to 1995 has to be requalified according to the current state of acceptance. The repository will not open for acceptance of waste materials until 2022. Up to now only a small amount of acceptable waste packages exist. Therefore WAK GmbH established a scheme to improve and accelerate the processes and to have 2 annual delivery capacities (5000 m³ in total) ready by the end of the decade.

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.

The WAK-HDB was founded in the 1960ies to decontaminate materials and instruments used in the nuclear facilities of the Research Centre Karlsruhe (now KIT) and to dispose of the radioactive waste arising from nuclear research, operation of the research reactors and the reprocessing plant present on site and consequently the decommissioning and dismantling of these installations.

The largest waste stream is intended for the limited or unlimited free release after decontamination and measurements proving the compliance to the respective limits.

The waste treatment strategies for radioactive waste packages are designed according to the waste streams coming from the operation and decommissioning of

the nuclear facilities and the defined product groups of the German repository Konrad, which define inventory limits for different types of waste derived from the assumed safety cases. The higher the quality of the waste treatment method and the container is, the higher is the allowed nuclide inventory.

Waste product groups exist for example for packaged materials, super compacted materials and grouted solids and liquids. In Figure 1 the main treatment strategies of the WAK-HDB are illustrated.

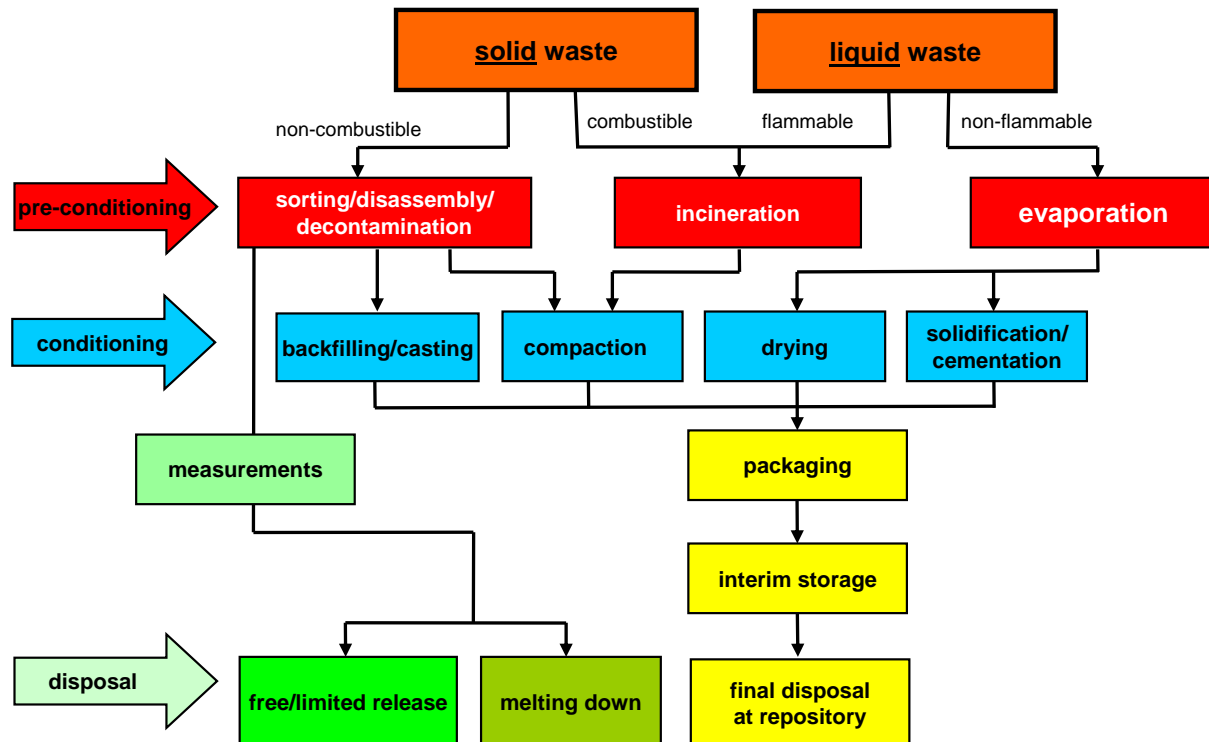


Figure 1: Operations scheme of WAK-HDB

After the conditioning process the waste products are mostly packed in 200 l drums. Since these drums are unacceptable waste packages for Konrad, the drums have to be inserted into defined container types (see Figures 3 and 4).

In Germany treated radioactive waste is categorized in 4 groups:

Table 1: Waste product categories

P1	Waste product treated according to a qualified method
P2	Waste products approved by the regulator
G1	Waste containers containing qualified products
G2	Approved container containing approved waste products including compositional declaration

Only waste containers of the category G2 are acceptable for disposal in Konrad.

To qualify a waste product the following criteria have to be fulfilled:

- The waste has to be treated according to a qualified method, which is usually defined in a quality control plan. The compliance to this scheme has to be proved on the basis of protocols authorized by the national and regional regulatory authorities. The radiological declaration has to be specified including an activity and mass balance over the entire treatment process, including the provenance of the waste.
- The composition has to be specified using substance codes of substance vectors.
- The waste must be inserted into a qualified container.

The compliance to these criteria can easily be proved for recently and presently treated waste. For waste which was treated in the 1980ies and 1990ies the existing data is insufficient for a complete declaration. Therefore, these waste materials have to be requalified using the tools specified below.

Qualification of the existing and arising waste

The WAK-HDB operates the largest interim storage facility for low-level waste (LLW) in Germany. In the storage buildings almost 70.000 drums are stored in approximately 6000 containers, 7000 single-drum shieldings or in drum stores.

All nuclear waste produced and stored by HDB is destined for the repository Konrad, which will open by 2022 [1].

WAK-HDB established a scheme to have enough containers ready by that time to ensure the full use of the capacity of WAK-HDB. Due to the high amount of waste present on site, the large annual capacity destined for Konrad and the limited time of acceptance proper fulfillment of the annual delivery quantity is critical for the project timescale of the company.

This scheme consists of several work packages concerning the actual production and already produced waste materials in the interim storage, which have to be requalified to prove concordance with the acceptance criteria of the repository Konrad.

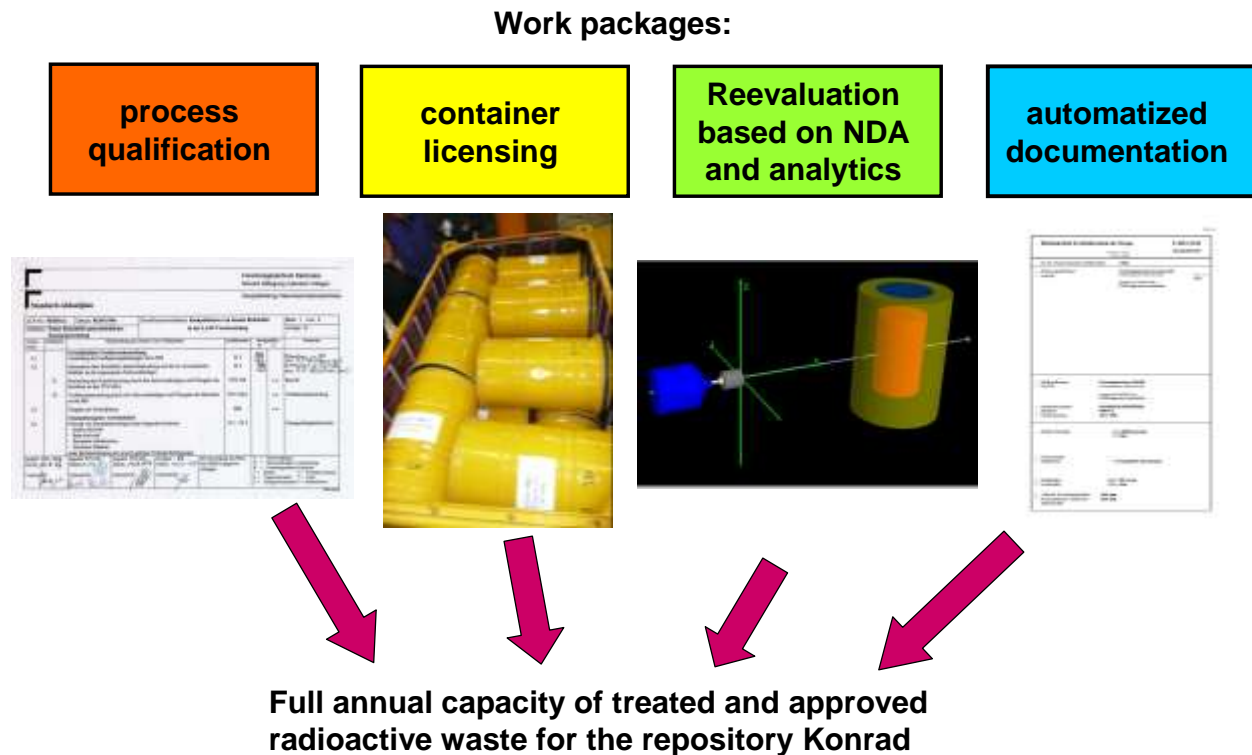


Figure 2: Intended work packages to achieve the required output

Work-package process qualification

- Since 2011 waste is only treated according to approved quality control plans yielding products which can be easily documented and hence qualified for the repository Konrad. In the last years several of the existing quality control plans were revised on the basis of the acceptance criteria Konrad of 2010. In this revision of the acceptance criteria the compositional declaration [3] as well as several new nuclides and a new requirement for the compositional declaration [4] were specified.
- All processes of waste treatment and all supplementary documents were revised and improved to accelerate the production as well as the verification process of the regulators.
- All quality-control plans and the documentation system KADABRA are in the process of requalification to ensure state-of-the-art work.
- The approved operations are certified by the regulatory authority during the production process to facilitate the assessment of the final documentation.

Work-package container licensing

- The pre-existing containers are in the status of requalification including verification of the existing documentation and use of finite-element models to prove material quality.
- All documented waste products are packed in licensed containers according to all requirements of the repository Konrad [2] yielding optimized final packages, which do not have to be retreated. The planned packing of the approved waste products has to be verified and agreed to by the regulatory authority.
- Containers which cannot be requalified are dismantled and the resulting drums are analyzed and declared on the basis of the analyses and pre-existing data yielding new waste products (see also work-package NDA).

Work-package NDA and analytics

- Old raw waste and interim products are analyzed by NDA (non-destructive assay) prior to treatment to verify the declaration and to avoid over-declaration or production of waste products which do not comply with the acceptance criteria of the repository.
- The requalification of legacy waste is approved by quality-control plans prior to redeclaration on the base of reevaluated vectors or NDA. This process will be established in 2016. The redeclaration of legacy waste is an extremely time-consuming and work-intensive task. The redeclaration and qualification of these legacy waste products must be managed parallel to the documentation of the current waste products so that a mix of radioactive inventory is available for the transport to Konrad at any time.
- A process to declare reprocessed legacy waste on the basis of destructive and non-destructive analytics and a vector is established. The dismantled legacy waste yields interim products (200 l-drum), which are sampled during production (1-l-bottle). The drum is analyzed on a γ -Spectrometry device as well as the bottle. The drum results are used for the declaration of the activation and fission products by correlation to a key nuclide like Cs-137. For low concentrations of actinides the analytical result from the lab γ -Spectrometry can be used to declare the major and minor actinides based on a given ratio to the analyzed key nuclide Am-241. For higher concentrations an aliquot of the lab sample is dissolved and analyzed for U- and Pu-Isotopes by mass-spectrometry. By this process all relevant nuclides can be analyzed, whereas the remaining nuclides are derived from an approved vector.

Work-package IT-supported documentation

- The documentation of the waste products is generated semi-automatically in the documentation system KADABRA shortly after production.
- All relevant reports are digitally present in the database to ease the documentation.

- Interim products are documented and approved by the regulators to ensure the acceptance of the final product.

Acceptance logistics

In Germany only waste packages with a radiological and compositional declaration approved by the federal Radiation Protection Authority (BfS) on the basis of the acceptance criteria of the repository Konrad [1] will be accepted for final disposal.

The logistic in the repository defines 6 cubic types of containers, which will be handled via spreaders and 2 cylindrical types of containers (concrete or cast-iron) which will be handled with forklifts.

WAK has mainly two geometries to pack the waste materials:

- Type 4 Containers (7,14 m³ each, see Figure 3) and
- Type 1/2 cylindrical single-drum containers (1,3 m³ each, see Figure 4).

For the transport 2 of the cylindrical containers will be placed on a transport device. So each transport category is either 7,14 m³ or 2,6 m³ (= 2 * 1,3 m³). The planned transports will be 2 or 3 transports per week for 17 weeks each year. It is impossible to reach the full capacity with cylindrical containers only. So a mixed transport must be obtained.



Figure 3: Technical specification and photograph of Konrad Type 4 Container (the dimensions in the drawing are in millimeters)

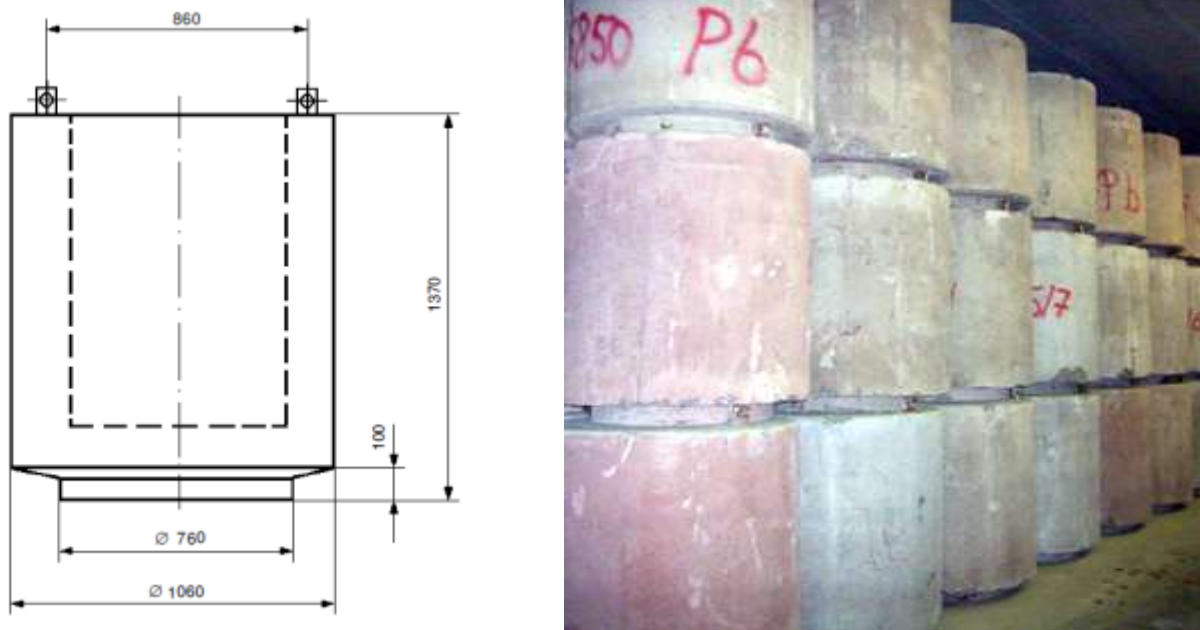


Figure 4: Technical specification and photograph of Konrad Type 1/2 single-drum shielding container (the dimensions in the drawing are in millimeters)

The share of WAK is 2500 m³ per year. The regulations require a naming of the containers 2 years prior to transport for logistic planning and generation of the transport papers and allowances. The aim of WAK is to have 2 shares (5000 m³) of completely documented waste ready by approximately 2020 to be able to achieve a continuous transport regime.

From 2021 onwards a continuous amount of 2500 m³ of documented waste products ready for Konrad has to be provided by the HDB, so that a continuous transport to the repository will be guaranteed.

In order to avoid having only very low level waste readily documented by the time of delivery start to Konrad, a strategy to ensure the optimum mix of the different waste containers (cubic and cylindrical) and of radioactive inventory has to be in place for an optimized waste disposal.

Summary

The qualification of the required volume of radioactive waste for shipment to the repository Konrad is crucial for the project lifetime of the WAK-HDB.

The large amount of treated legacy waste, which has to be requalified is the major risk for the shedule.

Therefore the entire production process was reevaluated and improved using more analytical data and stepwise approvals by the regulators and measures were established to accelerate the documentation of waste-packages as well as entire containers.

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