Waste Management of LLW / ILW at HDB

EURATOM Collaborative Project CAST

(CArbon-14 Source Term)

Training Course

C-14 behaviour under repository conditions

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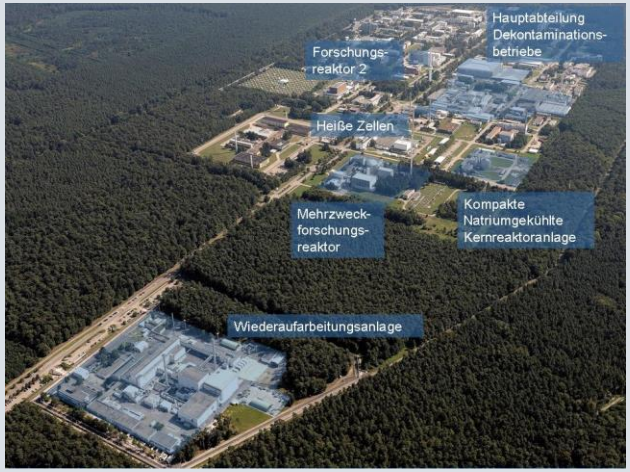
Primary assignments of the WAK

- **The WAK is the WAK dismantling and waste management company. Therefore the two major processes of the company is the dismantling of former prototype nuclear installations**



- **and the management of the resulting waste.**

Die HDB der WAK GmbH

The assignment of the HDB is the collection and treatment of radioactive waste:

- Sorting by material and contamination status
- Decontamination and free release
- Incineration of combustible materials
- Concentration of aqueous liquids
- Cementation of concentrates
- Hydraulic compaction of inorganic waste
- Interim storage of waste products

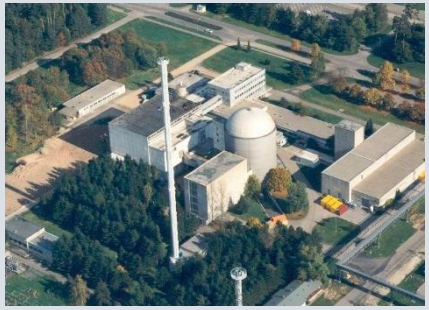
Goal: repository KONRAD in Lower Saxony

In the future the radioactive waste packages will be delivered to the repository KONRAD in Lower Saxony The acceptance will not start before 2022 and will continue for 30 to 40 years.

Critical for project timescale

KIT Campus Nord, ehem. Forschungszentrum Karlsruhe

Decommissioning Projects of the WAK GmbH



Prototype pressurized heavy-water reactor (PHWR)

MZFR

Prototype reprocessing plant

WAK

Prototype for advanced fast reactor cooled with liquid sodium

KNK

Material testing.

Hot Cells

Neutron source heavy-water research reactor

FR2

accelerators

Zyklotron, Van de Graaff-Generator

Prototype and research reactors

Nuklear research and prototype facilities

Waste-Management – in the decomissioning project

Transport of waste materials and components to the HDB

Storage for untreated waste

Hauptabteilung Dekontaminationsbetriebe (HDB)

Aerial view of HDB premises

Tasks of HDB

- Processing of radioactive waste and components
- Decontamination for free release (ca. 70 – 80% of total mass)
- Volume reduction and solidification of radioactive waste for safe final disposal
- Preparation of existing waste for final disposal; Container licensing
- Transport and storage

➡ Permanent staff in total: 169 (12/2015)

History of the HDB

- The Central Decontamination Department was founded in the 1960ies in order to treat and to dispose of the increasing amount of radioactive waste arising from nuclear research at the Karlsruhe site.

- On the Karlsruhe site several research reactors and the reprocessing plant WAK were operated from the 1960ies until today. The resulting process and decommissioning waste is treated by the HDB according to the acceptance criteria of the respective repository.

- The HDB operates the largest interim storage facility for low and intermediate active waste in Germany.

Treatment of waste at HDB

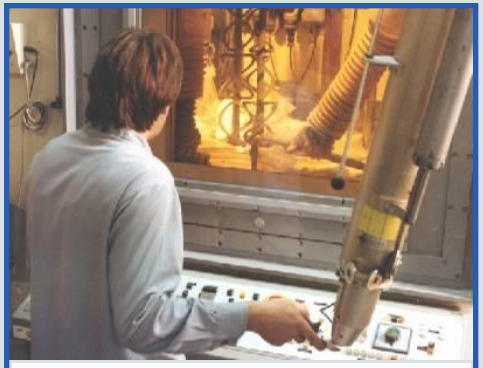
Dekontamination

Disassambling

LAW-scrapping

MAW-Scrapping

Incineration

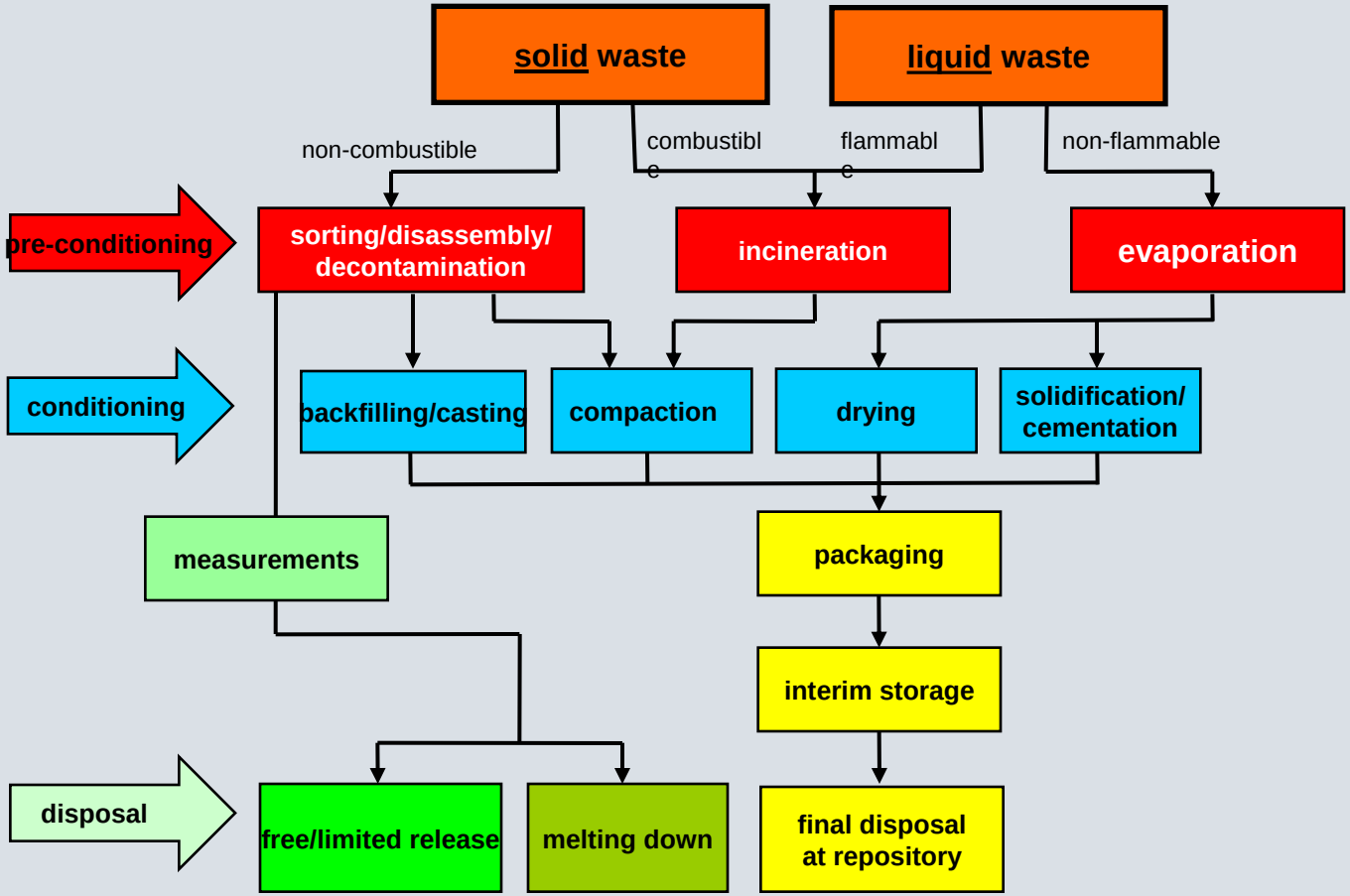


Concentration / Cementation

Origin of radioactive waste

- Operation and decommissioning of WAK (Reprocessing Plant Karlsruhe)
- Operation, decommissioning and deconstruction of research reactors
- European Institute for Transuranium (ITU)
- Federal State Collection Center Baden-Württemberg (incl. KIT institutes)
- External industrial clients and utilities

Pre-conditioning/Conditioning/Disposal



Nuclear Waste Management Division I (ANE I) Decontamination facility

Throughput (on average):
600 Mg/a

10% radioactive waste,
30% waste to melt down,
60% free/limited release

3 caissons,
sandblasting facility,
large component saw,
drying facilities,
backfilling & casting facilities

Nuclear Waste Management Division I (ANE I) Decontamination facility

Nuclear Waste Management Division I (ANE I)

LLW scrapping/compaction

Throughput (on average):
3,000 m³/a

Main tools:
scrapping press
(force 5,000 kN)
4-column press
(force 15,000 kN)

Nuclear Waste Management Division II (ANE II) Incineration of solid and liquid waste

Capacity (on average): 165 Mg/a

Furnace type:

shaft furnace with afterburn - chamber and flue gas scrubber, HEPA filters and dioxin filters

Special attribute: suitable for alpha waste

Nuclear Waste Management Division II (ANE II)

New evaporation facility (circulation evaporator)

2 tanks with 34 m³ usable volume

Evaporation throughput:

200 -250 l / h (depending on solid residues)

Annual throughput (on average):

470 m³ chemical effluents

20 m³ evaporation concentrate

Nuclear Waste Management Division III (ANE III)

ILW scrapping/compaction

Tools:

4-column press (20,000 kN),
hydraulic cutter, hacksaw,
hand and force manipulators,
small tools

Nuclear Waste Management Division III (ANE III)

New solidification facility

Throughput (on average)

approx. 20 m³ evaporation concentrate

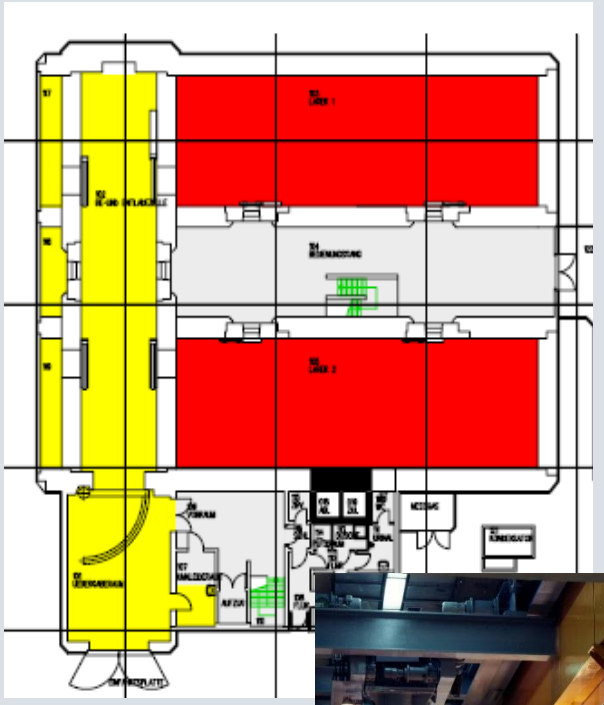
approx. 180 200l drums with solidified/cemented waste

Nuclear Waste Management Division III (ANE III)

Storage for heat-generating waste

Storage building 563 serves as a storage facility for wasteproducts (from decommissioning projects) as well as of raw waste products.

As of December 2014 storage chambers A and B hold 2,424 200l drums with either raw waste or waste products.



In order to maintain the possibility of accepting raw waste with high dose rates from the decommissioning projects of WAK and waste products from the treatment, a new storage has to be build in due time.

Nuclear Waste Management Division IV (ANE IV)

Interim storage for waste with negligible heat generation

Capacity:

77,400 m³ storage space

7,500 Type IV KONRAD containers

Stock:

62,000 m³ occupied

67,400 waste products

6,000 containers

7,000 single-cask shieldings

Storage is allowed only for waste products from FZK, WAK, ITU, the Federal State Collection Center BW, Siemens Hanau and GKN.

Waste products of any other clients can only be stored in preparation for transport.

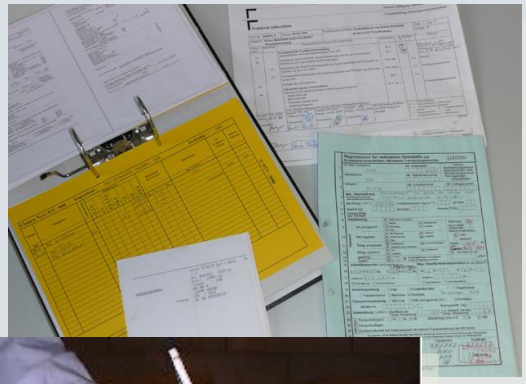
Nuclear Waste Management Division IV (ANE IV)

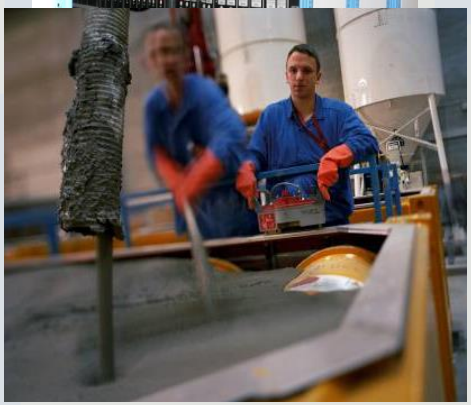
Receiving store and transport

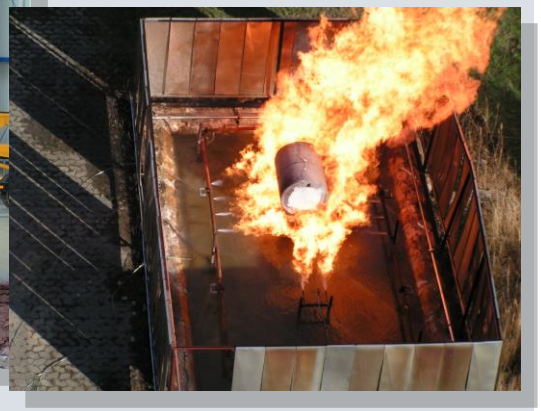
All incoming raw and pre-conditioned waste is stored in the receiving store until processing in one of the HDB facilities is possible.

Staff Division 1 – Final storage/documentation

- Documentation for final repository
- Container licensure
- Operational quality assurance/documentation

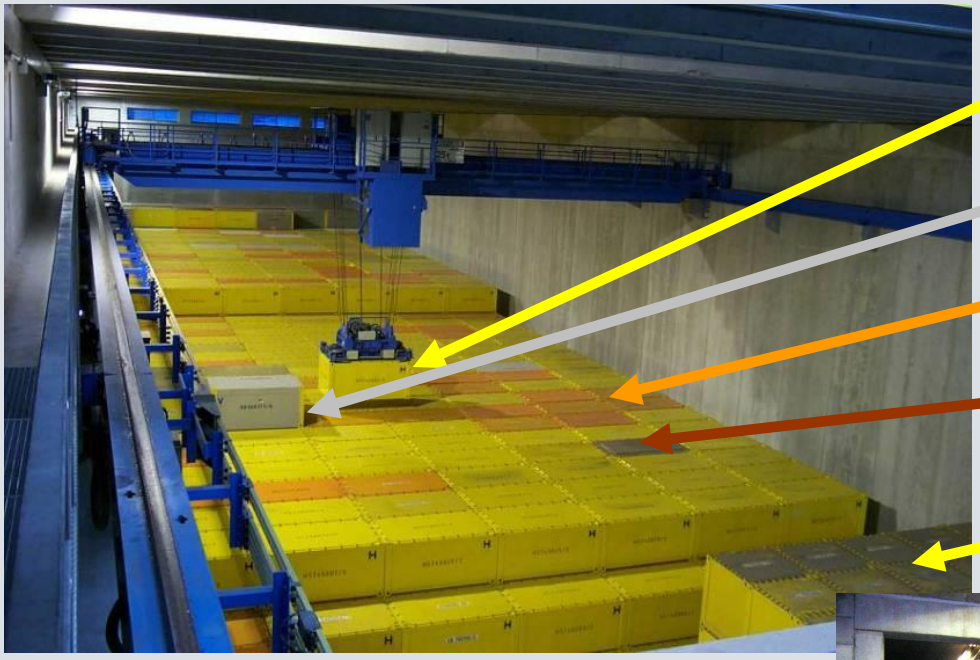


Container Licensing

Approx. 6,000 KONRAD containers and 7,000 single-concrete casks (VBA) without approval for transport and the final repository by BAM or BfS.



approx. 2,750 type IV FSC

approx. 1,000 type IV NBC

approx. 1,100 type IV PSC

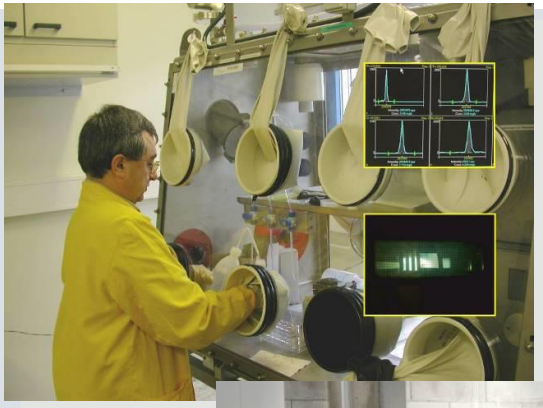
approx. 1,150 type IV SBC

approx. 240 type II PSC

approx. 7,000 type I VBA (NBA/SBA)

Staff Division 2 – Analytics

- Radiochemical laboratory (radioanalysis, elemental analysis)



- Reception and product control (NDA by-γ-Specrometry, dose-rate measurements and neutron counting)

Treatment of radioactive waste at HDB

Objective of waste treatment

1. Reduction of radioactive waste through decontamination and release
2. If this cannot be achieved
   - Reduction of volume (incineration, evaporation, compaction)
   - Compliance with requirements of the repository KONRAD through:
     - Solidification
     - Immobilization of radioactive parts (compaction, cementation)
     - Desiccation

C-14 in the waste streams of WAK GmbH

The waste materials present at HDB contain an overall activity of 1.57E+13 Bq of declared C-14.

The major contributions are:

- Core components from the various reactors
- Casings, hulls and ends from reprocessed nuclear fuel
- Solidified aqueous waste

C-14 in the waste streams of WAK GmbH

In Germany the acceptance criteria of the repository Konrad have the following requirements:

- Declaration of C-14 in terms of mobility (< 1%, 1-10 %, not specified)
- The overall activity of C-14 in Konrad is limited to 4.0E+14 Bq (Mean 1.3E+9Bq/m^3)
- Due to the high limitations generally C-14 is no problematic nuclide

C-14 exceeding the Konrad limitations

In Germany exist a variety of waste-streams containing C-14 beyond the limits of the repository Konrad:

- Core components
- Highly irradiated structural components
- Waste from C-14 production
- Vessel of the prototype reactor AVR

Recent development with regard to C-14

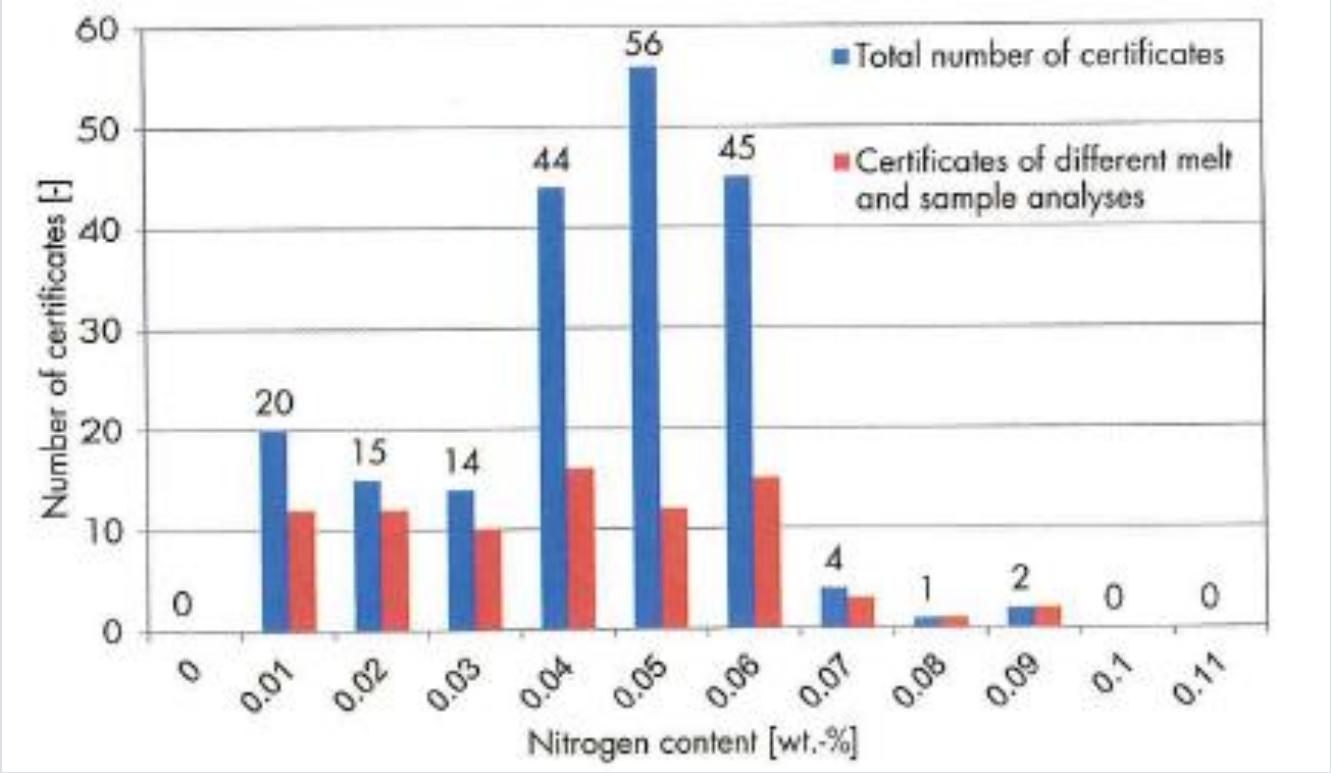
Due to the high uncertainties with regard to the Nitrogen-Content of the various metal types in nuclear reactors especially in the 1970ies and 1980ies GNS and WTI published a recalculation of C-14- in activated core components.

Nitrogen content [wt.-%]	C-14 activities for reference material 1.4550 relative to nominal value Flux factor					
	1	0.1	0.01	0.001	0.0001	0.00001
0.01	9.08 %	0.91 %	0.091 %	0.009 %	0.001 %	0.0001 %
0.03	27 %	2.74 %	0.274 %	0.027 %	0.003 %	0.0003 %
0.05	45 %	4.54 %	0.454 %	0.045 %	0.005 %	0.0005 %
0.07	63 %	6.37 %	0.637 %	0.064 %	0.006 %	0.0006 %
0.09	81 %	8.17 %	0.817 %	0.082 %	0.008 %	0.0008 %
0.11	4.16E+08[1)]	10 %	1 %	0.1 %	0.01 %	0.001 %

Tab. 1.
Calculated C-14 activities depending on the neutron fluence.

Recent development with regard to C-14

Distribution of N in the steel types



Legal requirements

- The acceptance and treatment of radioactive waste requires the compliance with the boundary conditions of:
  - the Atomic Energy Act
  - the Radiation Protection Ordinance
  - the waste acceptance requirements of the respective repository
  - the permission of the HDB.
- The German Radiation Protection Ordinance requires the accounting of radioactive wastes in terms of mass, radiological and physical composition in an electronic database to provide comprehensive information to the appropriate authority upon request.
- The methods of treatment have to be approved by the Bundesamt für Strahlenschutz (BfS, Federal Radiation Protection Authority for this reason treatment methods are regularly defined in tabular qualitie control plans (Ablaufpläne) .

Conditioning of radioactive waste at HDB

Necessary administration:

Transfer of waste to HDB → **Conditioning** → **Documentation** → **Goal: final disposal at KONRAD**

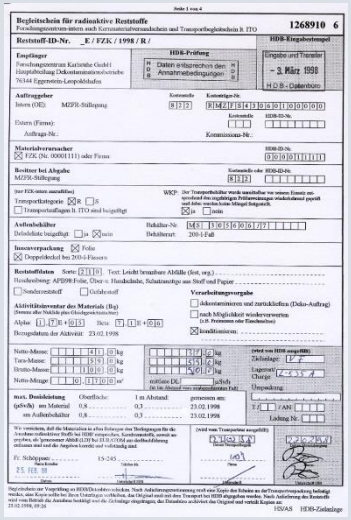
correct declaration of waste

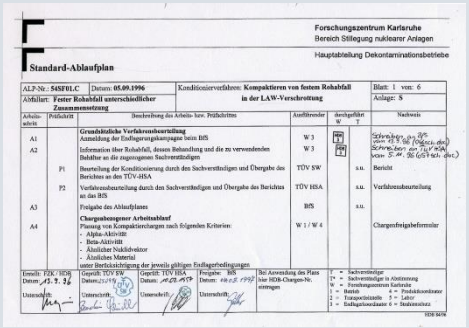
treatment according to process control plan

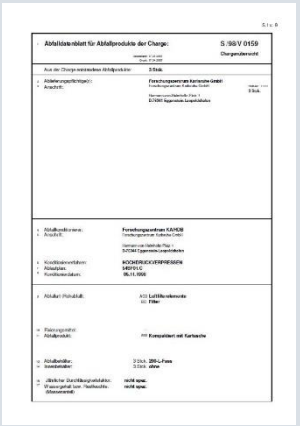
compilation and verification of waste data sheet

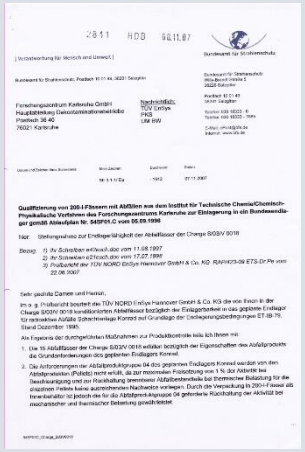
Proof of conducted product control measures

approval by BfS (federal authority) = compliance with KONRAD requirements



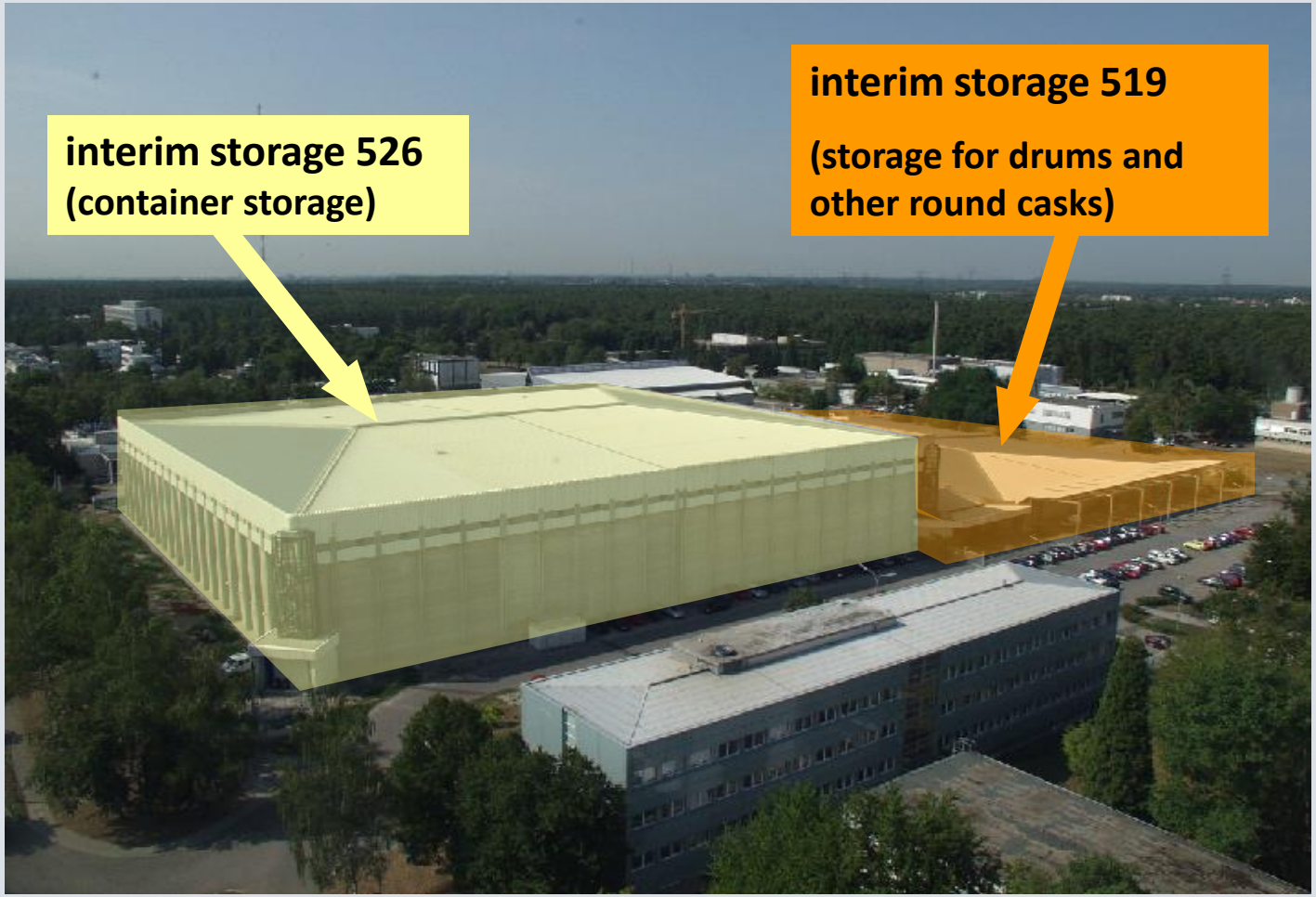






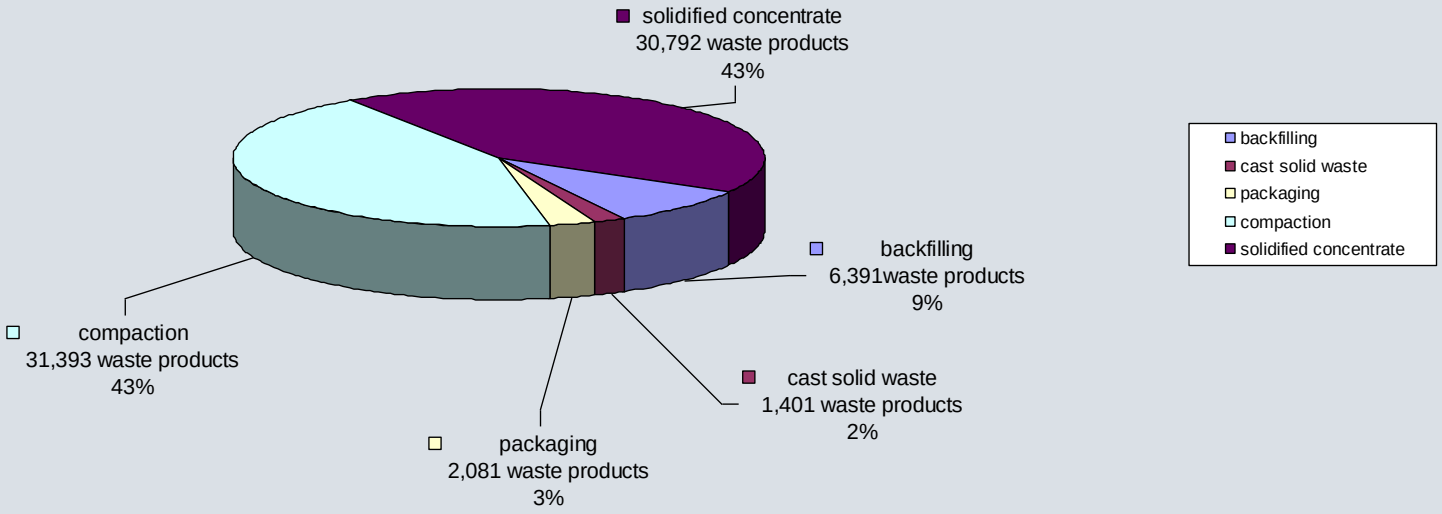
Inventory of radioactive waste

- **HDB interim storage 519/526**



Inventory of radioactive waste

- **Waste distribution at HDB interim storage**
  - **capacity 77,500 m³, approx. 66,000 m³ occupied ≙ approx. 85 %**



Total: 72,058 waste products

Inventory of radioactive waste

- **Interim storage 519**

storage chamber with drums

Cask inventory in L519

approx. 5,500 200-litre drums,
approx. 400 cast-iron casks (SGA, Mosaik) and
approx. 7,000 concrete-shielded casks

storage chamber with concrete-shielded casks

Waste package quality assurance

- **Waste package quality assurance**

unloading of containers

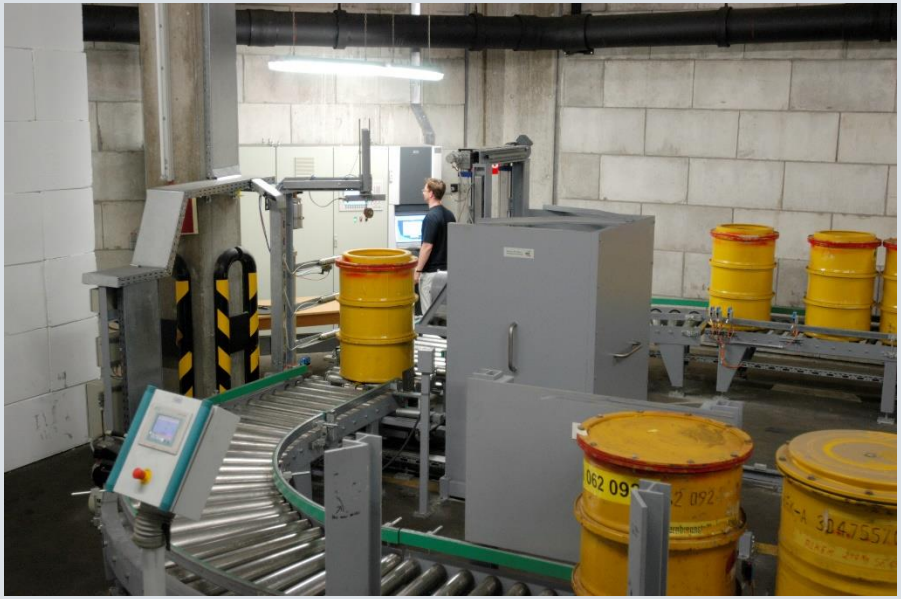
drill line

(placement of pressure relief valves and preparation for gas analysis)

Waste package quality qssurance

- **Waste package quality assurance**

gas sampling



gamma spectrometry

Waste package quality assurance

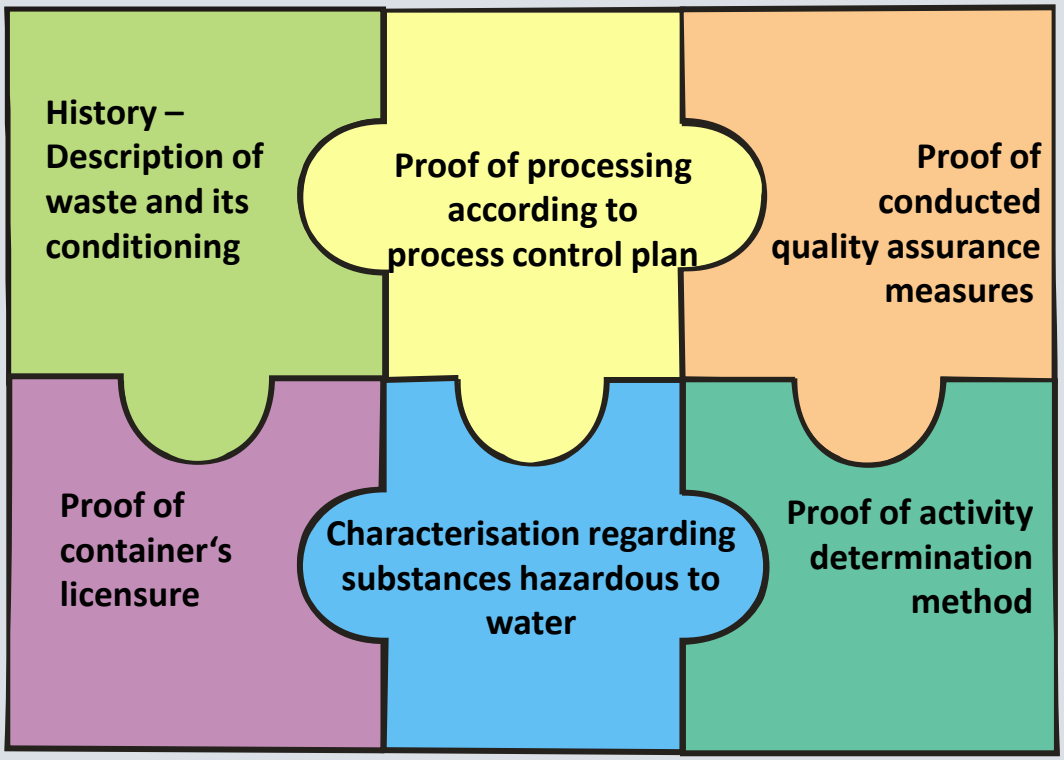
- **Waste package quality assurance**

dose rate measurement, weight check and photo documentation

cementing of containers

Goal: Repository KONRAD

Necessary documentation blocks:



WAK Safety and Responsibility.
For Decades.