

CONDITIONING OF OPERATIONAL AND DECOMMISSIONING WASTES AT THE KARLSRUHE RESEARCH CENTER

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The Karlsruhe Research Center was founded in 1956 in order to enquire scientific and technical know how in the field of the peaceful use of nuclear energy, to built and operate prototype facilities as well as to train and promote young scientists and engineers in these fields.

To fulfill these tasks, a number of installations was established in the cause to the years, such as radiochemical labs, research reactors, prototype power reactors and a prototype reprocessing plant.

During the operation, dismantling and decommissioning of these facilities, liquid and solid radioactive wastes are generated, which have to be treated before reuse, recycling or repository storage.

HDB, the Central Decontamination Operations Department, handles all the raw waste of the Karlsruhe Research Center and some other facilities in Germany (e. g. nuclear power plants or federal meeting points for radwaste) and process it to waste products ready for final disposal.

The HDB was constantly adapted to the changing tasks of the Research Center.

At the moment, the following facilities and groups are operated at the HDB:

THE ENTRY STORE FOR SOLID WASTES

All solid radioactive wastes arising at the Karlsruhe Research Center as well as from industrial customers are subjected to interim storage at our entry store prior to processing. The store has a capacity of about 200 20' containers and about 10,000 200 l drums. The inventory of radioactive substances as specified in the license branded under the atomic law is 3×10^{15} Bq.

INCINERATION PLANT

Until 1996, 3 incineration plants were operated:

One for solid α -waste, one for solid β -waste and one plant for liquid waste.

In 1990, a new Immission Control Act entered into force, as a result of which all 3 plants would have to be backfitted. At the same time, it became clear that the waste volume would decrease in the future. Consequently, the alpha-furnace only was backfitted and equipped with a burner for liquid wastes. The other 2 facilities were shut-down and the technical components were dismantled. The building is to be made available for other use.

Up to now, 4.300 Mg solid wastes with an activity of 2.5×10^{14} Bq were subjected to incineration in the incineration plants of the HDB. The volume reduction factor achieved by the incineration amounts in an average to 1:50. By subsequent compaction of the ashes, it is increased to 1:100.

As far as liquid wastes are concerned, 850 Mg with an activity of 1.7×10^{13} Bq were incinerated.

RELEASE MEASUREMENT STATION

Dismantling of the nuclear facilities of the Research Center gives a rise to large amounts of material which may be contaminated radioactively due to their former types of installation. This material has to be considered radioactive waste, as long as it is not proofed that the limit value specified in the operation license are not exceeded. This is demonstrated by the manual measurement of these wastes or by measuring large amounts of identical material in a measurement system especially designed for the purpose.

This measurement system consists of a roller conveyor with a integrated scales at the entry, a measurement chamber with 4 plastic detectors, each 50 cm x 80 cm size and a roller conveyor at the end. We have calibrate standards for different materials which are delivered either in 200 l drums or in boxes of 1.2 m length, 0.8 m width and 0.8 m height.

Up to now, 1,926 Mg wastes were subjected to release measurement in this facility. 1,487 Mg of these wastes were contaminated below the limit values and, hence, could be released.

Based on the repository storage costs as they are estimated at the moment, a cost reduction of 25 million DM is achieved.

THE EQUIPMENT DECONTAMINATION FACILITY

The facility for the decontamination of equipment and wastes was taken into operation in 1968. Until 1980 equipment to be used again in the research installations of the Research Center was subjected to decontamination and maintenance. Components that were no longer required were crushed and stored in 200l waste drums filled with concrete.

As of 1980, it became obvious that the scope of work of the Research Center will change in the following years by simultaneous reduction of the nuclear activities. The need to avoid waste and to reduce the volume came to the force. In accordance with the new task adopted, the gentle treatment methods installed were replaced by a blasting system based on steel grit, installed in a caisson.

In this caisson, components with a smearable surface contamination of up to 5 Bq/cm² for alpha-activity and up to 50 Bq/cm² for beta-activity are decontaminated for further unlimited reuse.

Components with a higher contamination are subjected to preliminary decontamination by high water pressure or wet-chemical methods. This also is done in two caissons, equipped with devices for the decontamination, crushing and embedding of solid wastes as well as for the homogenisation and solidification of liquid wastes. The wastes can be introduced into this caisson in 200 l drums via alpha-tight doublelid systems or in max. 20' containers via a double-lock system. The caissons are permanently kept at underpressure. As a rule, the exhaust air of the caissons is filtered before it is passed on to an other filter stage together with the exhaust air of the building. The exhaust air of the caisson we handle alpha-contaminated wastes is subjected to double filtering.

Since 1980 nearly 12,000 Mg metal wastes were treated in the plant, 6,500 Mg of which were transferred to unlimited reuse. About 1,600 Mg were subjected to controlled melting and about 3,900 Mg had to be conditioned to waste products for final disposal.

Devices with a total value of about 120 Million DM could be reused after decontamination.

About 90 % of the wastes is delivered in 20' containers. As the plant is not equipped with locks for these containers with the exception of the alpha-caisson, these containers have to be brought into the hall and unloaded. This often causes problems and contamination on the outer surface of the containers. To avoid this in the future, a lock system for the 20' containers is currently installed near the hall.

LAW SCRAPPING

In 1983 a two-stage compacting facility, installed in two connected caissons, was commissioned. The first caisson is equipped with tools to reduce the waste to small pieces as well as with a preliminary press. The staff works in gas-protection suits. In the second caisson a high-pressure compaction system is installed. It is operated in a remote-controlled manner.

Up to now about 10,300 Mg wastes with a volume of nearly 28,500 m³ are compacted. From this, about 100,000 compacts with a volume of 5,000 m³ were generated and filled into 25,000 200 l waste packages. The average compaction factor was 5.7.

MAW SCRAPPING

The first scrapping plant for components from reactors with medium and high activity was taken into operation in 1971. It consisted of a system of hot cells with an entry cell. The working cell is equipped with a force manipulator of 25 kN capacity, a hacksaw and mobile dismantling cutting tools.

In addition, this cell is equipped with docking systems for transport flasks and a double-lid system for the connection of 200 l waste drums. The cell is used about all for cutting work. Up to now nearly 1,000 Mg wastes with an activity of about 1 E17 Bq were conditioned to a form suitable for repository storage.

As the medium- and high-active wastes resulting from the dismantling of the three reactors of the Research Center and the reprocessing plant can not be conditioned in this plant within an acceptable period of time and without a high-expended intermediate storage, a large facility was taken into operation in october 1997. It consists of a lock cell, a charging and discharging cell and a working cell. The cell is equipped with a high-pressure compaction system of 20,000 kN compaction force, a heavy-load manipulator of 50 kN capacity, manipulators and cutting tools such as a scissor and a saw. In the press, the piston and the bell can be exchanged in a remote-controlled manner such that press drums of 180 l and 300 l in volume can be compacted. Residues, e.g. casks for fuel elements, are taken directly from shielding containers. It is also possible to connect 200 l and 400 l drums via a double-lid system.

Based on a co-operation agreement the plant can also be used by NPP operation organisations.

EVAPORATION FACILITY FOR LOW-ACTIVE LIQUID WASTES

The liquid wastes produced in the controlled areas of the Research Center are discharged separately, and transferred to the radioactive sewage processing plant upon sampling and analysis.

Decontamination takes place by distillation in one of the two vapor compression evaporators with forced circulation installed. Each evaporator has a throughput of 4 m³/h.

The raw water is evaporated til the solid content of 30-35 % is reached, the swamp contents, i.e. the radioactive concentrate, is discharged into one of the three collection tanks.

The distillate generated is transferred to the chemical sewage treatment plant after activity control and release.

Up to now, about 435,000 m³ of liquid waste with an initial activity of about 3.2 E15 Bq were decontaminated in the plant.

CEMENTATION PLANT FOR RADIOACTIVE EVAPORATOR CONCENTRATES

Evaporator concentrates, ion-exchanger resins, sludges and spent scrubbing solutions, have been solidified by cementation after radiological and chemical analysis.

The material is discharged from the acceptance tank and directly filled into a dosage system, by means of which it is discharged into a drum filled with cement powder. Then, mixing takes place. The amount of the cement and the amount of the waste are determined by weighing in accordance with our specifications.

The plant is operated in a program-controlled manner with each next step being started manually. Up to now, 1,450 m³ waste with an activity of 4.4 E15 Bq were processed in this plant to about 13,000 200 l drums ready for final disposal.

INTERMEDIATE STORAGE FACILITY FOR RADIOACTIVE WASTES

Due to the closure of the ASSE test repository storage facility in 1978, the Forschungszentrum had to built a storage facility for non-heat generating wastes in addition to a storage facility for heat-generating wastes. In accordance with the requirements, these storage facilities have been extended in the cause of the years.

Meanwhile, the following capacity is available:

- Storage facility for heat-generating wastes
capacity: 3,100 200 l drums
occupied: 2,500
- Storage facility for non-heat generating wastes
capacity: 77,000 m³
occupied: 44,000 m³

RADIOCHEMICAL LABORATORY

In accordance with the operation license and the respective acceptance conditions of the repository, the production of waste packages must be accompanied by measures for quality assurance. Quality assurance is understood to include among others the radiochemical

investigation of the wastes, with regard to the compliance of our acceptance criteria, the supply of the data required and of processing recommendations for the processing facilities as well as the compliance with the final disposal conditions. Besides the radiological, the chemical emissions of our incineration plant have to be controlled.

PRODUCT COORDINATION AND CONTRACT EXECUTION

All wastes delivered are subjected to processing in accordance with our operating license, the final disposal requirements, the provisions for the transport of dangerous goods on roads/by railway and under the aspect of cost minimisation. Based on these requirements, the product coordination group composes charges from the wastes delivered and prepares processing releases.

The contract execution group controls the execution of contracts in accordance with the schedule, the observation of the cost limits, determines the expenditure required for processing and is responsible for invoicing to external customers.

For accomplishing all requirements of the authority, the repository and the customers a waste management computer program is used. This program is not only a “passive” book-keeping system but an “active” program to help operators making decisions. In addition to the book-keeping the program performs the following tasks:

- it makes calculations by correlation of nuclides which cannot be measured in an usual way
- it describes the various material streams resulting from the material treatment
- it gives assistance to the operators to decide how many waste containers of which quality will have to be produced in agreement with the final disposal and transport requirements
- it describes the waste packages for the purpose of acceptance by final repository.