

Low- and Intermediate-Active Waste Management in the Federal Republic of Germany – 16567

Barbara Freund*

* Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Barbara.Freund@bmub.bund.de)

ABSTRACT

Waste with negligible heat generation (low- and intermediate-active waste) generated in Germany is to be emplaced in the Konrad repository. As the start of operation of the Konrad repository is expected in 2022, regulations have been developed that allow a longer storage period while keeping the same high level of safety. The guidelines for the storage of radioactive waste with negligible heat-generation have become part of the regulatory framework and its enforcement is thoroughly guided by the responsible Federal Ministry.

Radioactive waste generated during the operation or the decommissioning of nuclear power plants and nuclear fuel cycle facilities has to be stored by the operator until the Konrad repository is available. In contrast, radioactive waste generated from other industrial, medical and research applications including spent nuclear sources, initially has to be delivered to a *Land* collecting facility and has to be registered, treated and stored there. The *Land* collecting facilities will deliver the resulting waste packages to the disposal facility as of 2022. While the operation of the *Land* Collecting Facilities is a task of the responsible *Länder* authorities, the operation of the repository Konrad is a federal task. The interaction of the involved different parties will be described.

This paper will focus on the management of low- and intermediate-active waste. It will give an insight to the expected amounts and different kinds of waste streams. The different concepts for collecting and qualification procedures for waste packages depending on the origin of the waste will be presented.

INTRODUCTION

On the 19th of July 2011 the Council of the European Union adopted the Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste [1]. This Directive, also known as Waste Directive postulates many tasks for the Member States. One of these tasks was to provide one or several documents describing the strategy for the management of all generated and expected radioactive waste streams. In addition an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning shall be created. This task is referred to as National Programme. Germany has fulfilled these obligations in several documents published on the homepage of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Federal Environmental Ministry)[2].

This paper will focus on the aspects of the National Programme dealing with the management of the low- and intermediate- active waste streams. As Germany is a

federal state the organizational framework differs from other countries. With no repository available at the moment Germany has taken measures to ensure a safe storage of radioactive waste over longer time periods.

DESCRIPTION AND DISCUSSION

German Waste Classification

In Germany, it is intended to dispose of all types of radioactive waste in deep geological formations. Therefore it is not necessary to differentiate between waste containing radionuclides with comparatively short half-lives and waste containing radionuclides with comparatively long half-lives. In accordance with this approach to disposal, the waste classification must therefore comply with the requirements for safety assessment of an underground repository. In this respect, the effects of heat generation from radioactive waste on the design and evaluation of a repository system are particularly important, since the natural temperature conditions may be significantly altered by the deposited waste. For these reasons radioactive waste is initially subjected to a basic subdivision into

- heat-generating waste and
- waste with negligible heat generation.

Heat-generating radioactive waste is characterized by high activity concentrations and thus by a high decay heat. This type of waste includes, in particular, the fission product concentrate, hulls, structural components and feed sludge from the reprocessing of spent fuel, and the spent fuel itself if it is to be disposed of directly as radioactive waste.

Wastes with clearly lower activity concentrations from the operation, decommissioning and dismantling of nuclear facilities as well as from the application of radioisotopes are classified among the radioactive waste with negligible heat generation. "Radioactive waste with negligible heat generation" in this context means that the increase in temperature at the wall of the disposal chamber caused by decay heat from the radionuclides contained in the waste packages must not exceed 3 K on average. This ensures that the temperature conditions prevailing underground will only be influenced by the waste packages emplaced to a negligible extent. This waste stream comprises e.g. disused plant components and defective components such as pumps or piping, ion exchange resins and air filters from waste water and exhaust air decontamination, contaminated tools, protective clothing, decontamination, cleaning agents, laboratory waste, sealed radiation sources, sludges, suspensions, oils as well as contaminated and activated concrete structures and debris.

Inventory of Radioactive Waste With Negligible Heat Generation and Prediction

At the reference date of 31 December 2014 about 117,000 m³ of conditioned radioactive waste have been generated in the federal republic of Germany. The inventory is shown in table I.

TABLE I. Current inventory of radioactive waste with negligible heat-generation (as at 31 December 2014)

Processing condition	Mass or Volume
Raw waste and pretreated waste	21,662 Mg
Conditioned waste products	16,908 m ³
Disposal Containers	100,288 m ³

The volume of raw waste and pretreated waste is given as their mass since the volume of this waste is usually reduced by conditioning and therefore does not allow any conclusions as to the volume to be disposed of. The conditioned waste is given as waste volume since in this case, the expected volume to be disposed of will usually only grow by the packaging of the waste products in disposal containers, but not by any changes of the waste product itself.

Radioactive waste with negligible heat generation is mainly generated during the operation and during the dismantling of nuclear power plants. To a lesser extent, this type of radioactive waste is also generated by the application of ionizing radiation in research, medical and industrial applications including spent nuclear sources. Fig. 1 shows the proportion of conditioned radioactive waste allocated to the different waste generators.

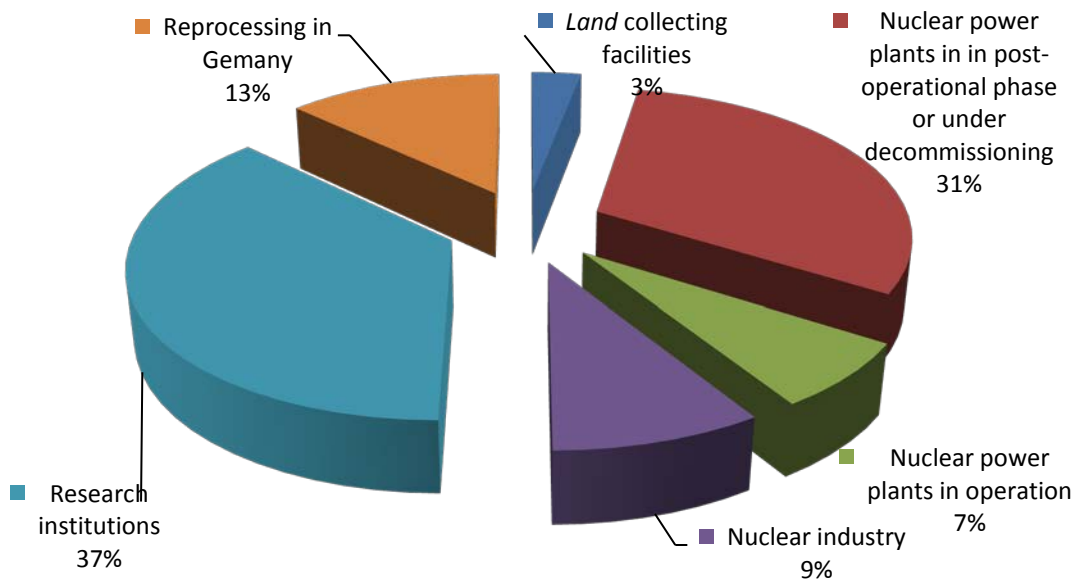


Fig. 1. Proportion of conditioned radioactive waste allocated to the different waste generators as at 31 December 2014

For the prediction of the generated volume of radioactive waste with negligible heat generation, the waste originators were asked to provide data. The information provided by the waste generators also includes the predicted volumes of waste that will arise in connection with the decommissioning and dismantling of nuclear facilities, respectively. The data in question are planning levels which are subject to uncertainties.

The data provided by the waste generators were translated into the numbers of containers suitable for emplacement in the Konrad repository in order to be able to indicate the waste package volume. Regarding the *Land* collecting facilities, the estimate was carried out by the Federal Office for Radiation Protection (BfS) on the basis of the volume of waste of the past years.

The time pattern of the cumulated amount of radioactive in the future as it is expected by the waste originators is shown in fig. 2. It becomes clear from this figure that no further large amounts of waste are expected to arise from the decommissioning of the nuclear power plants after the year 2045.

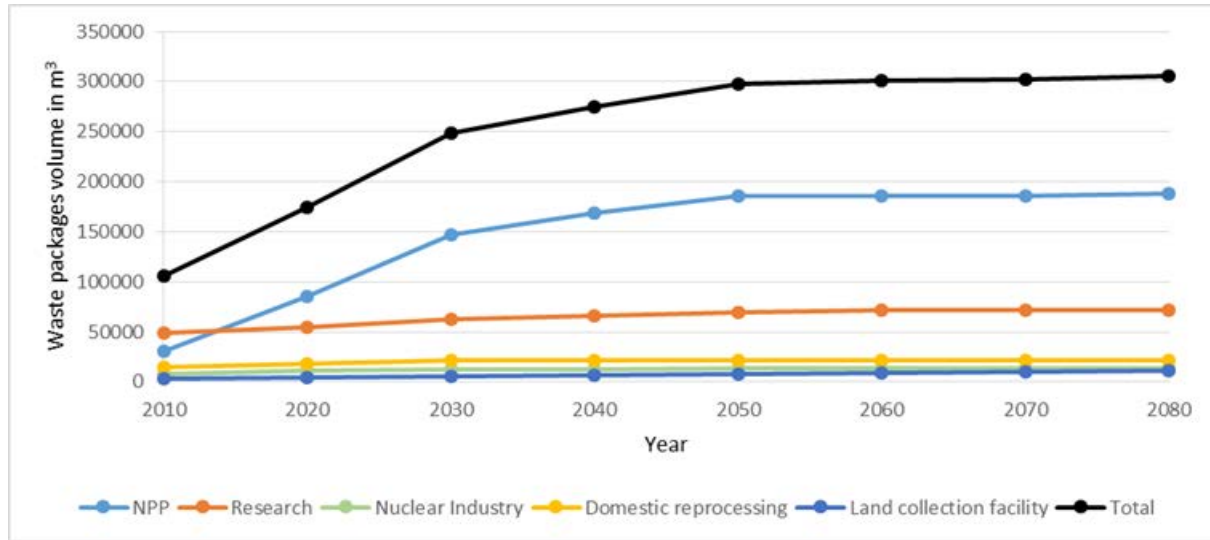


Fig. 2. The time pattern of the cumulated amount of radioactive waste with negligible heat generation as it is expected by the waste generators and which according to the valid license (plan approval) are to be emplaced in the Konrad disposal facility, shown as waste packages volume until the year 2080

Management of Waste with Negligible Heat Generation (Concepts and Responsibilities Within the Regulatory Body)

Germany is a federal state. The responsibilities for the legislative framework and the law enforcement are divided between the bodies of the Federal Government and the Länder according to the respective regulatory duties. Specifications are regulated by the provisions of the Basic Law.

In the Federal Republic of Germany, the construction, operation and closure of disposal facilities for radioactive waste are a federal task. The licensing and supervision activities in the field of radioactive waste management are allocated to the different bodies as shown in Fig. 3. A uniform application of the legal requirements and harmonised licensing practices are ensured by supervision of legality and expediency by the Federal Environment Ministry.

	Radioactive waste management	Legal basis	Licence	Supervision
Spent fuel and waste from reprocessing	Processing	§ 7 of the Atomic Energy Act	<i>Land</i> authority	<i>Land</i> authority
	Storage	§ 6 of the Atomic Energy Act	Federal Office for Radiation Protection	<i>Land</i> authority
	Disposal	§ 9b paragraph 1a of the Atomic Energy Act	Federal Office for the Regulation of Nuclear Waste Management	BfS Repository Surveillance ¹⁾
Radioactive waste with negligible heat generation	Processing	§ 7 of the Radiation Protection Ordinance ²⁾	<i>Land</i> authority	<i>Land</i> authority
	Storage			
	Disposal	§ 9b paragraph 1 of the Atomic Energy Act	Federal Office for the Regulation of Nuclear Waste Management ³⁾	BfS Repository Surveillance ¹⁾

¹⁾ There is no supervision under nuclear law as defined in § 19 of the Atomic Energy Act for federal facilities for the disposal of radioactive waste; surveillance of such a facility takes place within the Federal Office for Radiation Protection by the organisational unit for repository surveillance. The Federal Environment Ministry exercises comprehensive legal and technical supervision of the Federal Office for Radiation Protection and the Federal Office for the Regulation of Nuclear Waste Management.

²⁾ if not already included in a licence pursuant to §§ 6, 7, 9 or 9b of the Atomic Energy Act

³⁾ *Land* authority still competent as a transitional provision for the Konrad repository and the Morsleben repository for radioactive waste

Fig. 3. Responsibilities relating to the licensing and supervision in the field of radioactive waste management in the Federal Republic of Germany

In the area of radioactive waste with negligible heat generation the *Länder* authorities are responsible for the licensing and supervision of processing and storage facilities. Who is the operator of the storage facility depends on the origin of the waste stream. Radioactive waste generated during operation, decommissioning and dismantling of nuclear power plants and nuclear fuel cycle facilities is to be stored until delivery to a disposal facility by the license holder himself or a third party acting on his behalf. Radioactive waste from industrial, medical and research applications initially has to be delivered to the collecting facility of the respective *Land* (*Land* collecting facility) and is stored there. The *Land* collecting facilities are responsible for the treatment of the waste and deliver the radioactive waste stored in them to a disposal facility (see Fig. 4).

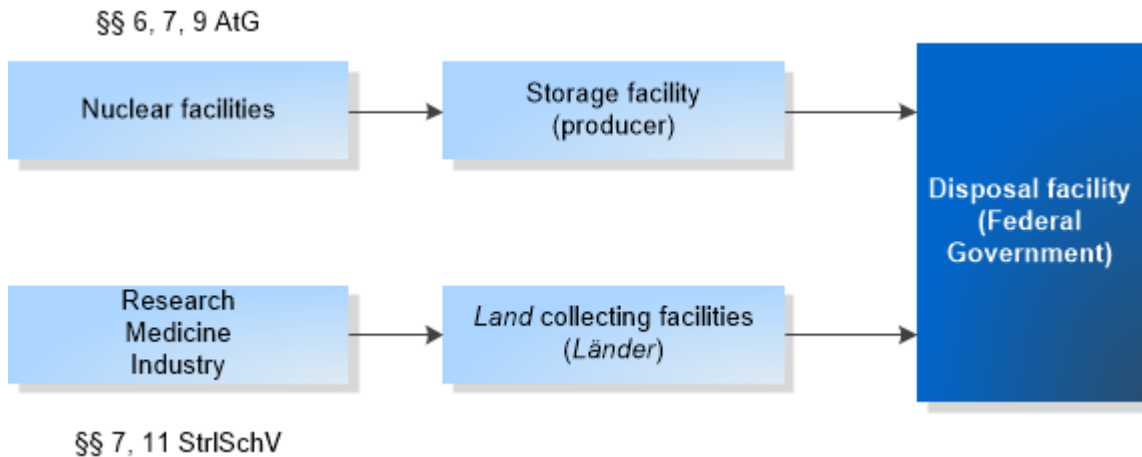


Fig. 4. Obligation to deliver radioactive waste and responsibilities

For spent fuel and radioactive waste management, the polluter-pays principle applies until delivery to a disposal facility. Accordingly, the waste generators bear the cost responsibility and thus have to bear all the costs of waste management. For radioactive waste that is directly delivered to a disposal facility the waste generator is directly responsible for the treatment and the qualification of the waste packages that are accepted at the disposal facility. The costs for the disposal facility projects are demanded from the waste generators by the Federal Government for each phase (site selection procedure for the planned disposal facility especially for heat-generating radioactive waste, planning and construction, operation and closure of all disposal facilities). The *Land* collecting facilities demand fees that cover the costs for treatment, storage and disposal of the waste.

Interdependencies in Radioactive Waste Management

The Waste Directive also puts a focus on the interdependencies between all steps in spent fuel and radioactive waste generation and management. Member states are obliged to spell out in their National Programme the concept and technical solutions for spent fuel and radioactive waste management from generation to disposal, which means in a “cradle to grave” approach.

Waste with negligible heat generation is to be emplaced in the Konrad repository. With regard to the interdependencies, the stored waste should already be treated and documented to meet the disposal requirements or be treated in a way that allows later handling for further treatment to meet the disposal requirements. The start of operation of the Konrad repository is expected in 2022 and the emplacement of the radioactive waste is expected to take around 40 years.

Therefore it has to be assumed that the radioactive waste will need to be stored for longer time periods. Waste that has already been treated to meet the disposal requirements is more suited for these longer storing periods.

Guidelines for the Storage of Radioactive Waste with Negligible Heat Generation

Acknowledging the need for longer storing periods the German Nuclear Waste Management Commission has updated and issued guidelines for the storage of radioactive waste with negligible heat generation. This commission consists of experts from all areas of the nuclear waste management community and advises the Federal Environmental Ministry.

These guidelines set out recommendations for the storage of waste with negligible heat generation and help to ensure high safety standards even over long periods. Among others the most important fundamental protection goals for the waste packages, the storage facility with the technical installations and storage facility operation are:

- Safe confinement of the radioactive substances,
- Avoidance of any unnecessary radiation exposure, limitation and control of the radiation exposure of operating personnel and the general public.

Facilities for the storage of radioactive waste with negligible heat generation should be provided with passive safety features to the largest possible extent while dependence on active safety features, such as monitoring measures performed by the operating personnel for maintenance of safety, should be as low as possible. In case that a safety function can practically not be realized by passive safety features, fulfillment of the safety has to be maintained by active safety features.

For storage, waste forms and waste containers have to be chemically and physically sufficiently stable during the period of storage until their disposal. By treatment of radioactive waste for storage or disposal it has to be ensured that waste package properties relevant for storage or disposal are maintained over the period of storage. Basically, the characteristics relevant for disposal of radioactive waste are also relevant for storage. Therefore treating the waste so it already meets the disposal requirements is recommended.

The guidelines also comprise recommendations on the layout of the storage facility, criticality safety, shielding of ionizing radiation and radiation protection. Aspects relevant for the structural design of new storage halls, technical installations and accident analysis are also covered in the guidelines.

The guidelines emphasize the importance of monitoring and recurrent tests. If it has to be assumed for storage that the retention properties of the waste packages are subject to a relevant change in the course of time, measures are to be taken for an early detection of adverse developments. The visual examinations and inspections can be performed on reference packages. On the basis of the condition of these reference packages, conclusions are drawn on the condition of the other waste packages. This proceeding requires that the reference packages are stored under representative conditions with regard to potential degradations of their retention properties. This procedure may help to reduce the relevant radiation exposure for the inspecting personnel.

Over one year after the adaption of the guidelines the German Nuclear Waste Management Commission requested to check on the implementation of the guidelines. Thus the Federal Environmental Ministry issued a questionnaire to the *Länder*. Evaluation of the questionnaire showed that the guidelines had been implemented to a different degree in the various storage facilities in Germany. Thereupon the German Nuclear Waste Management Commission issued recommendations on the implementations of the guidelines. These especially focus on the importance on the expeditious treatment of raw waste and the further improvement on the monitoring of the waste packages. The enforcement of these recommendations will be guided by the Federal Environmental Ministry and the ministry is planning on repeating the evaluation of the implementation in about two years.

CONCLUSIONS

To fulfill the obligations of the Waste Directive Germany has published five documents laying out the German strategy for radioactive waste management. Technical details, information on the financing and an inventory of radioactive waste are also part of these documents.

Germany will dispose of all radioactive waste in deep geological formations. Waste with negligible heat generation (that is waste of the low-active and intermediate-active waste category) will be emplaced in the Konrad repository.

Radioactive waste generated in nuclear power plants and fuel-cycle facilities is treated, stored and delivered to a federal disposal facility by the waste generators themselves. Radioactive waste generated in research, medical and industrial applications is delivered to a *Land* collecting facility which treats and stores this waste until delivery to a federal disposal facility. The polluter-pays principle applies in both cases.

As the commissioning of the Konrad repository is expected for 2022, regulations have been developed that allow a longer storage period while keeping the same high level of safety. The guidelines for the storage of radioactive waste with negligible heat-generation have become part of the regulatory framework and the implementation has and will be checked by the Federal Environmental Ministry.

REFERENCES

- [1] Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste - EU-Abl L199/48 v. 2.8.2011
- [2] <http://www.bmub.bund.de/en/topics/nuclear-safety-radiological-protection/nuclear-safety/sicherheit-endlager/national-programme/>
- [3] Recommendation of the Nuclear Waste Management Commission (ESK) ESK guidelines for the storage of radioactive waste with negligible heat generation