Federal Ministry
for the Environment, Nature Conservation,
Nuclear Safety and Consumer Protection

Fourth report on the implementation of Directive 2011/70/Euratom

(Report under Article 14(1) of 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)

August 2024

In the event of discrepancies between this translation and the original German version, the latter shall prevail.

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Preface

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 obliges the Member States (MS) of the European Union (EU) to submit a report on the implementation of this Directive (Member State Report), for the first time by 23 August 2015, and to update it every three years. The fourth Member State Report must be submitted by 23 August 2024.

This report was prepared under the leadership of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), taking into account the "Guidelines for Member States reporting on Article 14.1 of Council Directive 2011/70/Euratom" of the European Nuclear Safety Regulators Group (ENSREG).

All information and data provided by the report apply as at the deadline of 31 December 2023 unless expressly specified otherwise. For some aspects in this report, more detailed information can be found in the *Report for the Eighth Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (hereinafter referred to as Report for the Review Meeting of the Joint Convention).

A. Overview

A.1 Generation of spent fuel and radioactive waste

Spent fuel[1] has been generated from the operation of installations for the fission of nuclear fuel for the commercial generation of electricity (hereinafter referred to as power reactors) and from the operation of installations for fission of nuclear fuel not used for the commercial generation of electricity (hereinafter referred to as non-power reactors).

With the German decision to phase out the use of nuclear energy for the commercial generation of electricity, all nuclear power plants were to be shut down permanently in stages by the end of 2022. Against the background of the geopolitical developments in 2022, it was decided to allow the remaining three nuclear power plants to continue operation until 15 April 2023 with the existing nuclear fuel. Shutdown took place as planned on this date. As at 10 June 2024, two research reactors and four reactors for training purposes are in operation. Three power reactors and three non-power reactors are in the post-operational phase. 36 reactors (including the non-power reactors) are in the

[1] *[The footnote of the German original states that the term "abgebrannte Brennelemente" (spent fuel) used in the previous report is synonymous with the term "bestrahlte Brennelemente" (irradiated fuel) used in the German version of the report. The English translation continues to use "spent fuel".]*

decommissioning phase. Decommissioning has been completed for three power reactors and 29 non-power reactors[2] and they have been released from supervision.

Furthermore, a uranium enrichment plant and a fuel fabrication plant are in operation in Germany.

The delivery of spent fuel from power reactors to reprocessing plants has no longer been permitted since 1 July 2005. The waste from reprocessing of spent fuel in other European countries is going to be returned to the Federal Republic of Germany and stored until its disposal.

In the Federal Republic of Germany, low- and intermediate-level radioactive waste was or is mainly generated:

a) during the operation and decommissioning of power and non-power reactors as well as other nuclear waste management facilities and installations,
b) in uranium enrichment and in fuel fabrication (nuclear industry),
c) in basic and applied research,
d) in the use of radioisotopes in other research institutions, universities, trade and industrial companies, hospitals or medical practices,
e) at other waste producers, such as the military sector,
f) in the future, during the conditioning of spent fuel intended for direct disposal.

Between 4 April 1967 and 31 December 1978, low- and intermediate-level radioactive waste had been emplaced in the Asse II mine. Since 1988, there has been a continuous inflow of groundwater from the overburden into the southern flank of the mine. According to § 57b AtG, the Asse II mine must be closed immediately. Closure is to take place after retrieval of the radioactive waste. The concept of retrieval provides for recovering and conditioning of the radioactive waste and storing it until disposal.

From 1971 to 1998, solid and solidified radioactive waste as well as disused sealed radioactive sources had been disposed of in the Morsleben repository for radioactive waste (ERAM). Emplacement of low- and intermediate-level radioactive waste in the ERAM ended and only radioactive waste is disposed of that is generated during the operation of the ERAM to keep the mine open. The disposal facility is to be closed and sealed for the long term.

A.2 Authorities and organisations involved in spent fuel and radioactive waste management

By organisational decree, the Federal Government designates the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) as the federal ministry responsible for nuclear safety and radiation protection. The administrative tasks are performed by authorities of the Federation and the *Länder*.

[2] The nuclear ship “Otto Hahn” and the Frankfurt-2 research reactor are not taken into account.

Figure A-1 shows the organisational framework of the authorities involved with their responsibilities and interdependencies.

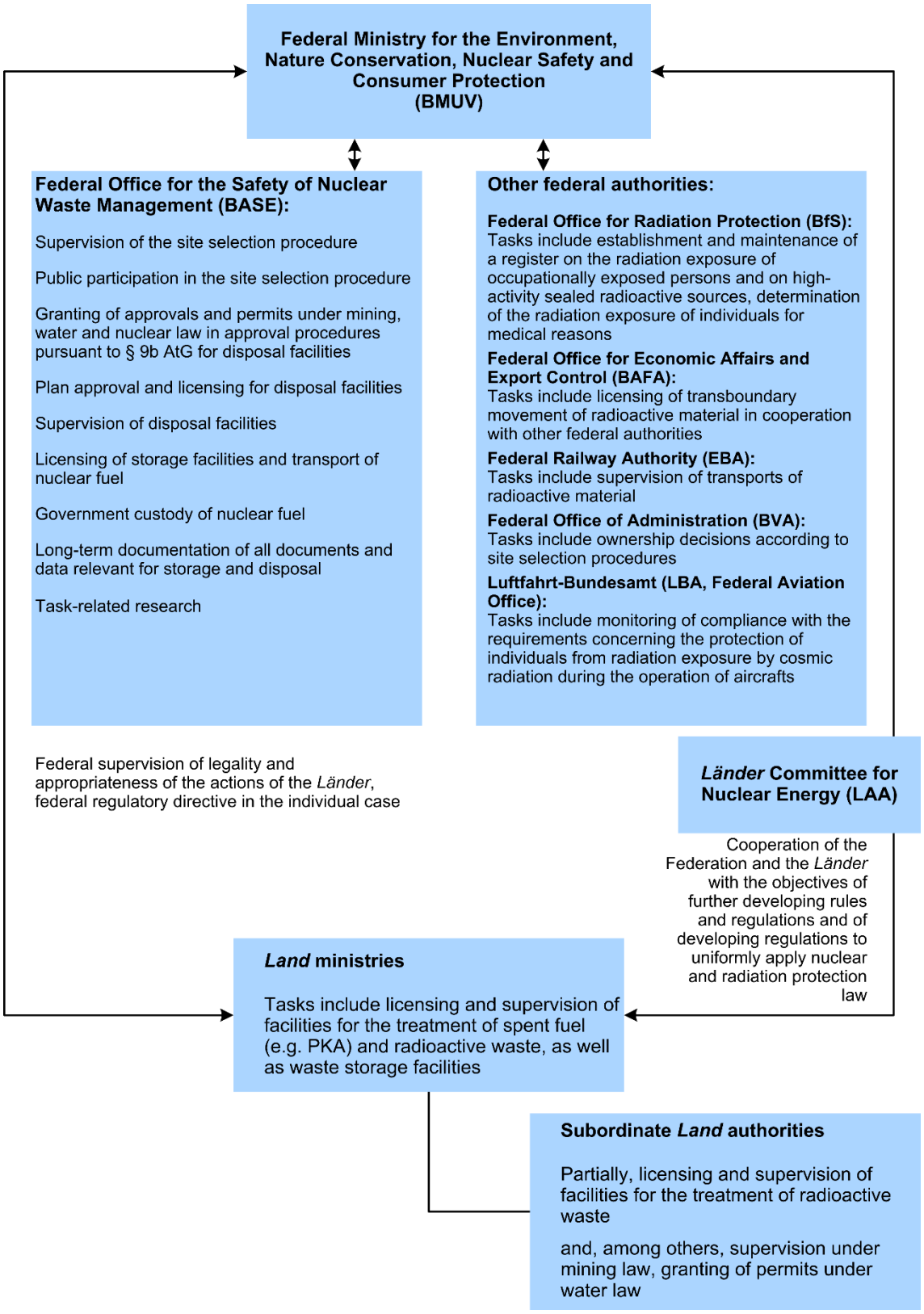

Figure A-1: Regulatory organisational framework in the field of spent fuel and radioactive waste management in the Federal Republic of Germany

As higher federal authority, the Federal Office for the Safety of Nuclear Waste Management (BASE) is the competent approval and supervisory authority for facilities for disposal to be established by the Federation according to § 9a(3) AtG, with transitional provisions applying to the Konrad repository and the ERAM. BASE is also responsible for licences pursuant to § 6 AtG for the storage of nuclear fuel, for licences pursuant to § 4 AtG for the transport of nuclear fuel, and for the execution of government custody pursuant to § 5 AtG. In addition, BASE supervises the Asse II mine under nuclear and radiation protection law and the implementation of the site selection procedure and is also responsible for public participation in the site selection procedure.

According to § 9a(3) AtG, the Federation is responsible for the provision of disposal facilities, which has transferred the performance of its tasks to the private-law Bundesgesellschaft für Endlagerung mbH (BGE) in shareholding management by the BMUV and whose sole shareholder is the Federation. The BMUV performs the task of shareholding management organisationally separately from its nuclear tasks. The BGE is the project implementer of the site selection procedure and is responsible for the operational tasks of the search for a site, the construction, the operation and the closure of disposal facilities as well as the operation and the closure of the Asse II mine. Furthermore, the BGE ensures compliance with the waste acceptance criteria by qualifying conditioning measures and waste packages; the latter is a sovereign task.

Other administrative tasks in the area of licensing and supervision of nuclear installations and facilities are carried out by the *Länder* on behalf of the Federation. Subordinate authorities may also be entrusted with licensing and supervisory tasks.

The *Länder* Committee for Nuclear Energy (LAA) serves the purpose of preparatory coordination of the activities of federal and *Land* authorities. For preparing decisions to be taken by the General Committee, the LAA avails itself of several technical committees as well as the working groups assigned to the technical committees for special permanent tasks.

In the area of legislation, the LAA is an important instrument of early and comprehensive involvement of the *Länder* which supplements the formal right of participation of the *Länder* in the legislative procedure of the *Bundesrat*.

The management of spent fuel and radioactive waste is based on the polluter-pays principle. According to § 9a(1) AtG, the producers of residual radioactive material and plant components are required to ensure that these are utilised without detrimental effects or are disposed of as radioactive waste in a controlled manner. If the residual material is classified as radioactive waste, it is to be delivered to a disposal facility or a *Land* collecting facility, as stipulated in § 9a(2) AtG. Furthermore, the producers are responsible for the conditioning and storage of spent fuel and radioactive waste (see also Chapter I).

The producers of radioactive waste from the operation and decommissioning of the power reactors are responsible for its conditioning and storage unless it was delivered as radioactive waste properly packaged pursuant to § 2 EntsorgÜG (Waste Management Transfer Act) – upon fulfilment of the requirements – to a third party commissioned by the Federation, i.e. BGZ Gesellschaft für Zwischenlagerung mbH (BGZ) who will then be responsible for further storage.

The operators of nuclear installations and facilities are responsible for carrying out decommissioning.

The *Länder* established *Land* collecting facilities for the storage of radioactive waste from medicine, industry and research generated within their territories. With the delivery of radioactive waste to a *Land* collecting facility, the ownership is transferred to this facility and the operator of the *Land* collecting facility assumes responsibility for its conditioning and storage.

A.3 National radioactive waste management policy fundamentals

The national radioactive waste management policy is based on the following decisions:

- The utilisation of nuclear fission for the commercial generation of electricity in the Federal Republic of Germany ended in April 2023.
- The delivery of spent fuel from installations for the commercial generation of electricity to reprocessing plants has no longer been permitted since 1 July 2005. The current waste management objective provides for its direct disposal. The radioactive waste from the reprocessing of spent fuel from power reactors in other European countries is going to be returned to Germany and stored until its disposal.
- A licence for the export of spent fuel from the operation of nuclear fission facilities for research purposes may only be granted for serious reasons of non-proliferation of nuclear fuel or for reasons of sufficient supply of fuel elements to German research reactors for medical and other top level research purposes. Notwithstanding this, a licence for the export of spent fuel shall not be granted if it is stored in Germany on the basis of a licence pursuant to § 6 AtG. This does not apply to the shipment of fuel assemblies with the aim of producing waste packages that are suitable for disposal and that are to be disposed of in Germany.
- The Federation shall establish facilities for the safekeeping and disposal of radioactive waste. It plans to dispose of all types of radioactive waste in deep geological formations. For radioactive waste with negligible heat generation[3], the Konrad mine in Salzgitter is currently being converted into a repository. The site for disposal of high-level radioactive waste will be determined by a selection procedure established in accordance with the Site Selection Act (StandAG) and has officially been started in 2017.

The strategy for the management of all spent fuel and radioactive waste that has been and will be generated is outlined in the *Programme for the responsible and safe management of spent fuel and radioactive waste* (hereinafter referred to as National Programme).

[3] This radioactive waste with negligible heat generation corresponds to a partial quantity of low- and intermediate-level radioactive waste.

A.4 Periodic self-assessment and peer review

As an international peer review that meets the requirements of Directive 2011/70/Euratom, an IRRS mission (Integrated Regulatory Review Service) was conducted in the Federal Republic of Germany from 31 March to 12 April 2019, an IRRS follow-up mission from 9 to 16 October 2023 and an ARTEMIS mission (IAEA Radioactive Waste Management Integrated Review Service) from 22 September to 4 October 2019, followed by an ARTEMIS follow-up mission from 6 to 12 November 2022. Results of these reviews are presented in Chapter L.

B. Developments since the third Member State Report

Developments in the legal and administrative framework:

- All remaining responsibilities for nuclear energy and nuclear safety and waste management research were transferred from the area of responsibility of the Federal Ministry for Economic Affairs and Climate Protection (formerly: Federal Ministry for Economic Affairs and Energy) to the BMUV, with the exception of responsibility for financing dismantling and waste management.

- With the Seventeenth Act Amending the Atomic Energy Act of 10 August 2021, existing security-related substatutory regulations were raised to the level of the Atomic Energy Act and legal certainty was increased in the way in which the requirements and measures that are relevant for the nuclear security of nuclear power plants, storage facilities, conditioning facilities, disposal facilities and transports are defined.

- With the Eighteenth Act Amending the Atomic Energy Act of 10 August 2021, regulations were introduced on the financial compensation of the electric power utilities for phasing out the commercial use of nuclear energy.

- With the Nineteenth Act Amending the Atomic Energy Act of 4 December 2022, it was decided to continue operating the last three power reactors in operation – Emsland, Isar 2 and Neckarwestheim 2 – for a limited period of time beyond the end date for power operation on 31 December 2022 previously provided for under the Atomic Energy Act until 15 April 2023.

- With the shutdown of the last three German power reactors Isar 2, Neckarwestheim II and Emsland on 15 April 2023, the nuclear phase-out was completed in accordance with the Atomic Energy Act.

- Upon proposal from the Federal Environment Ministry, the Federal Government adopted the general federal emergency plan (ANoPl-Bund) as a general administrative provision with the approval of the *Bundesrat* on 14 November 2023. In particular, it specifies basic protection strategies for different types of radiological emergencies with varying degrees of severity.

Developments in responsible and safe waste management:

- Since January 2021 and until June 2024, four more permanently shut-down power reactors (Grohnde, Gundremmingen C, Isar 2 and Neckarwestheim II) have been granted licences for decommissioning.

- Due to the currently not yet available disposal facility, the storage capacities for radioactive waste from operation and decommissioning of the power reactors have been and will be increased at various sites. Since January 2021, two other radioactive waste storage facilities (AZR in Grafenrheinfeld and AZN in Neckarwestheim) have been commissioned and have thus been transferred to BGZ in accordance with the Waste Management Transfer Act. Another storage facility was built in Brunsbüttel and is currently being commissioned.

- Radioactive waste from the reprocessing of spent fuel from German power reactors still has to be taken back from France. Originally, it was planned to return five Castor casks with vitrified intermediate-level radioactive waste to the Philippsburg storage facility and 152 large casks of a newly developed TGC27 design with high-pressure compacted intermediate-level metal residues to the Ahaus storage facility. The French and German industrial partners have concluded an agreement to change the allocation of the waste still to be returned by the German nuclear power plant operators. Instead of the 157 (= 152 + 5) casks with intermediate-level radioactive waste, vitrified high-level radioactive waste (CSD-V) will now be returned in four casks. These four casks with high-level radioactive waste will be stored in Philippsburg instead of the previously planned five casks with intermediate-level radioactive waste. In addition, 24 empty and disused transport casks ("end used cask" – EUC) for spent fuel will be sent for further utilisation as a mass equivalent, if necessary after storage.

- For removal of the casks from the AVR cask storage facility in Jülich, the option of transportation to Ahaus is being pursued. The option of building a new storage facility in Jülich is being kept open in parallel. The option of shipping the nuclear fuel to the USA has not been further pursued since October 2022. Parallel to the two options mentioned above, attempts are made to obtain a new storage licence for the existing AVR cask storage facility for a period of nine years.

- The BGE has reassessed the remaining activities for the construction of the Konrad repository and has come to the conclusion that the work will be delayed by around two years and that the Konrad repository cannot be completed before the end of 2029.

- Within the framework of the site selection procedure, the BGE published the "Subareas Interim Report" at the end of September 2020. BASE organised a Subareas Conference for public participation with three meetings in 2021. The results of the Subareas Conference were submitted to the BGE for further consideration in the site selection procedure. The site selection procedure is currently in Step 2 of Phase I in which siting regions for surface exploration are being determined on the basis of the previously identified subareas.

C. Scope and inventory

Article 2 – Scope

Article 2.1

(1) This Directive shall apply to all stages of:

a) spent fuel management when the spent fuel results from civilian activities;
b) radioactive waste management, from generation to disposal, when the radioactive waste results from civilian activities.

Article 2.2

(2) This Directive shall not apply to:

a) waste from extractive industries which may be radioactive and which falls within the scope of Directive 2006/21/EC;
b) authorised releases.

Article 2.3

(3) Article 4(4) shall not apply to:

a) repatriation of disused sealed sources to a supplier or manufacturer;
b) shipment of spent fuel of research reactors to a country where research reactor fuels are supplied or manufactured, taking into account applicable international agreements;
c) the waste and spent fuel of the existing Krško nuclear power plant, when it concerns shipments between Slovenia and Croatia.

Article 2.4

(4) This Directive shall not affect the right of a Member State or an undertaking in that Member State to return radioactive waste after processing to its country of origin where:

a) the radioactive waste is to be shipped to that Member State or undertaking for processing; or
b) other material is to be shipped to that Member State or undertaking with the purpose of recovering the radioactive waste.

This Directive shall not affect the right of a Member State or an undertaking in that Member State to which spent fuel is to be shipped for treatment or reprocessing to return to its country of origin radioactive waste recovered from the treatment or reprocessing operation, or an agreed equivalent.

Article 12 – Contents of national programmes

Article 12.1

(1) The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:

c) an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;

Article 14 – Reporting

Article 14.2

(2) On the basis of the Member States' reports, the Commission shall submit to the European Parliament and the Council the following:

b) an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects.

The safety of management of spent fuel from German power and non-power reactors, which is to be stored and disposed of, falls under the scope of this Directive and thus under the reporting obligation. Furthermore, the scope covers the safety of the management of radioactive waste from the operation and decommissioning of German nuclear installations and facilities as well as from the use of radioactive substances in medicine, industry and research (see Chapter A.1 for details).

In the Federal Republic of Germany, a distinction is drawn between radioactive waste that is nuclear fuel and handled on the basis of licences under the Atomic Energy Act or other radioactive substances that require a handling licence under radiation protection law on the one hand, and waste only containing naturally occurring radioactive material (NORM) on the other hand. For NORM, some of the applicable requirements (e.g. with regard to release from control under radiation protection law) are principally different from requirements applicable to radioactive waste from nuclear installations or from other handling which is licensed under nuclear or radiation protection law. In Germany, NORM is not considered as radioactive waste and therefore does not fall under the reporting obligation.

Based on the intention to dispose of all types of radioactive waste in deep geological formations and taking into account disposal-relevant aspects, a basic subdivision was chosen in the Federal Republic of Germany which meets the requirements for the registration and classification of radioactive waste from the point of view of disposal:

- heat-generating radioactive waste (also referred to as high-level radioactive waste: spent fuel and vitrified waste from its reprocessing), and
- low- and intermediate-level radioactive waste.

The first type is classified as high-level radioactive waste (HLW) and largely corresponds to high level waste according to IAEA classification. Other radioactive waste is classified as low- and intermediate-level radioactive waste (LILW) and mainly corresponds to low and intermediate level waste according to the IAEA classification. Part of the LILW corresponds to radioactive waste with negligible heat generation, which is to be disposed of in the Konrad repository. This basic subdivision is also maintained if the waste packages to be disposed of are kept in extended surface storage before being delivered to a disposal facility. Detailed information on the inventory of spent fuel and radioactive waste as at 31 December 2023 can be found in the Inventory of Radioactive Waste, which covers spent fuel and radioactive waste from reprocessing in other European countries as well as all types of radioactive waste that are to be disposed of in the Federal Republic of Germany. In addition, the Inventory of Radioactive Waste provides a forecast of the expected radioactive waste volume up to the year 2080. As at 31 December 2023,

around 16,711[4] Mg HM[5] had been generated from the operation of power reactors in the Federal Republic of Germany in the form of spent fuel, which will have to be disposed of in Germany. Of these, 1,896 Mg HM are stored in the spent fuel pools of the power reactors and 7,463 Mg HM are kept in dry storage. 6,673 Mg HM of spent fuel have already been removed from the nuclear power plants either for reprocessing or for permanently remaining abroad. The remaining 675 Mg HM are kept in transport and storage casks in the central spent fuel storage facilities in Ahaus and Gorleben and in the Storage Facility North (ZLN) in Rubenow near Greifswald.

The radioactive waste returned from reprocessing of German spent fuel in other European countries and the vitrified high-level radioactive waste generated in Germany is stored in the form of 3,332 canisters in 119 casks.

The amount of spent fuel from the non-power reactors is stored in the wet storage facilities of the research reactors in Berlin (102 kg HM), Garching (334 kg HM) and Mainz (764 g uranium) and in 479 casks (11 Mg HM, dry storage) in the spent fuel storage facility in Ahaus, in the AVR cask storage facility in Jülich and in the ZLN in Rubenow.

As at 31 December 2023, there were 25,460 Mg of raw and pretreated waste, and 134,290 m³ of treated and conditioned radioactive waste stored in the Federal Republic of Germany.

About 47,000 m³ of low- and intermediate-level radioactive waste were emplaced in the Asse II mine. This waste is to be recovered, conditioned and stored until disposal. Current estimates assume a volume of approx. 175,000 to 220,000 m³ of conditioned waste for later disposal.

During the period from 1971 to 1998, around 37,000 m³ of radioactive waste and 6,621 disused sealed radioactive sources were disposed of in the ERAM. The radioactive waste generated from 1998 to the end of 2023 from operation for keeping the disposal facility open was also emplaced in the disposal facility.

Further information on the categorisation of radioactive waste can also be found in the Report for the Review Meeting of the Joint Convention (Chapter B.1.5). To allow for classification according to the system of the International Atomic Energy Agency (IAEA), a transfer table (**Table C-1**) has been developed. It should be noted, however, that this is only an approximation which is subject to uncertainties.

[4] The quantities given in Mg HM are rounded to the nearest whole number. This may result in minor differences in the total compared to other figures published.

[5] Megagram of heavy metal (Mg HM) is the unit of the mass of heavy metal and hence a measure for the fuel content (uranium, plutonium and thorium) of a fuel assembly.

Table C-1:Table for transfer into the IAEA classification

Waste class*	**VLLW**	**LLW**	**ILW**	**HLW**	**Waste management route**
NHGW**	-	90 %	10 %	-	Disposal in deep geological formations
HGW (m^3)***	-	-	2 %	98 %	Disposal in deep geological formations
HGW (Mg HM)****	-	-		100 %	Disposal in deep geological formations

* NHGW waste with negligible heat generation; HGW: heat-generating waste

** The percentages are based upon waste characteristics including radionuclide inventory and estimated annual arisings (provided by the waste producers). The characteristics were compared with the limits for long-lived nuclides and heat generation specified in the IAEA's waste classification scheme.

*** The percentages are based on the current amount of waste from reprocessing returned to Germany and other radioactive waste. The ratio will change in the future.

**** Spent fuel is classified as high level waste (HLW).

Note: In future, radioactive waste will also be produced during the conditioning of spent fuel – depending on the disposal concept, also intermediate level waste (ILW) such as structural parts. The ratio refers only to spent fuel (Mg HM).

D. Article 4 – General principles

Article 4 – General principles

Article 4.1

(1) Member States shall establish and maintain national policies on spent fuel and radioactive waste management. Without prejudice to Article 2(3), each Member State shall have ultimate responsibility for management of the spent fuel and radioactive waste generated in it.

Article 4.2

(2) Where radioactive waste or spent fuel is shipped for processing or reprocessing to a Member State or a third country, the ultimate responsibility for the safe and responsible disposal of those materials, including any waste as a by-product, shall remain with the Member State or third country from which the radioactive material was shipped.

Article 4.3

(3) National policies shall be based on all of the following principles:

g) the generation of radioactive waste shall be kept to the minimum which is reasonably practicable, both in terms of activity and volume, by means of appropriate design measures and of operating and decommissioning practices, including the recycling and reuse of materials;

h) the interdependencies between all steps in spent fuel and radioactive waste generation and management shall be taken into account;

i) spent fuel and radioactive waste shall be safely managed, including in the long term with passive safety features;

j) implementation of measures shall follow a graded approach;

k) the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials;

l) an evidence-based and documented decision-making process shall be applied with regard to all stages of the management of spent fuel and radioactive waste.

Article 4.4

(4) Radioactive waste shall be disposed of in the Member State in which it was generated, unless at the time of shipment an agreement, taking into account the criteria established by the Commission in accordance with Article 16(2) of Directive 2006/117/Euratom, has entered into force between the Member State concerned and another Member State or a third country to use a disposal facility in one of them.

Prior to a shipment to a third country, the exporting Member State shall inform the Commission of the content of any such agreement and take reasonable measures to be assured that :

a) the country of destination has concluded an agreement with the Community covering spent fuel and radioactive waste management or is a party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management ('the Joint Convention').

b) the country of destination has radioactive waste management and disposal programmes with objectives representing a high level of safety equivalent to those established by this Directive; and

c) the disposal facility in the country of destination is authorised for the radioactive waste to be shipped, is operating prior to the shipment, and is managed in accordance with the requirements set down in the radioactive waste management and disposal programme of that country of destination.

The ultimate responsibility for the management of spent fuel and radioactive waste lies with the Federal Republic of Germany.

Regarding the responsible and safe management of spent fuel and radioactive waste, the National Programme includes, among other things, the following aspects:

- The management of spent fuel and radioactive waste shall, as a rule, be carried out within German national responsibility. Disposal is to be on German national territory. All types of radioactive waste are to be disposed of in deep geological formations.
- The radioactive waste from reprocessing of spent fuel from power reactors in other European countries is going to be returned to Germany and stored until its disposal. Since 1 July 2005, delivery of spent fuel for the purposes of reprocessing has been prohibited. The waste management objective is its direct disposal.
- In addition to German facilities, facilities abroad are also used for the processing of radioactive waste; radioactive waste produced in the process is returned to the Federal Republic of Germany. Until its disposal, radioactive waste from the operation and decommissioning of nuclear installations and facilities is treated and stored in decentralised or central facilities.

For the disposal of spent fuel and radioactive waste, the following main principles are taken into account in Germany:

D.1 Minimisation principle

In accordance with § 8 StrlSchG for the avoidance of unnecessary exposure and dose reduction, the generation of radioactive waste shall also be limited to the extent that is reasonably practicable in terms of activity and volume, taking into account the state of the art in science and technology. This is achieved by appropriate design, operation and decommissioning measures, including the recycling and reuse of materials. So, for example, the operators must consider the requirements relating to the proposed decontamination and dismantling methods in the decommissioning concept. In order to achieve a condition adequate for the implementation of decommissioning measures, the volume must be reduced in addition to the individual and collective doses and the residual material must be utilised as harmlessly as possible, also taking into account the secondary waste volumes. In addition to the non-detrimental utilisation of radioactive residues, decay storage is also pursued to facilitate processing and, where applicable, clearance of the materials at a later stage and thus to reduce the volume for disposal. Special volume reduction methods are used to further reduce the demand for storage and disposal capacities. The pretreatment of radioactive waste serves, e.g., to reduce the volume and to convert the raw waste into manageable intermediate products that can be conditioned for disposal. All radioactive waste is sorted when it is produced and documented according to type, content and activity. The Nuclear Waste Management Ordinance (AtEV) and the Guideline for the control of residual radioactive material and radioactive waste specify the sorting criteria for this. Other volume-reducing treatment methods include, for example, compaction, melting or incineration (see also Inventory of Radioactive Waste for details).

D.2 Interdependencies between all steps in spent fuel and radioactive waste generation and management

Interdependencies

The waste producers have to submit a waste management concept for all radioactive waste generated containing details on the technical and organisational provisions for collection and registration as well as on the whereabouts. As stipulated in § 1 AtEV, the expected annual amount of radioactive waste is to be estimated for the entire period of operation indicating the planned whereabouts, and evidence on the whereabouts is to be provided annually, notifying the competent authority about the amount of the radioactive waste accordingly. In addition, according to § 9a AtG, proof that adequate waste management provisions have been made is to be provided annually regarding the non-detrimental utilisation or controlled disposal of spent fuel. Furthermore, similarly structured proof is also furnished to the supervisory authorities regarding the storage of waste from the reprocessing of spent fuel in foreign countries to be returned, as well as for the reuse of the separated plutonium from the reprocessing of spent fuel in nuclear power plants, and for the whereabouts of the separated uranium from the reprocessing of spent fuel. In the meantime, recycling of all separated plutonium has been completed by the reuse of MOX fuel. Some of the separated uranium was recycled in German nuclear power plants, but a small amount was also transferred to the reprocessing companies. In accordance with the concept of the Federal Republic of Germany to store the spent fuel at the sites of the power reactors, spent fuel storage facilities were licensed, constructed and commissioned under nuclear law at twelve power reactor sites.

The decommissioning of facilities for spent fuel management and management of other radioactive waste is taken into account already at the design stage and during their construction, applying mutatis mutandis the stipulations and recommendations contained in the statutory and substatutory regulations on the decommissioning of nuclear installations. The design ensures that the decommissioning of these facilities at a later stage takes place under consideration of the radiological protection of operating personnel and adherence to the radiological protection regulations. In particular, the structural requirements are to be met to ensure the use of specific decontamination and dismantling methods, including remote-controlled methods, during the later decommissioning of the facility. With regard to facilities for the dry storage of spent fuel and radioactive waste from reprocessing, the guidelines of the Nuclear Waste Management Commission (ESK; see also Chapter F for details) are also applicable. These require that a storage facility must be designed and constructed in such a way that it can be decommissioned and either reused or removed in compliance with the radiological protection regulations.

It is assumed that the data submitted by the waste producers, in accordance with their obligations to provide for radioactive waste management, on the generated and expected radioactive waste and spent fuel and the forecast in the Inventory of Radioactive Waste provide sufficient information on which to base the work involved in planning a disposal facility. The forecast waste volumes also include the waste that will be generated during the decommissioning of nuclear installations and facilities. These are planning values that are subject to uncertainties and will have to be reviewed and adjusted in the future.

Product control

Part of the general quality assurance is the product control of radioactive waste. Its task is to ensure compliance with waste acceptance criteria. These are the result of the site-specific safety analysis for the disposal facilities. The corresponding evidence requires the existence of organisational and administrative regulations defining the spheres of responsibility, tasks and activities of the parties involved. Bundesgesellschaft für Endlagerung mbH (BGE) ensures that the waste acceptance criteria are met by examining waste packages and by qualification and accompanying control of conditioning measures. This is a sovereign task.

Product control comprises regulations on quality assurance in the registration and conditioning of radioactive waste as well as in the production of waste containers, including the registration and documentation of the characteristics of the waste packages relevant for disposal.

Organisational and administrative regulations governing the spheres of responsibility, tasks and activities of the parties involved are laid down in the guideline for the control of residual radioactive material and radioactive waste of 19 November 2008. The supervisory authorities of the *Länder*, the BGE, the commissioned authorised experts, the waste producers and the service companies acting on their behalf as well as the operators of the storage facilities and the *Land* collecting facilities are all involved in product control. The nature and extent of the product control measures are determined depending on the conditioning technique, waste characteristics and acceptance criteria of the disposal facility. The measures required to ensure the safety of a disposal facility for radioactive waste are laid down in the respective approval.

For the spent fuel and radioactive waste intended for emplacement in the disposal facility in accordance with the Site Selection Act (StandAG), waste acceptance criteria for disposal have not been defined yet since the disposal concept depends on the site which is determined by law not before termination of the selection procedure according to the Site Selection Act. Here, storage must take place in such a way that later conditioning to meet the waste acceptance criteria is possible.

Figure D-1 shows how it is ensured by a workflow schedule, approved by the BGE with the involvement of the supervisory authorities of the *Länder,* that storage takes place in a way that already corresponds to conditioning that already meets the waste acceptance criteria or allows later conditioning meeting the waste acceptance criteria.

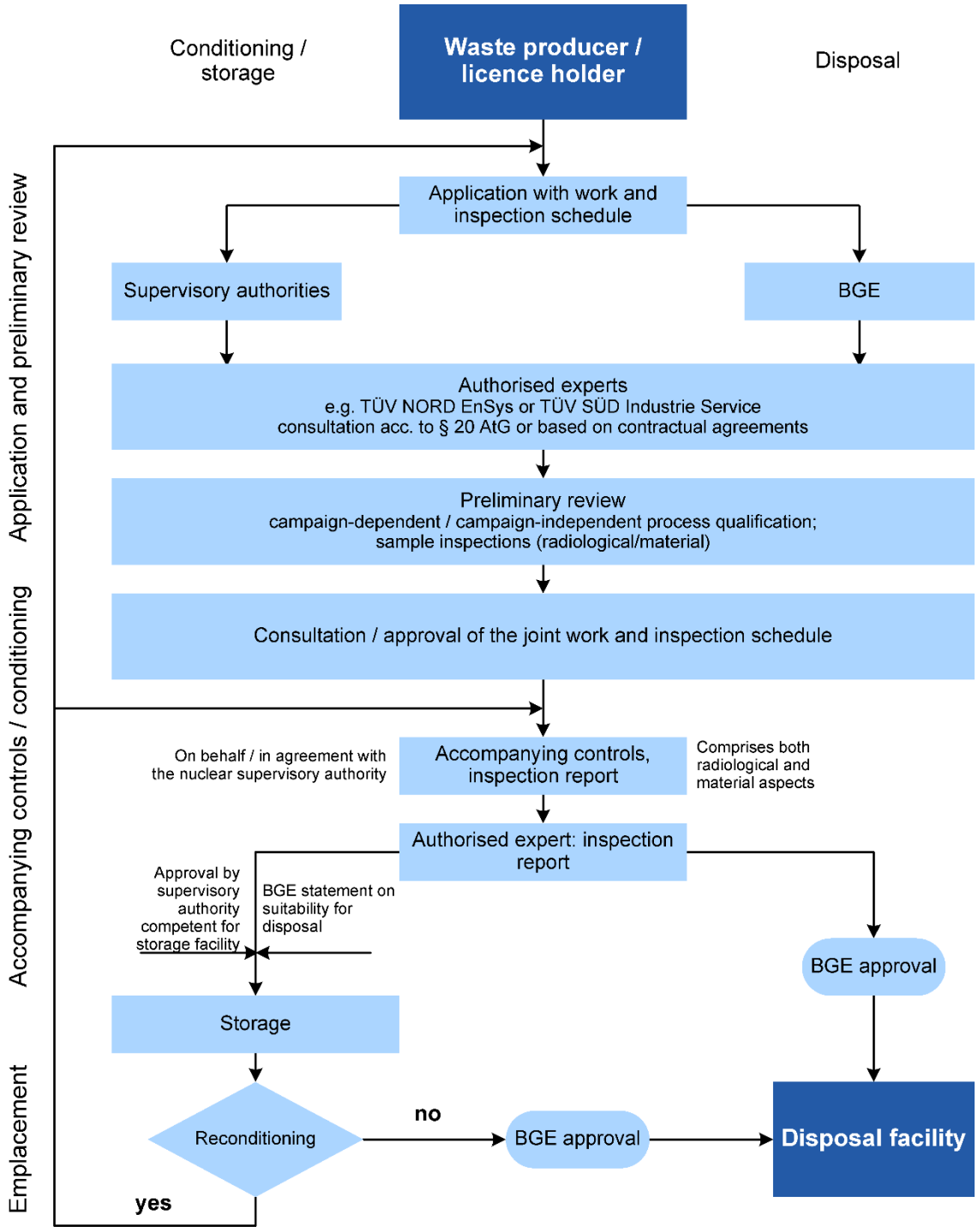

Figure D-1: Product control flow chart for waste packages regarding their conditioning, storage and disposal

D.3 Aspects of passive safety

According to § 2d AtG, as a matter of principle, passive safety features are to be given priority in Germany within the framework of the National Programme in the disposal of spent fuel and radioactive waste with regard to long-term safety.

The ESK guidelines summarise the requirements specifically for the storage of spent fuel and radioactive waste. Among other things, they describe the preference of passive over active safety systems. For example, the storage facilities were built with passive air convection, which removes the heat from the casks independently of any active technical systems.

In the case of spent fuel, the casks made of cast iron or forged steel with double-lid closure system ensure the passive safety features with regard to the fundamental protection goals of “confinement of the radioactive inventory”, “maintenance of subcriticality” and “removal of the decay heat” as well as “adequate shielding of the radiation”. Compliance with the resulting requirements is to be demonstrated at least for the licensed operating period.

The disposal of all radioactive waste in deep geological formations is intended to ensure isolation from the biosphere in the long term, thus ensuring the safety of man and the environment without any need for maintenance and control. For surveillance after the disposal facility has been released from supervision under nuclear law, the aim is to have a system that can mainly take credit from the passive safety measures that are to be included in the design of the disposal facility.

D.4 Graded approach and evidence-based and documented decision-making process

Installations and facilities for waste processing, storage and disposal are subject to approval under the Atomic Energy Act and the Radiation Protection Act. The approval requirements are based on the present hazard potential, which is determined, in particular, by the type of installation or facility and the existing or planned type, quantity and radioactivity of the radioactive material in them. This applies e.g. to the protection against safety-relevant events, to the limitation of exposure resulting from incidents, or to ensuring protection against disruptive action or other malicious acts.

The approval procedure ensures that up to granting of the licence, all decisions are evidence-based and documented (see Chapter E.2 for details). More information on the course of the individual licensing procedures can be found in the Report for the Review Meeting of the Joint Convention (Chapter E.2.3).

D.5 Management of all types of spent fuel and radioactive waste

For radioactive waste with negligible heat generation, the Konrad mine in Salzgitter is currently being converted into a disposal facility.

The site of a disposal facility for high-level radioactive waste, i.e. spent fuel and vitrified radioactive waste from reprocessing, will be determined by a selection procedure in accordance with the StandAG. In the course of the selection procedure, it will also be examined whether a separate disposal facility for low- and intermediate-level radioactive waste that cannot be emplaced in the Konrad repository can also be constructed at the site of the disposal facility to be determined for the high-level radioactive waste while

maintaining the same level of safety. This radioactive waste is not suitable for emplacement in the Konrad repository owing to its nuclide inventory and/or its chemical composition or the time of its generation. Furthermore, the radioactive waste that is to be retrieved from the Asse II mine is also to be taken into account with a view to a possible construction of a disposal facility for low- and intermediate-level radioactive waste at the site of the disposal facility for high-level radioactive waste. The same applies to the depleted uranium that has been generated and will be generated from uranium enrichment if it should not be reutilised. If it is not possible to build an additional disposal facility for larger quantities of low- and intermediate-level radioactive waste at the site of the disposal facility for high-level radioactive waste, a separate site must be designated for this disposal facility. It is assumed that at the end of the site selection procedure, a solid geoscientific database will be available for this purpose. In addition to the safe containment of the waste, the infrastructural and socio-technical conditions and the feasibility of realisation should also be taken into account when determining the next steps. The disposal facility required for this waste should be constructed at the site that offers the most favourable conditions for the disposal of low- and intermediate-level radioactive waste.

The realisation of a disposal facility for high-level radioactive waste has priority in the site selection procedure. The additional disposal of the above-mentioned radioactive waste at the site of a disposal facility for high-level radioactive waste is only permissible in a sufficiently distant, unconnected host rock area if there will be no negative interactions.

Disused sealed radioactive sources are returned by the operator to the manufacturer for further utilisation or delivered to a *Land* collecting facility as radioactive waste. In the *Land* collecting facilities, disused sealed sources are usually conditioned together with other radioactive waste, documented and stored until disposal.

Emplacement of low- and intermediate-level radioactive waste in the ERAM has been completed. This disposal facility is to be closed and safely sealed for the long term.

The management of spent fuel and radioactive waste is based on the polluter-pays principle. This also applies to its financing. An exception is spent fuel from power reactors on the territory of the former German Democratic Republic (GDR) as well as the ERAM and the Asse II mine, the costs of which are borne by the Federation. Further information on the financing of waste management can be found in Chapter I.

E. Article 5 – National framework

Article 5 – National framework

Article 5.1

(1) Member States shall establish and maintain a national legislative, regulatory and organisational framework ('national framework') for spent fuel and radioactive waste management that allocates responsibility and provides for coordination between relevant competent bodies. The national framework shall provide for all of the following:
   a) a national programme for the implementation of spent fuel and radioactive waste management policy;
   b) national arrangements for the safety of spent fuel and radioactive waste management. The determination of how those arrangements are to be adopted and through which instrument they are to be applied rests within the competence of the Member States;
   c) a system of licensing of spent fuel and radioactive waste management activities, facilities or both, including the prohibition of spent fuel or radioactive waste management activities, of the operation of a spent fuel or radioactive waste management facility without a licence or both and, if appropriate, prescribing conditions for further management of the activity, facility or both;
   d) a system of appropriate control, a management system, regulatory inspections, documentation and reporting obligations for radioactive waste and spent fuel management activities, facilities or both, including appropriate measures for the post-closure periods of disposal facilities;
   e) enforcement actions, including the suspension of activities and the modification, expiration or revocation of a licence together with requirements, if appropriate, for alternative solutions that lead to improved safety;
   f) the allocation of responsibility to the bodies involved in the different steps of spent fuel and radioactive waste management; in particular, the national framework shall give primary responsibility for the spent fuel and radioactive waste to their generators or, under specific circumstances, to a licence holder to whom this responsibility has been entrusted by competent bodies;
   g) national requirements for public information and participation;
   h) the financing scheme(s) for spent fuel and radioactive waste management in accordance with Article 9.

Article 5.2

(2) Member States shall ensure that the national framework is improved where appropriate, taking into account operating experience, insights gained from the decision-making process referred to in Article 4(3)(f), and the development of relevant technology and research.

E.1 General overview

E.1.1 Organisational framework of the regulatory body

In the Federal Republic of Germany, the "regulatory body" consists of authorities of the Federation and the *Länder*. By organisational decree, the Federal Government designates the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) as the federal ministry responsible for nuclear safety and radiation protection. The administrative tasks are performed by authorities of the Federation (e.g. Federal Office for the Safety of Nuclear Waste Management (BASE), Federal Office for Radiation Protection (BfS)) and the *Länder*. The organisational framework of the regulatory body with its responsibilities and interdependencies is described in Chapter A.2 and shown in **Figure A-1**.

In the interest of, in particular, ensuring that nuclear law is enforced as uniformly as possible throughout Germany, the *Land* authorities are subject to the BMUV's supervision of legality and appropriateness.

E.1.2 National safety provisions

The hierarchical structure of the national regulatory framework is shown in **Figure E-1** together with the authority or institution adopting the regulation as well as its legal effect. The Basic Law (GG) contains fundamental principles that also apply to nuclear law. The Atomic Energy Act contains the general national provisions for protective and precautionary measures and the management of spent fuel and radioactive waste. Most of the provisions laid down in the Atomic Energy Act are formally and materially concretised by further laws, ordinances as well as by the substatutory regulations. The substatutory regulations have regulatory relevance in particular by virtue of the legal requirement that precautions have to be taken as are necessary in the light of the state of the art in science and technology. The legal requirement that the necessary protection against malicious acts must be ensured is implemented by analogy.

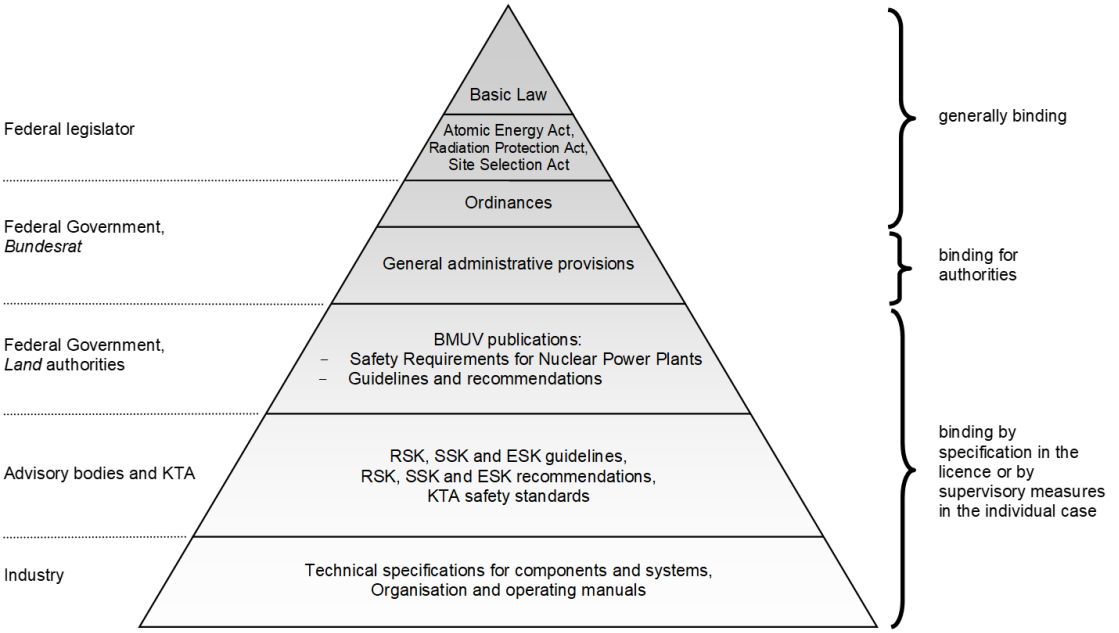

Figure E-1: Regulatory pyramid (hierarchy of the national regulations, the authority or institution adopting the regulation as well as its legal effect)

The strategy for a responsible and safe management of spent fuel and radioactive waste is outlined in the National Programme. The components of the National Programme and the principles to be taken into account are laid down by law in §§ 2c and 2d AtG. They are to be considered in all radioactive waste management planning and administrative procedures by the actors in the field of nuclear waste management.

The legal framework for spent fuel and radioactive waste management in Germany is described in detail in the Report for the Review Meeting of the Joint Convention (Chapter E.2.2).

Regarding legislation and administrative actions in Germany, the international treaties concluded by the Federal Republic of Germany in accordance with Article 59(2) GG, sentence 1 are on the same level as formal federal law. As a matter of principle, rights and obligations under such treaties only apply to the Federal Republic of Germany as contracting party. In the Federal Republic of Germany, international treaties in the areas of nuclear waste management, nuclear safety, radiation protection, liability and national implementing provisions have been ratified or are in the process of ratification. A list of the legal provisions and conventions relevant for the above-mentioned areas can be found in the Report for the Review Meeting of the Joint Convention (Section L(d)).

Nuclear and radiation protection law in Germany is subject to continuous development so that new regulations and amendments to existing legislation are regularly made, to a large extent also due to European and international requirements.

E.2 Special aspects

E.2.1 Approval process

With respect to the protection against the dangers arising from radioactive substances and the control of their utilisation, the nuclear and radiation protection legislation requires subjecting the construction, operation and decommissioning of nuclear installations and facilities as well as other facts or circumstances, such as the handling of radioactive substances, to regulatory approval (i.e. licensing or plan approval decision). The approval requirement is laid down in various provisions, depending on the type of facility and activities involved.

Responsibilities relating to the approval and supervision of nuclear waste management facilities and activities under nuclear and radiation protection legislation are summarised in **Table E-1**. It shows that for approval and supervision of the various facility types and activities, in some cases different authorities are responsible. Their interdependencies are described in chapters A.2 and E.1.1.

As a rule, approval is granted without any limitation in time with the exception of storage of spent fuel and radioactive waste from reprocessing. Here, the licences are either limited in time by specifying an expiry date, or the duration of the licence is limited to 40 years starting from the emplacement of the first cask. According to § 6(5) AtG, a storage licence for the storage facilities at the sites of power reactors may only be renewed on imperative grounds and after prior referral to the German *Bundestag*.

Table E-1: Responsibilities for approval and supervision under nuclear and radiation protection law in the area of waste management

Material	Activity	Legal basis	Approval	Super-vision	Facilities (exemplary)
Nuclear fuel and waste containing fissile material	Production, processing, treatment	§ 7 AtG	*Land* authority	*Land* authority	PKA, VEK
	Treatment, use	§ 9 AtG	*Land* authority	*Land* authority	Activities outside of facilities governed by § 7 AtG (e.g. laboratory-scale handling of nuclear fuel or the conditioning facilities for waste containing fissile material)
	Fact-finding	§ 9 AtG	*Land* authority	BASE	Asse II mine
	Storage	§ 6 AtG	BASE	*Land* authority	Spent fuel storage facilities
Other radioactive substances acc. to § 2(1) AtG, nuclear fuel acc. to § 2(3) AtG (e.g. waste with low fissile material content)	Handling, e.g. storage	§ 12 StrlSchG[1)]	*Land* authority	*Land* authority	*Land* collecting facilities, radioactive waste storage facilities, conditioning facilities
Low- and intermediate level radioactive waste	Disposal	§ 9b AtG	BASE [2)]	BASE	ERAM, Konrad repository
High-level radioactive waste	Disposal	§ 9b(1a) AtG	BASE	BASE	-

[1)] Unless there is a licence according to §§ 6, 7, 9 or 9b AtG already extending to the activity.

[2)] Transitional provisions apply to existing repository projects. In the case of the Konrad repository, the tasks are transferred from the *Land* of Lower Saxony to the Federation (BASE) after approval of commissioning of the repository. In the case of the Morsleben repository, the tasks are transferred from the *Land* of Saxony-Anhalt to the Federation (BASE) after the plan approval decision will have become enforceable. In the case of the Asse II mine, the responsibilities for granting licences under nuclear and radiation protection law remain with the *Land* of Lower Saxony.

The approval application is submitted to the competent authority in written form and shall be accompanied, depending on the type of installation or facility and handling, by documents containing all data relevant for the assessment. On the basis of the documents submitted, the competent authority examines whether the requirements are met. All federal, *Länder*, local and other regional authorities whose jurisdiction is affected are to be involved in the approval procedure, including in particular the authorities responsible for civil engineering, water, regional planning and disaster control.

If an environmental impact assessment is to be carried out, it is determined and described in a report what impact a project will have on humans, in particular human health,

fauna, flora, biodiversity, land, soil, water, air, the climate, the landscape as well as cultural heritage and other material assets. The public and specialist authorities, as well as citizens and authorities in neighbouring countries that may be affected, may express comments and opinions on the report.

The final decision of the approval authority is based on the entirety of the application documents, opinions of authorised experts consulted, the opinion of the BMUV and the authorities involved, as well as the findings from objections raised in the public hearing.

Figure E-2 gives an overview of the parties involved in supervision, the interaction between the authorities and organisations involved as well as the participation of the public, using the example of a nuclear approval and supervisory procedure for a disposal facility.

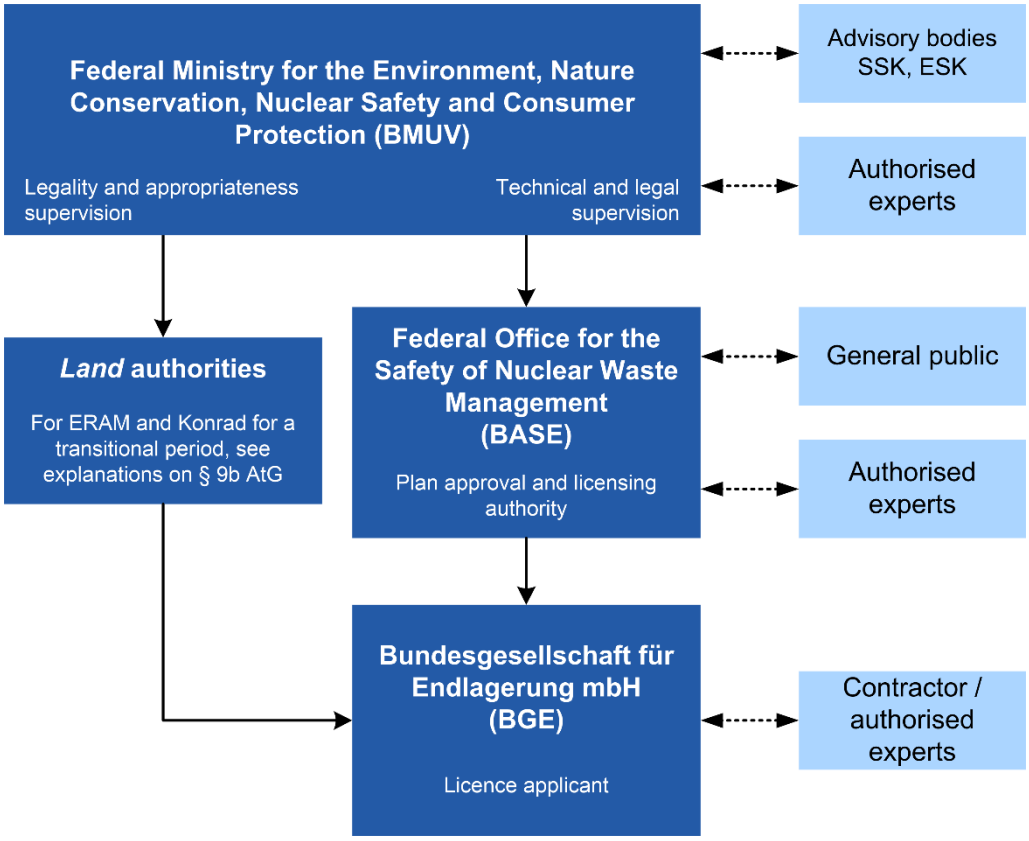

Figure E-2: Responsibilities in the approval and supervision of a disposal facility under nuclear and radiation protection law (solid lines represent supervision, dashed lines information exchange)

The actual details and procedure of e.g. licensing in accordance with § 7 AtG are regulated in more detail in the Nuclear Licensing Procedure Ordinance (AtVfV). The Nuclear Licensing Procedure Ordinance also applies to other nuclear licensing and plan approval procedures (§§ 6 and 9b AtG) mutatis mutandis, in some cases limited to the parts specified in the law. In the decision-making process, the competent authority specifies within the licence in writing, in which way it reviewed the information and documents of the applicant and which legal provisions have been taken into account for it. In addition, it is to be specified in the licensing notice what type of facility or activity will be licensed and

what conditions must be fulfilled. A licence may only be granted if the licensing requirements stated in the Atomic Energy Act or in other legal provisions have been fulfilled. For review of the information and documents submitted, the licensing authority may consult independent authorised experts, but the responsibility for the assessment and licensing decision lies with the authority.

In a plan approval procedure pursuant to § 9b(1) AtG, all areas of law are concentrated within a single procedure. Thus, the plan approval decision covers, unlike other nuclear procedures, almost all other licences required, e.g. under the terms of building legislation or nature conservation legislation. Exceptions are the legitimacy of the project under the provisions of mining and subsurface storage law as well as water law permits. Moreover, the plan approval procedure also provides for public participation.

The legitimacy of the project regarding all public interests affected by it will also be verified by a licence pursuant to § 9b(1a) AtG. Apart from the licence, all other decisions made by the authorities, especially licences issued under public law, concessions, permits, permissions, consents and plan approval decisions shall not be required with the exception of permits and permissions relating to water law and of decisions regarding the legitimacy of the project according to the provisions of the mining and subsurface storage law.

E.2.2 System of appropriate controls and reporting obligations

Throughout their operating lives, including construction and decommissioning, nuclear installations and facilities are subject to continuous regulatory supervision, after having been granted the necessary approval, according to § 19 AtG and the associated nuclear ordinances. **Table E-1** shows the relevant competent supervisory authority.

The legal basis for the documentation and reporting of radioactive waste are §§ 1 and 2 AtEV and § 85 StrlSchV (record keeping and notification). § 85 StrlSchV requires the keeping of records and notification within one month of the extraction, production, acquisition, transfer and other dispositions of radioactive substances, specifying type and activity. In addition, the inventory is reported annually. The competent authority is entitled to verify the correctness of record keeping at any time. As an example, reference is made to the waste flow tracking and product control system (AVK), which is used by many nuclear power plant operators.

An obligation to report to the corresponding supervisory authority also exists for measures taken by the operators to utilise any residual radioactive material without detrimental effects or dispose them of as radioactive waste in a controlled manner in accordance with § 9a(1) AtG. In particular, proof that adequate waste management provisions have been made is to be provided annually (see Chapter D.2 for details).

Safety-relevant events in facilities approved according to §§ 7 and 9b AtG, in connection with storage according to § 6 AtG, during handling of radioactive material in the Asse II mine and in connection with activities licensed according to § 9 AtG and § 12(1)(3) StrlSchG have to be reported to the authorities in accordance with § 6 AtSMV. In addition, the operator has further reporting obligations with regard to operating procedures,

maintenance measures, tests and radiation protection, and regular inspections as well as own measurements are carried out at the approval holders.

E.2.3 Enforcement actions

As regards the implementation of the national regulations, the supervisory authority may, in accordance with § 19 AtG, require the approval holder to comply with the national safety requirements and the terms of the respective approval. Under certain conditions, laid down in § 17 and § 9b(3) AtG, the nuclear approval authority may also impose obligations subsequently in order to ensure safety. If a nuclear installation or facility poses a major hazard to workers or the general public and if this hazard cannot be eliminated within a reasonable period of time by means of appropriate measures, then the authority must revoke the approval granted. Revocation is also possible if prerequisites for the approval cease to apply at a later date, or if the approval holder violates legal provisions or decisions by the authorities. The Atomic Energy Act, the Radiation Protection Act, the Criminal Code and the nuclear and radiation protection ordinances provide for sanctions to prosecute violations. Moreover, for i.a. nuclear installations, § 327 StGB stipulates that whoever operates, possesses, substantially modifies or decommissions such a facility without the required permit shall be punished.

E.2.4 Allocation of responsibilities for spent fuel and radioactive waste management (including funding)

The management of spent fuel and radioactive waste is based on the polluter-pays principle. According to § 9a(1) AtG, the producers of residual radioactive material are required to ensure that this is utilised without detrimental effects or disposed of as radioactive waste in a controlled manner. The authorities and organisations involved in the management of spent fuel and radioactive waste and their responsibilities are described in Chapter A.2, and organisational and administrative regulations governing the spheres of responsibility, tasks and activities of the parties involved in product control in Chapter D. Regulations on the financing of nuclear waste management are set out in Chapter I.

E.2.5 Public information and participation

Approval procedures are usually carried out with the participation of the public. Through public participation within the framework of the Nuclear Licensing Procedure Ordinance (AtVfV) and the Environmental Impact Assessment Act (UVPG) as well as informing the public in accordance with the legislation on freedom of information, in particular the Environmental Information Act (UIG), it is ensured that the public is adequately involved and that it has access to all the necessary information regarding the safety of planned facilities for the treatment or storage of spent fuel and radioactive waste.

Further provisions relating to the information and participation of the public within the framework of the site selection procedure for a disposal facility for high-level radioactive waste are contained in the Site Selection Act.

In-depth information on public participation can be found in the Report for the Review Meeting of the Joint Convention (Chapter E.2.3).

E.2.6 Update and improvement of the regulatory framework and the national framework

The authorities responsible for the development of the rules and regulations of the Federation and the *Länder* continuously review the regulatory framework and perform updates. In order to identify any need for amendments to the national regulatory framework, a systematic evaluation of the state of the art in science and technology and of international rules and regulations is carried out on a continual basis. This is done:

- through the participation of the BMUV and BASE in international committees,
- by evaluating the work results of the relevant international, multi- and bilateral bodies and institutions,
- based on the results of research programmes funded by the BMUV,
- within the framework of the research carried out and supported by BASE,
- through other international specialist contacts, and
- by studying the international specialist literature.

The results of site-independent, application-oriented basic research in the context of project funding by the BMUV, the work of the Federal Institute for Geosciences and Natural Resources (BGR) and the Federal Institute for Materials Research and Testing (BAM) as well as the basic research of the Federal Ministry of Education and Research (BMBF) are also considered in the review and updating of the national regulations. Moreover, international regulations constitute additional sources of knowledge in the determination of the state of the art in science and technology. The BMUV is supported in this by the subordinate authorities (e.g. BASE) and Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH.

In addition, the BMUV is consulted on safety-related and generic issues as well as on operating experience in all types of nuclear installations by its advisory bodies, the Reactor Safety Commission (RSK), the Nuclear Waste Management Commission (ESK) and the Commission on Radiological Protection (SSK). The statements made by these commissions have an impact on the updating of the national rules and regulations.

Overall, it is ensured that the state of the art in science and technology, but also findings from operation, research and licensing in the sense of a process that systematically supports learning (learning process) lead to an adaptation of the regulatory framework and the national framework.

F. Article 6 – Competent regulatory authorities

Article 6 – Competent regulatory authority

Article 6.1
(1) Each Member State shall establish and maintain a competent regulatory authority in the field of safety of spent fuel and radioactive waste management.

Article 6.2
(2) Member States shall ensure that the competent regulatory authority is functionally separate from any other body or organisation concerned with the promotion or utilisation of nuclear energy or radioactive material, including electricity production and radioisotope applications, or with the management of spent fuel and radioactive waste, in order to ensure effective independence from undue influence on its regulatory function.

Article 6.3
(3) Member States shall ensure that the competent regulatory authority is given the legal powers and human and financial resources necessary to fulfil its obligations in connection with the national framework as described in Article 5(1)(b), (c), (d) and (e).

By organisational decree, the Federal Government designates the federal ministry responsible for nuclear safety and radiation protection. This responsibility was transferred to the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV). The administrative tasks are performed by authorities of the Federation and the *Länder*. Thus, in line with Article 6, the regulatory authority is composed of several independent authorities led by the BMUV in terms of technical or federal supervision.

More details on the organisational framework of the regulatory authority in the Federal Republic of Germany are given in Chapter A.2 and E.1.1. The responsibilities relating to approval and supervision are described in Chapter E.2.1 and E.2.2. For detailed information on advisory bodies and commissions, see Chapter E.2.6.

F.1 Principle of separation

The economic use of nuclear energy[6] lies in private hands and not in the public sector, whereas nuclear licensing and supervision are governmental functions. Thus, there is a separation of spheres of interest.

At the level of the supreme federal authorities, state-organisational separation is ensured by the competence of the BMUV for all decisions relating to nuclear safety and radiation protection on the one hand and the competence for energy industry policy lying with the Federal Ministry for Economic Affairs and Climate Action (BMWK) on the other.

According to § 9a(3) AtG, the organisation of the planning, construction, operation and closure of facilities for the disposal of radioactive waste is a federal task. The Federation has assigned the performance of this task to the federally-owned company under private-

[6] The operation of the last power reactors was terminated on 15 April 2023.

law, the Bundesgesellschaft für Endlagerung mbH (BGE), which is subject to supervision under nuclear law by BASE. According to § 9b AtG, BASE is also generally responsible for plan approval and licensing of disposal facilities; transitional regulations apply to already existing disposal facility projects (see Chapter A.2). In this case, the BGE acts as the applicant. The BMUV is responsible for supervising the execution of tasks by BASE in terms of legality and appropriateness.

In addition, there are federal authorities being responsible for specific issues of nuclear safety and radiation protection as well as for spent fuel and radioactive waste management. So, for example, the Federal Office for Economic Affairs and Export Control (BAFA) is responsible for licensing of the import and export of radioactive materials as defined in § 3 AtG (technical supervision in this regard the BMUV).

At the *Länder* level, the principle of separation is adhered to on the basis of organisational provisions. The unbiased, safety-oriented decision-making is additionally strengthened in terms of state organisation law through the legality and appropriateness supervision of the administrative action of the *Land* authorities by the BMUV (see **Figure A-1** in Chapter A.2). This ensures within the democratically legitimised supervision established at the governmental level that the assertion of safety-relevant interests by the regulatory authorities will take place independently of economic or other extraneous influences and interests. This also applies to the regulatory framework accordingly. All groups that contribute to the safety of nuclear installations and facilities are involved in the review and, where required, updating of the regulatory framework. Safety-related interests have priority over other interests.

All approval decisions are made in an evidence-based and documented administrative procedure (see Chapter D.4) so that all decisions in this area are also independent and safety-oriented.

F.2 Human and financial resources of the licensing authorities

The rights and duties of the Federation and the *Länder* are sketched out by the Basic Law. The financial means available to the federal authorities for their own personnel and for the consultation of authorised experts are fixed by the German *Bundestag* in the respective budgets. The responsibility for organisation, staffing and financial resources of the nuclear authorities of the Federation lies with the BMUV.

The BMUV has an annual budget of around 33 million euros for investigations in the fields of nuclear safety, nuclear supply and waste management and on issues related to radiation protection. These funds are used to finance direct support for the BMUV, for scientific and technical support and for the participation of external authorised experts in international cooperation. Furthermore, these funds are used to finance projects that also serve to maintain the competence of Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH as expert organisation of the Federation in the above-mentioned areas.

In addition, the BMUV has a title of around 38 million euros annually that is to be allocated to project funding related to nuclear safety research (reactor safety research, research into extended storage and the treatment of high-level radioactive waste and research into waste disposal).

As an authority subordinate to the BMUV, BASE finances contract research for the fulfilment of its own tasks by means of a so-called title for research to the amount of 3.8 million euros. This concerns research projects in the fields of nuclear safety, storage, transport, waste management and public participation. In addition, BASE can conduct research via the BMUV's departmental research plan.

For the decision on approval applications, costs will be charged to the applicant by the competent authorities (federal and *Land* authorities), which cover the expenses of the authorities and the costs for the consultation of authorised experts (§ 21 AtG). The same applies to measures of the supervisory authorities.

The staff of the BMUV, BASE and the competent supreme *Land* authorities consists of permanent civil servants and public service employees. The legal civil servants or public service employees are required to have qualified at university and to have passed the corresponding examinations. The scientific-technical civil servants are required to have completed a corresponding course at a university or a university of applied sciences. Furthermore, there are high demands on the reliability and impartiality of authority staff.

With its Directorate-General “Nuclear Safety, Radiological Protection”, the BMUV is the nuclear regulatory authority of the Federation and comprises three directorates. Among other things, it deals with the fulfilment of obligations for the safe management of spent fuel and radioactive waste. BASE provides technical and scientific support to the BMUV in these fields and also performs enforcement tasks for the Federation under the Atomic Energy Act. BASE also supports the BMUV in its responsibilities through scientific research. The BMUV is also supported as regards scientific and technical issues by advisory bodies (especially the ESK), by GRS as the expert organisation of the Federation and, where required, also by other authorised experts.

The staffing needs of the BMUV and BASE are regularly checked by means of a review of the public functions and tasks and adjusted as necessary. The staff appointment schemes of the authorities on which the staffing is based are part of the federal budget that is drawn up by the Federal Government and adopted by the budgetary legislator (*Bundestag*).

For staffing of the authorities competent for reactor safety and radiation protection of the *Länder*, these are responsible. Depending on the number of nuclear installations and facilities to be supervised there, different numbers of staff are employed. The supreme *Land* authorities are supported in their tasks by subordinate authorities. In nuclear approval and supervisory procedures, as a rule, the *Land* authorities consult authorised experts (see § 20 AtG).

The costs arising from approval and supervision of nuclear installations and facilities are basically refinanced in accordance with § 21 AtG (costs for decisions on applications, including review of the results of safety reviews) as well as in accordance with § 21a AtG

(costs for the use of facilities pursuant to § 9a(3) AtG). Fees for the consultation of authorised experts are also reimbursed by the applicant or the approval holder as expenses.

G. Article 7 – Approval holders

Article 7 – Approval holders

Article 7.1

(1) Member States shall ensure that the prime responsibility for the safety of spent fuel and radioactive waste management facilities and/or activities rest with the licence holder. That responsibility can not be delegated.

Article 7.2

(2) Member States shall ensure that the national framework in place require licence holders, under the regulatory control of the competent regulatory authority, to regularly assess, verify and continuously improve, as far as is reasonably achievable, the safety of the radioactive waste and spent fuel management facility or activity in a systematic and verifiable manner. This shall be achieved through an appropriate safety assessment, other arguments and evidence.

Article 7.3

(3) As part of the licensing of a facility or activity the safety demonstration shall cover the development and operation of an activity and the development, operation and decommissioning of a facility or closure of a disposal facility as well as the post-closure phase of a disposal facility. The extent of the safety demonstration shall be commensurate with the complexity of the operation and the magnitude of the hazards associated with the radioactive waste and spent fuel, and the facility or activity. The licensing process shall contribute to safety in the facility or activity during normal operating conditions, anticipated operational occurrences and design basis accidents. It shall provide the required assurance of safety in the facility or activity. Measures shall be in place to prevent accidents and mitigate the consequences of accidents, including verification of physical barriers and the licence holder's administrative protection procedures that would have to fail before workers and the general public would be significantly affected by ionising radiation. That approach shall identify and reduce uncertainties.

Article 7.4

(4) Member States shall ensure that the national framework require licence holders to establish and implement integrated management systems, including quality assurance, which give due priority for overall management of spent fuel and radioactive waste to safety and are regularly verified by the competent regulatory authority.

Article 7.5

(5) Member States shall ensure that the national framework require licence holders to provide for and maintain adequate financial and human resources to fulfil their obligations with respect to the safety of spent fuel and radioactive waste management as laid down in paragraphs 1 to 4.

G.1 General requirements relating to the approval holder

As defined in § 7c(1) AtG in conjunction with § 9h AtG, primary responsibility for the nuclear safety of a spent fuel and radioactive waste management facility lies with the approval holder and cannot be delegated. The approval may only be granted if the applicant fulfils the legal prerequisites pursuant to §§ 6, 7, 9 and 9b AtG or § 13 StrlSchG, respectively. The approval prerequisites include i.a. that the responsible persons are trustworthy and have the requisite technical qualification, that adequate safety is demonstrated, and that construction and operation have to be such that the necessary precautions against damage have been taken as are necessary in the light of the state of the art in science and technology.

In the case of companies with several board members authorised to represent it, the approval holder has to nominate to the competent authority the person from among the board members authorised to represent it who assumes the role of radiation protection executive. The radiation protection executive is responsible for the entire area of radiation protection (see § 72 StrlSchG) and is the person who must apply for the necessary licences pursuant to § 69 StrlSchG. § 70 StrlSchG stipulates that he has to appoint a sufficient number of radiation protection supervisors for technical activities and monitoring of operation. These ensure due compliance with all protection and supervisory provisions of the Radiation Protection Ordinance. According to § 70(6) StrlSchG, the radiation protection supervisors must not be hindered in the performance of their duties or suffer any disadvantages by virtue of their activities.

In order to better meet the specific requirements of nuclear safety in facilities licensed under § 7(1) AtG, the additional position of a nuclear safety officer according to § 2 AtSMV has been created as a further instance within the company organisation. It is his responsibility to supervise nuclear safety issues in all areas of operation independently of the corporate interests of cost-effective facility operation. He should be involved in all activities concerning modifications, should assess any reportable events and the evaluation of operating data, and has the right to report directly and at any time to the facility manager.

When performing their tasks, the radiation protection supervisors, together with the nuclear safety officer, act independently from the company hierarchy.

Any enforcement measures on the part of the competent supervisory authorities will always be directed in the first instance at the holder of the approval, with the objective that the ultimately responsible individuals will personally meet their respective obligations. If this is not the case, the authority can question the trustworthiness of such individuals, which is a prerequisite for granting the approval. Consequently, in such cases, any proceedings relating to an administrative or criminal offence will be directed at individual persons.

The operation of an installation or facility is continuously monitored by the operator so that any safety-relevant incidents and accidents will be reliably detected and the countermeasures specified in the operating manual can be taken. Safety-significant incidents and accidents are to be reported to the supervisory authority in accordance with the specified reporting channels. In addition, the prescribed condition of the safety-relevant systems and equipment of a facility or installation is ensured by recurring inspections. Their frequency depends on the safety significance of the component to be inspected. The recurring inspections are laid down in a testing manual. The results of the recurring inspections are to be documented and are available for the purpose of long-term monitoring.

Responsibility if there is no licence holder

If there is no licence holder or other party responsible for an installation or facility for the management or storage of radioactive waste, or such a person fails to meet his obligations, then responsibility for the safety of the installation or facility or related activities shall rest with the competent *Land*.

In cases where the direct owner of nuclear fuel has no authorisation for possession, he shall establish authorised possession pursuant to § 5(2) AtG. If such authorised possession cannot be established, the Federal Office for the Safety of Nuclear Waste Management (BASE) shall temporarily take the nuclear fuels into its charge ("government custody") according to § 5(3) AtG in conjunction with § 23d(8) AtG. Such a situation may also arise if nuclear fuels are found or in case of loss of authorisation on the part of the private licence holder (e.g. in case of licence withdrawal). If, however, the supervisory authority issued an order under § 19(3) AtG, then this order shall have priority over government custody. Whoever is responsible for nuclear fuels under government custody shall also ensure authorised possession outside government custody (see § 5(3) AtG, sentence 2). This does not only apply to the direct owner who delivered for government custody but also to the owner of utilisation and consumption rights to nuclear fuel held in government custody, and to anyone who is required to take over or take back nuclear fuel from a third party (see § 5(3) AtG, sentence 3).

If radioactive substances are lost, found or misused, the *Land* concerned is responsible for averting nuclear-specific danger. In severe cases, it is supported in this task by the Federal Office for Radiation Protection (BfS). This applies, in particular, to the finding of radioactive substances for which no licence holder or other responsible party can be identified.

G.2 Safety demonstrations

To prove that approval prerequisites are met, it is required, among other thigs, to already furnish a safety demonstration in the approval procedure for the construction, operation and decommissioning of nuclear installations and facilities as well as the handling of radioactive substances, which comprises the facility site, the facility and its operation, the exposure in the environment, accident analyses and the effects of facility operation on the environment.

For a disposal facility for high-level radioactive waste – as for other nuclear installations or facilities– a comprehensive safety report for all operating states of the disposal facility is an essential part of the licensing documents. The safety requirements and the requirements for the performance of safety analyses for a disposal facility for high-level radioactive waste are specified in ordinances, which entered into force on 15 October 2020. Fulfilment of the safety requirements must be reviewed at least every ten years within the framework of periodic safety reviews (see Chapter G.3) and, where necessary, adapted to the state of the art in science and technology.

In addition, a long-term safety analysis must be carried out for the disposal facility for high-level radioactive waste, which, according to the Disposal Facility Safety Analyses Ordinance (§ 9 EndlSiUntV), must cover the entire assessment period and at least the containment of the radioactive waste, the integrity and robustness of the containment-providing rock zone and the main engineered and geotechnical barriers, the estimation of dose values and the assurance of subcriticality. For the analysis of the behaviour of the disposal facility system during the assessment period, sufficiently qualified numerical model calculations are to be performed on the basis of realistic assumptions.

The site-specific safety analysis and the safety assessment comprise all information, analyses and arguments verifying the safety of the installation or facility and explain why confidence is placed on this assessment.

G.3 Periodic safety review

The Atomic Energy Act contains obligations directed to the operators of waste management facilities – including disposal facilities – to periodically perform a safety review and assessment (periodic safety review – PSR). During the operation of an installation or facility, a safety review is carried out every ten years, particularly taking into account the state of the art in science and technology. The PSR pursues the overall objective of regularly reviewing and assessing the nuclear safety of the respective installation or facility and continuously improving it. The results of the review and assessment are to be submitted to the nuclear supervisory authority.

The ESK has developed guidelines for the performance of periodic safety reviews and technical ageing management for storage facilities for spent fuel and high-level radioactive waste. In accordance with the guidelines, a technical ageing management system is set up to control the long-term and ageing effects that are relevant for safety during the service life of the storage facility applied for. The monitoring concept is designed according to the requirements regarding the quality condition and the age-related changes in the condition of the storage building to be expected as well as the safety-relevant systems and components required for storage. The results of the monitoring measures are documented and regularly reported to the supervisory authority. The measures of operational ageing management are reviewed in the integrated PSR. The most recent reviews have shown that the storage facility operators have successfully implemented an integrated management system, as required, thus guaranteeing a further contribution to safety also with regard to the entire storage period.

G.4 Management systems

The management system identifies those processes that are necessary to achieve the organisational goals, including the provision of means necessary for compliance with all requirements and for task performance. Safety management is designed in such a way that a high level of confidence in the quality of the organisation and in the compliance with all safety requirements and existing limits, reference levels and criteria is justified. It ensures that the safety standards of the licence holder can be assessed on a continual basis in the light of advancing information.

A safety management system is set up to realise the safety management. It includes all specifications, regulations and organisational tools for the handling of safety-relevant activities and processes. All its elements are derived and justified in a comprehensible manner. Interactions, interfaces and delimitations between different processes are designed and described in a comprehensible manner. The documentation of the management system includes, for example for storage facilities for spent fuel and high-level radioactive waste, the following:

- the company's safety policy,
- a description of the management system,
- a description of the roles and responsibilities, their assignment, the decision-making structures and the interaction between the management, the performers and those who have to assess the performance,
- a description of the cooperation with relevant external organisations, and
- a description of the processes, including information regarding preparation, independent review, performance and documentation of the work. In addition, the measures for assessment and, if applicable, improvement of the processes and activities are to be described.

The safety management system, that is generally part of an integrated management system, gives highest priority to ensuring and continuously improving safety over other management objectives and supports the development and maintenance of a high safety culture. As part of the operating manual, the safety management system is reviewed by the supervisory authority.

G.5 Human and financial resources

For the safe operation of the nuclear installation or facility, the approval holder is required to provide for and maintain adequate human resources. This staff must have the necessary competence for the tasks to be performed. All approval applications for a nuclear installation or facility or activity, respectively, shall be accompanied by the proof of the qualification of the responsible persons as well as of the necessary knowledge of the staff otherwise engaged during operation of the installation. The measures of the operator to ensure adequate staffing are reviewed by the supervisory body on the basis of the reports submitted.

In order to fulfil his obligations with regard to the safety of the individual waste management steps in the handling of spent fuel or radioactive waste in the respective nuclear installation or facility, the respective operator shall provide for and keep available adequate financial resources on a permanent basis as stipulated in § 7c(2)(2) AtG in conjunction with § 9h AtG. The obligation ensures that the obligated party can fulfil his responsibility for the nuclear safety of the nuclear installation or facility also in financial terms. Evidence of continued assurance of adequate financial resources shall be provided in the light of the applicable approval. Financial resources may therefore not be withdrawn insofar as safety concerns would be compromised.

(See Chapter I for details on securing/ensuring the financing of all obligations and, in particular, the obligation to dispose of waste pursuant to § 9a(1) AtG, sentence 1.)

G.6 Interdependencies

In order to take into account interdependencies (see Chapter D.2 for details), a corresponding concept for decommissioning must already be available at the design and construction stage of the facility. This concept includes specifications, which depend primarily on whether the radioactive waste management facility is constructed as part of a major nuclear facility, thus being integrated into the decommissioning project of this facility, or whether it constitutes a separate site, thus entailing an independent decommissioning concept, directly related to this facility. Further decisive parameters of the decommissioning concept are determined by the composition of the radioactive waste processed at the facility, in particular by whether or not it involves waste containing fissile material.

Within the context of the decommissioning concept, the operator plans the decommissioning procedure, assuming that any residual quantities of the radioactive waste processed at the facility will be removed beforehand. If activation by neutrons can be virtually excluded, the requirements with regard to decontamination and dismantling methods result from the contamination of the components. In this respect, however, it is important to consider that during processing of waste containing fissile material or waste with other alpha-sources, contamination from alpha-emitting nuclides may also be present. The requirements relating to the proposed decontamination methods take into account the reduction of individual and collective doses during the decommissioning measures, as well as the reduction of volume and the utilisation of residual material as harmlessly as possible, while also taking into account secondary waste volumes. The requirements relating to the dismantling methods depend on the technological task (material, size of the component, environmental conditions, accessibility), the radiation protection conditions (existing activity, potential for aerosol formation, risk of contamination, confinement of mobile activity, limitation of the individual and collective dose), and the intended subsequent treatment as a residue for reuse, conventional disposal, or disposal as radioactive waste.

The decommissioning of the Karlsruhe vitrification facility (VEK), for example, will primarily be performed using the equipment required for operation, which was already considered in the design of the facility. The planned steps and measures for decommissioning of the facility were described by the applicant in his safety report.

With the shutdown of German nuclear power plants and the increased use of mobile conditioning facilities, the need for stationary conditioning of operational waste decreases. For this reason, for example, the conditioning of operational waste by GNS Gesellschaft für Nuklear-Service mbH (GNS) in Duisburg was already discontinued in 2017. At the same time, waste management centres with new capacities for the conditioning of local decommissioning waste are being established at various nuclear power plant sites. In order to provide a sufficient volume of waste packages for disposal in the Konrad repository, the conditioning capacities were also expanded at some sites. The GNS facility in Jülich, for example, has been extended in recent years by a separate annex to the existing building with an automatic drum measuring system and a caisson including equipment for loading of containers.

Due to the currently not yet available disposal facility, the storage capacities for radioactive waste at various sites have been and will be increased. At the Ahaus storage facility, additional storage capacity was created for waste from operation and decommissioning

until its delivery to the Konrad repository. At the Philippsburg, Biblis and Unterweser sites, the storage capacities have been increased and operations started in 2018 and 2020, respectively. In 2021 and 2022, additional radioactive waste storage facilities were commissioned in Grafenrheinfeld and Neckarwestheim. Construction of the radioactive waste storage facility in Brunsbüttel has been completed and is currently being commissioned. In addition, the storage capacity in Krümmel is to be increased by erecting a new radioactive waste storage facility. Furthermore, applications have been submitted for additional storage capacities at the Grohnde and Emsland sites.

Regarding the consideration of interdependencies in the context of disposal, see Chapter D.2 for details on product control.

H. Article 8 – Expertise and skills

Article 8 – Expertise and skills

Article 8
Member States shall ensure that the national framework require all parties to make arrangements for education and training for their staff, as well as research and development activities to cover the needs of the national programme for spent fuel and radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills.

H.1 Education and training of staff

The federal departments of the then Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Federal Environment Ministry) and the then Federal Ministry for Economic Affairs and Energy (Federal Economics Ministry) drew up a joint strategy for competence building and the development of future talent for nuclear safety against the background of the completed phase-out of nuclear energy for the commercial generation of electricity, which was adopted by the Cabinet on 26 August 2020. However, nuclear technology is to be retained in Germany through applications in materials testing, basic research and the production of radiopharmaceuticals. Nuclear technology expertise is an essential component of the energy transition in Germany to enable the targeted development of options for the safe radioactive waste management, also after the phase-out of nuclear energy.

In order to take into account a wider range of technical expertise in addition to the political discussion, an exchange takes place at the national level with various stakeholders from the main organisations active in Germany in the field of nuclear safety within the framework of the Alliance for Competence in Nuclear Technology (KVKT) of German research institutes, the German Association for Repository Research (DAEF) and the Competence Network for Radiation Research (KVSF). The competence networks help to maintain and further develop technical expertise in the respective areas. Further project funding from the Federal Economics Ministry takes place at German universities to contribute to the further development of the state of the art in science and technology and to promote young scientists. With the NUSAFE (Nuclear Waste Management, Safety and Radiation Research) programme, the Helmholtz Association of German Research Centres (HGF) is involved in basic research into nuclear safety. The funding initiative to maintain competence in nuclear technology (KEK) is intended to promote the long-term maintenance of expertise in nuclear technology.

Research and teaching at German universities are to play a special role in the recruitment of young talent. In cooperation between operators, project implementers, supervisory and licensing authorities and German universities, scientific and technical topics will continue to be taught. In total, there are still just under 20 universities and colleges in Germany that offer chairs for technical issues in nuclear physics and nuclear chemistry. The events offered by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH within the framework of its GRS Academy for example, serve the training and further qualification of expert staff from authorities and authorised expert organisations. Seminars are held on topics such as on the fundamentals of reactor physics, nuclear fuel

supply and waste management, prominent events/incidents/accidents in nuclear installations, International Nuclear Event Scale (INES) User Manual of the International Atomic Energy Agency (IAEA), fundamentals of radiation protection, radiological emergency preparedness, external hazards, regulatory supervision of the operation of nuclear reactors, legal and technical nuclear standards, selected topical issues of the nuclear licensing and supervisory procedure, fire protection in nuclear power plants, operation management of nuclear power plants, and decommissioning of nuclear installations.

In cooperation with universities, the Federal Office for the Safety of Spent Fuel Management (BASE) trains young scientists as doctoral students in the fields of nuclear waste management safety. Newly recruited staff take part in the knowledge transfer of the nuclear licensing and supervisory authorities. They are trained on the basis of individual plans. In addition, experienced staff are required to maintain or further develop their knowledge and skills and to continuously keep their expertise up to date.

BGZ Gesellschaft für Zwischenlagerung mbH (BGZ) has established a “holistic knowledge management” in which, for example, a balance sheet of knowledge is drawn up every two years in accordance with the approach balance sheet of knowledge – made in Germany (*Wissensbilanz* – Made in Germany), taking into account ISO 30401 (Knowledge Management Systems). The focus here is on strategic personnel development in order to ensure the transfer of knowledge and the development and maintenance of the necessary competencies in the field of nuclear waste management at an early stage. The aim is to provide a particularly practice-oriented, technically and methodologically up-to-date and scientifically sound education in order to qualify graduates for a wide range of fields of activity.

Bundesgesellschaft für Endlagerung mbH (BGE) tries to meet the demand for qualified personnel by developing new, future-oriented concepts. It trains its own skilled staff in areas such as electronics, industrial mechanics, mining technology, IT and office management, offers dual courses of study in in safety engineering with a specialisation in radiation protection, offers internships, supervises and supports final theses and doctoral projects and teaches at colleges and universities. In order to update and build up expert knowledge, the BGE staff regularly take part in in-house training courses or individual seminars, conferences, symposia and forums. For the exchange of up-to-date knowledge and as an instrument for recruiting junior staff, there is also cooperation with universities and technical colleges. As a first concrete measure in the field of advanced and continuing training, the BGE is seeking cooperation with the BGZ on the topics of maintaining expert knowledge and a cooperative study programme. In addition, the BGE and BGZ as well as BASE and the Federal Office for Radiation Protection (BfS) were part of a project team set up by the Federal Environment Ministry which, among other things, analysed demands in the field of national nuclear waste management safety in order to develop a concept for the perspective maintenance of expert knowledge and qualified personnel mentioned above.

The operators are responsible for ensuring that the necessary competence is available for the safe operation of nuclear installations. Similar requirements regarding the applicant's trustworthiness also apply with regard to licences for the storage of nuclear fuels as well as the treatment, processing and any other use of nuclear fuel outside facilities requiring a licence.

§ 74 of the Radiation Protection Act (StrlSchG) and §§ 47 to 51 of the Radiation Protection Ordinance (StrlSchV) include regulations concerning the requisite qualification and knowledge in the field of radiation protection as well as its acquisition and conservation. The Nuclear Safety Officer and Reporting Ordinance (AtSMV) regulates the appointment of nuclear safety officers for nuclear installations licensed under § 7(1) AtG.

The legal basis is further specified within the framework of related guidelines, in particular by guidelines on the required technical qualification of the responsible personnel and on the assurance of the necessary knowledge of the persons otherwise engaged in nuclear power plants, which are also applied analogously to plants under decommissioning. Furthermore, the exchange of information and knowledge, including experience feedback, is regulated in special requirements. There are also various guidelines that specify the requirements for the required technical qualification in radiation protection.

Prior to the deployment of personnel stated in guideline relating to the proof of the technical qualification of nuclear power plant personnel (management personnel) or guideline relating to the proof of the technical qualification for facilities for the storage of nuclear fuel, the supervisory authority requires the submission of documents which verify the necessary technical qualification and practical experience. It reviews these documents for compliance with the requirements of the respective guideline.

The implementation of the content of these regulations results in a hierarchy of responsibilities, each of which has varying requirements with respect to technical qualification and expert knowledge. The high level of education and qualification in Germany is maintained through courses for achieving and maintaining the required technical qualification, education and training, as well as research and teaching at universities.

H.2 Research and development

On 8 December 2021, the responsibilities for nuclear safety and waste management research within the Federal Government, previously held by the Federal Ministry for Economic Affairs and Climate Protection (Federal Economics Ministry), have been transferred to the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Climate Protection (Federal Environment Ministry). As part of the associated project funding programme for application-oriented basic research, the Federal Environment Ministry supports, among other things, waste management research (research on extended storage and management of high-level radioactive waste, research on radioactive waste disposal and related research on interdisciplinary issues).

The Federal Ministry of Education and Research (BMBF) is funding, among other things, research for the dismantling of nuclear installations (FORKA). The aim of this funding programme is to further improve the protection of people and the environment in connection with nuclear dismantling and radioactive waste management and to increase the efficiency of the procedures and methods used. At the same time, another important aim is to support the maintenance of nuclear expertise and the training of the next generation of scientists.

In addition, BASE conducts research in the subordinate area of the Federal Environment Ministry on the basis of its own research strategy and agenda for the site selection procedure and topics relating to the safety of nuclear waste management. Research projects within the framework of the site selection procedure concern, for example, public participation in the search for a disposal facility as a cross-generational, self-questioning and learning process.

The BGE conducts task- and site-related research and development with the aim of providing the scientific and technical basis for the implementation of its tasks and, where necessary, closing knowledge gaps and further developing the state of the art in science and technology. This also includes topics and issues of so-called preliminary research. Corresponding projects are carried out either by the BGE itself, in cooperation with other (national and international) institutions or by third parties as part of research and development contracts. The research and development activities are described in the BGE research and development strategy. These activities also serve to build up and maintain expertise and specialised knowledge.

The experience gained in the application of nuclear technology over the past decades enables the Federal Republic of Germany to actively contribute its accumulated expertise to nuclear safety issues on an international level, also in its own safety interests.

The research carried out in the field of radioactive waste management contributes to the continual development of the state of the art in science and technology as demanded i.a. by the Atomic Energy Act (AtG) so that the stringent requirements for the safe handling and management of the radioactive waste and spent fuel are met. Furthermore, the research activities contribute substantially to the development and maintenance of scientific and technical competence and promotion of young researchers in the field of radioactive waste management.

A significant scientific contribution to the waste management research and, especially, to the research on radioactive waste disposal as well as to the international cooperation in these areas is made by the German Association for Repository Research (DAEF). The aim of the DAEF is the further development and expansion of cooperation of its members and the use of their cumulative expertise in the field of research on radioactive waste disposal.

Regarding the extended storage of spent fuel and high-level radioactive waste from reprocessing, national and international experience are evaluated to be able to identify safety issues at an early stage and to be able to make competent assessments on corresponding concepts and strategies for extended storage. As part of national research programmes, issues relating to safety proofs for casks, inventories and building structures and their long-term behaviour are already being investigated. Another research focus is on the investigation of social-science and socio-technical aspects. Research on fuel rod behaviour is currently conducted by various project groups, e.g. as part of the Studsvik Cladding Integrity Project IV (SCIP-IV), the European Joint Programme or by BGZ with its Long-Term Experimental Dry Storage Analysis (LEDA) research project.

For several decades, researchers from Germany have been involved in international research projects on waste management and disposal with the aim to build up and expand

experience and knowledge, as well as to obtain the necessary expertise in connection with the application and use of methods and technologies. As, on the one hand, there are no underground laboratories in Germany that make the various host rocks accessible, and, on the other hand, there is the need to carry out specific studies and experiments under realistic conditions, research in the international underground laboratories (in particular Mont Terri (CH), Grimsel (CH), Äspö (S), Bure (F), Bukov (CZ), Horonobe (JPN)) is of great importance and has to be regarded as indispensable. In particular, this research substantially advances the state of knowledge in Germany on the host rocks clay rock and crystalline rock, which have not been sufficiently researched yet. Furthermore, these research activities can be used to build up and expand considerable knowledge in German organisations. This will allow well-founded assessments of advantages and disadvantages of disposal facility concepts in all host rock types. The research activities that lie within the responsibility of the Federal Environment Ministry and are carried out by German research institutions as part of international cooperations are performed within the framework of the EU Framework Programmes for Research, bilateral agreements with waste management organisations, by way of project-funded participation in multilateral consortia, and as part of direct contractual agreements of scientific and technical cooperation.

International cooperation currently takes place mainly with organisations from other European countries and with the United States of America.

In the EU context, several German research institutions participate in the European Joint Programme on Radioactive Waste Management (EURAD), the successor to which, EURAD II, is currently being set up and will include topics relating to disposal but also to storage. In order to improve the national exchange on EURAD, the Federal Environment Ministry has set up a steering group (StEURAD), which meets several times a year as required to transfer information from EURAD to the research landscape and, in return, to contribute joint positions to EURAD. In addition, German interests with regard to waste management research are also represented through participation in the European technology platform Implementing Geological Disposal of Radioactive Waste – Technology Platform (IGD-TP).

Within the framework of cooperation with the OECD/NEA, German institutions participate in the Integration Group for the Safety Case (IGSC) as well as the Working Party on Information, Data and Knowledge Management (WP-IDKM), the Working Group on the Characterisation, the Understanding and the Performance of Argillaceous Rocks as Repository Host Formations (CLAY CLUB), in the Expert Group on Repositories in Rock Salt Formations (SALT CLUB), and in the Expert Group on Repositories in Crystalline Formations (CRYSTALLINE CLUB). Within the IAEA framework, Germany participates, for example, in the Underground Research Facilities Network for Geological Disposal (URF).

I. Article 9 – Financial resources

Article 9 – Financial resources

Article 9
Member States shall ensure that the national framework require that adequate financial resources be available when needed for the implementation of national programmes referred to in Article 11, especially for the management of spent fuel and radioactive waste, taking due account of the responsibility of spent fuel and radioactive waste generators.

In accordance with the principle that the costs of waste management shall be paid by the waste producers, the operators of nuclear power plants are obliged under § 9a(1) of the Atomic Energy Act (AtG), sentence 1, to bear the costs of management for the radioactive waste they produce. For nuclear installations and facilities, the respective approval holder shall provide for and maintain permanent adequate financial resources for the fulfilment of his obligations with regard to the nuclear safety of the particular installation or facility (see Chapter G.5).

Financing of the decommissioning of the nuclear installations and facilities of the public sector as well as the management of radioactive waste from them is ensured by the Federation and the *Länder* from the public budgets. The State also bears the costs for the closure of the Morsleben repository for radioactive waste and the Asse II mine.

The necessary expenses for the planning, construction and operation of disposal facilities are principally borne by the waste producers through fees and contributions together with advance payments according to §§ 21a and 21b AtG in conjunction with the Repository Prepayment Ordinance (EndlagerVIV) and the financing regulations according to the Site Selection Act. As the remaining surveillance of a disposal facility after its sealing is a governmental task, the necessary funds are provided by the Federation.

The use of *Land* collecting facilities for the long-term management of radioactive waste from research, medicine and industry (see Chapter D for details) is financed through costs (fees and expenses) or charges according to §§ 21 et seq. AtG, which have to be paid by the waste producers. The fees are intended to cover all expenses associated with the subsequent management of the waste, applying the cost recovery principle. A percentage of the fees levied by the *Land* collecting facilities is related to the disposal of radioactive waste and is forwarded directly to the Federation.

The Waste Management Transfer Act regulates the responsibility for nuclear waste management in the area of power reactors, and the Waste Management Fund Act secures financing of decommissioning and waste management in the long term. According to the Waste Management Transfer Act, the Federation shall be responsible for the storage and disposal of spent fuel and radioactive waste from power reactors. Financing of storage and disposal is provided from the federal budget and refinancing by the fund for the financing of nuclear waste management (KENFO).

The funds for the financing of the governmental tasks in the fields of storage and disposal were provided by the operators of the power reactors specified in the Waste Management Fund Act. They have transferred a total of around 24.1 billion euros to the KENFO. The amount paid in includes a so-called basic amount and a risk premium of around

6.2 billion euros, which is intended to cover cost and interest rate risks beyond the calculated waste management costs. This means that the Fund is now obliged to provide advance payments instead of the operators of power reactors. Waste producers that are not listed in the Waste Management Transfer Act (e.g. research institutions) continue to be liable to make advance payments or pay allocated costs.

The operators of power reactors continue to be responsible for the entire management and financing of decommissioning, dismantling and the proper packaging of radioactive waste. To provide for the costs arising from this in the future, they must continue to form provisions in accordance with commercial law. As an additional provision to secure financing, the Follow-up Liability Acts regulates the follow-up liability of the companies for their operators with regard to the tasks remaining with them.

Under the Transparency Act, the operators are required to submit to the Federal Office for Economic Affairs and Export Control (BAFA) a detailed annual statement, based on the annual financial statements, of the provisions recognised in the balance sheet for the decommissioning and dismantling of the power reactors and the packaging of the radioactive waste, broken down by the various tasks of radioactive waste management. This presentation must include the expenses expected for the individual tasks in the future financial years. It must also show which assets will be available to the operator in the future to cover these expenses.

The information and data provided by the operators were last verified by the BAFA for the reporting year 2022. The BAFA again came to the positive conclusion that there are no objections to the determination of the companies' provision amounts and that there are no indications that the companies might not meet their obligations. As at 31 December 2022, the provisions for obligations, presented in the statements of provisions prepared on the basis of the operators' annual financial statements under commercial law, amounted to approximately 20.5 billion euros.

The results of the examination by the BAFA formed the basis of the report of the Federal Government to the German *Bundestag* on the financial provisions of the nuclear power plant operators for their obligations, last published in November 2023. The report contains a summary assessment of the information submitted to the BAFA by the operators of nuclear power plants as part of their statutory obligation to provide information.

Further information on costs and funds can be found in the *Report on the cost and financing of the disposal of spent fuel and radioactive waste.*

J. Article 10 – Transparency

Article 10 – Transparency

Article 10.1

(1) Member States shall ensure that necessary information on the management of spent fuel and radioactive waste be made available to workers and the general public. This obligation includes ensuring that the competent regulatory authority inform the public in the fields of its competence. Information shall be made available to the public in accordance with national legislation and international obligations, provided that this does not jeopardise other interests such as, inter alia, security, recognised in national legislation or international obligations.

Article 10.2

(2) Member States shall ensure that the public be given the necessary opportunities to participate effectively in the decision-making process regarding spent fuel and radioactive waste management in accordance with national legislation and international obligations.

Information is made available to the general public in accordance with national legislation and international obligations. In this regard, in particular information relating to the applicable regulatory framework for monitoring of the environment, reportable events, radiological emergency situations, but also for the topic of radioactive waste management are to be listed.

In addition to the site-specific monitoring of the vicinity of power reactors according to the Guideline on Emission and Immission Monitoring (REI), the general environmental radioactivity is recorded by extensive measurements in the entire territory of the Federal Republic of Germany, i.e. also in the vicinity of waste management facilities, by means of the Integrated Measurement and Information System for the Monitoring of Environmental Radiation (IMIS) in accordance with the Radiation Protection Act. The data are published in the annual reports “Environmental Radioactivity and Radiation Exposure”[7] issued by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and are partly accessible to the public via the Internet.

Events in nuclear waste management facilities for which reporting is mandatory are classified by the approval holders of these facilities according to the International Nuclear Event Scale (INES) of the International Atomic Energy Agency. The approval holders inform the public about all reportable events in their facilities. Own staff will be informed internally about these events. The Federal Office for the Safety of Nuclear Waste Management (BASE) records these events and informs all *Land* authorities and authorised experts in quarterly reports and the general public in monthly and annual reports on its website.

With respect to the obligation of informing the general public in the event of radiological emergency, stipulations are laid down in the Radiation Protection Act and in the Radiation Protection Ordinance. Here, a distinction is made between the information to be provided to the public in advance as general preparation for a radiological emergency

[7] https://doris.bfs.de/jspui/handle/urn:nbn:de:0221-2015060312762/browse?type=title&sort_by=2&order=DESC [in German only]

without having such a situation, and the relevant information to be provided to the public in an actual emergency to keep the impacts of this special event as low as possible.

Public information relating to spent fuel and radioactive waste management through the competent authorities and their project management organisations mainly takes place through the publicly available annual reports and their respective websites, or for specific topics through separate publications. The websites are usually also available in English.

Bundesgesellschaft für Endlagerung mbH (BGE) operates the information centres “INFO Konrad” in Salzgitter, “INFO Morsleben” near the Morsleben repository for radioactive waste and “INFO Asse” near the Asse II mine for information of the public. The BGE organises early public participation in licensing procedures for the retrieval of radioactive waste from the Asse II mine and operates an information platform for the publication of Asse-related documents. All information centres offer dialogue formats and magazines and carry out outreach public relations work. In addition, the BGE offers a newsletter for each project and specific information on two websites (www.bge.de/en and www.einblicke.de *[in German only]*).

The BGE offers comprehensive information on the progress of the site selection process on both websites, as well as a comprehensive document directory as essential documentation. Interactive maps are used to provide regional information for specific target groups. The BGE also supports the Nationales Begleitgremium (NBG) in obtaining access to records and files in the BGE, thus enabling it to inspect all requested documents. The BGE offers dialogue formats on various topics relating to site selection, publishes methodology-related work statuses and makes them available for discussion and is available for the extensive participation formats offered by BASE or the planning team for the repository search forum.

In general, the public can access environmental information according to the Environmental Information Act.

In parallel with the wide range of information provided to the public, the public is involved within the framework of the approval procedure for radioactive waste management facilities. By this, it is given the opportunity to bring in their interests directly into the procedure.

If an approval procedure is to be carried out with public participation, the applicant has to submit, among other things, an understandable brief description of the facility and the change applied for to inform the public. A safety report, which is checked by the competent authority with the help of technical experts in the course of the approval process, is also to be prepared by the applicant. It essentially serves to describe the impacts related to the change, including the possibly changed effects of design basis accidents, and to set out the precautionary measures, so that affected persons can assess whether they want to act to preserve their rights. The approval authority takes account of the objections in their decision-making and presents this in the approval statement.

As part of the drafting of the National Programme as well as in case of future major changes to it and the pending revision, a Strategic Environmental Assessment (SEA) has been and will be carried out by the BMUV according to the Environmental Impact

Assessment Act[8]. To this end, the potential environmental impacts to be expected from the implementation of the programme were and will be determined and presented in an environmental report for public participation. In the framework of the SEA, the environmental impacts of the National Programme, including the alternatives considered, have been and will be assessed with public involvement, also involving the neighbouring countries.

The public is to be given the opportunity of intensive participation in the site selection procedure for a disposal facility for high-level radioactive waste at the national and regional level. The organiser and coordinator of public participation is BASE. Since the start of the site selection procedure, BASE has offered, in some cases with partners, numerous opportunities for public information and participation that go beyond the legal requirements. These include, for example, online consultations, the repository search forum or workshops for youth participation. The licence procedure pursuant to § 9b(1a) AtG, which follows the decision on a site, also contains participatory elements, in particular participation by the public in the context of the required environmental impact assessment.

On 28 September 2020, the BGE published the so-called Sub-areas Interim Report and presented its findings publicly during the kick-off event for the Subareas Conference. Interested members of the public had the opportunity to contribute their comments in three consultation sessions at the Subareas Conference, which was organised with the support of BASE. The results of the consultations were then submitted to the BGE.

At the national level, the NBG was formed in December 2016. This board is composed of 18 members, 12 of which are renowned public figures appointed by the *Bundestag* and the *Bundesrat*. The other six members are citizens who were selected from a nationwide random sample according to a qualified selection system and appointed by the Federal Environment Minister, among them two representatives of the young generation. The central task of the NBG is to accompany the process of site selection as a mediating and independent body until reaching a decision on a site, in particular with regard to public participation. For this purpose, it may seek scientific advice.

At the level of the regions concerned, the so-called regional conferences will be institutionalised in the site selection procedure pursuant to § 10 StandAG. They will be established in all regions proposed for surface exploration. They should be provided with necessary appropriations to be able to accompany the repository site selection procedure critically and constructively by involving independent expertise. A council of the regions (§ 11 StandAG) will serve the networking of the regions, who will include the municipalities of the existing storage facilities for high-level radioactive waste, as these are already concerned by the future disposal issue.

Moreover, the Site Selection Act (StandAG) includes detailed information about the conducts of the site selection procedure and the associated requirements (see Chapter 2 StandAG) as well as the criteria and requirements for site selection.

[8] https://www.bmuv.de/en/download/national-programme/

For other aspects of public participation, see also the National Programme (Chapter 5).

K. Articles 11 and 12 – National programmes

Article 11 – National programmes

Article 11.1

(1) Each Member State shall ensure the implementation of its national programme for the management of spent fuel and radioactive waste ('national programme'), covering all types of spent fuel and radioactive waste under its jurisdiction and all stages of spent fuel and radioactive waste management from generation to disposal.

Article 11.2

(2) Each Member State shall regularly review and update its national programme, taking into account technical and scientific progress as appropriate as well as recommendations, lessons learned and good practices from peer reviews.

Article 12 – Contents of national programmes

Article 12.1

(1) The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:
   a) the overall objectives of the Member State's national policy in respect of spent fuel and radioactive waste management;
   b) the significant milestones and clear timeframes for the achievement of those milestones in light of the over-arching objectives of the national programme;
   c) an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;
   d) the concepts or plans and technical solutions for spent fuel and radioactive waste management from generation to disposal;
   e) the concepts or plans for the post-closure period of a disposal facility's lifetime, including the period during which appropriate controls are retained and the means to be employed to preserve knowledge of that facility in the longer term;
   f) the research, development and demonstration activities that are needed in order to implement solutions for the management of spent fuel and radioactive waste;
   g) the responsibility for the implementation of the national programme and the key performance indicators to monitor progress towards implementation;
   h) an assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time;
   i) the financing scheme(s) in force;
   j) a transparency policy or process as referred to in Article 10;
   k) if any, the agreement(s) concluded with a Member State or a third country on management of spent fuel or radioactive waste, including on the use of disposal facilities.

Article 12.2

(2) The national programme together with the national policy may be contained in a single document or in a number of documents.

K.1 National Programme

The *Programme for the Responsible and Safe Management of Spent Fuel and Radioactive Waste (National Programme)* was drafted under the leadership of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Federal Environment Ministry) (see chapters A.3 and E).

The Federal Government meets its reporting obligation imposed by Directive 2011/70/Euratom by submitting several documents (see **Figure K-1**). The National Programme contains a programmatic overview of the spent fuel and radioactive waste management planning. The current status of spent fuel and radioactive waste management is reported every three years in the *Report for the Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*. Progress in the implementation of the National Programme is also reported every three years (for the first time by 23 August 2015) within the framework of the *Report on the Implementation of Directive 2011/70/Euratom* to the European Commission. In this context, the *Inventory of Radioactive Waste (Current inventory and prediction)* is also updated and submitted to the European Commission. This also applies to the *Report on the Costs and Financing of the Management of Spent Fuel and Radioactive Waste*.

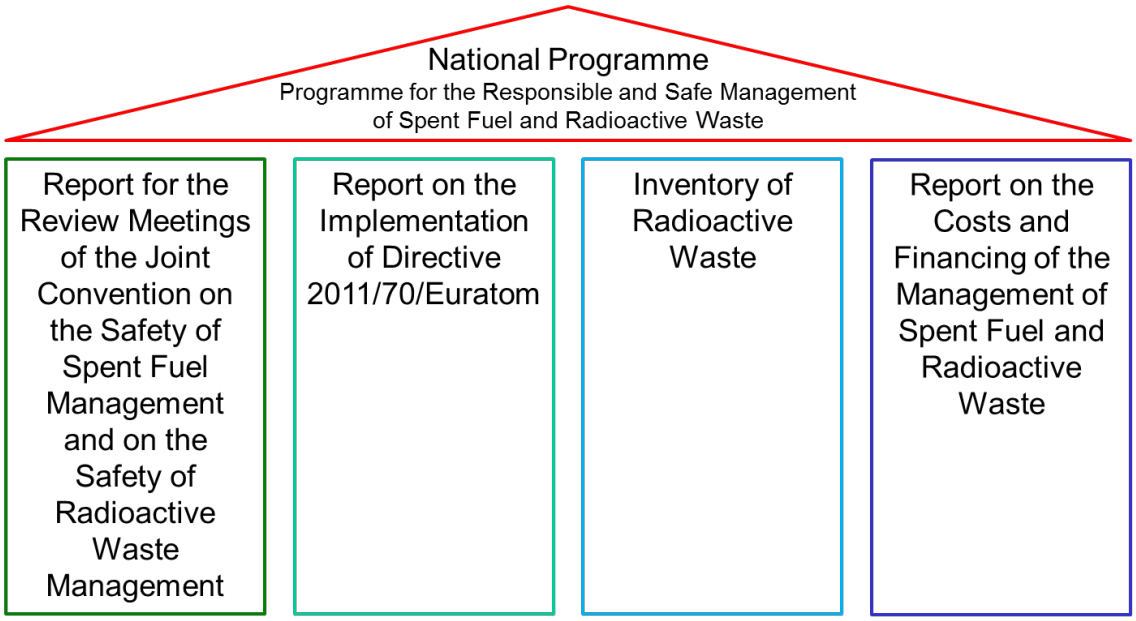

Figure K-1: Concept of the Federal Government to fulfil its reporting obligation within the framework of Directive 2011/70//Euratom

K.2 Implementation of the National Programme and key performance indicators

Waste management under national responsibility

Germany continues to fulfil its obligation according to which the management of radioactive waste is a national responsibility and that disposal should always take place in Germany. Since mid-2005, fuel assemblies from power reactors may no longer be delivered to reprocessing plants. Since May 2017, a licence for the export of spent fuel from the operation of facilities for the fission of nuclear fuels for research purposes may only be granted for serious reasons of non-proliferation of nuclear fuel or for reasons of sufficient supply of German research reactors with fuel elements for medical and other top-

level research purposes. This does not apply to the shipment of spent fuel with the aim of producing waste packages suitable for disposal and that are to be disposed of in Germany. By way of derogation, a licence for the export of spent fuel shall not be granted if it is stored in Germany on the basis of a licence pursuant to § 6 AtG.

The implementation of the National Programme is carried out by the respective responsible waste producers and operators and is monitored by the federal authority responsible for nuclear safety and radiation protection issues at the highest federal level, the BMUV. At the project level, progress in the projects and processes of waste management is generally recorded and evaluated by the operators. In particular, they use plan/actual comparisons, forecasts and key performance indicators (e.g. milestones with milestone trend analysis, process indicators) for monitoring, which are continuously documented.

The Bundesgesellschaft für Endlagerung mbH (BGE) and BGZ Gesellschaft für Zwischenlagerung mbH (BGZ) provide the BMUV with the management report and the annual financial statements for the respective financial year and publish them in the Federal Gazette. Furthermore, both companies summarise and report their activities to the BMUV in the form of quarterly reports, which take into account all the main tasks of the companies and contain information on progress, risks and resource planning. These reports are not public due to the partly sensitive nature of the information.

The quarterly reports of the BGE and BGZ describe, among other things, the progress of strategic projects or partial projects as well as the achievement of performance targets and milestones, such as for the BGE the construction of the Konrad repository, product control or the site selection procedure. In addition to the project status and the completion of tasks, the report also describes project risks and risk management measures. For this purpose, the BGE and BGZ operate a company-wide risk management system with which risks are uniformly identified, described, qualitatively and semi-quantitatively analysed and controlled.

The status of the performance targets and milestones is also summarised in tabular form; the status of implementation can be tracked using a traffic light system. In addition to the tabular presentations, the individual performance targets and possible delays and their reasons are also dealt with. Necessary changes and any necessary new targets or target dates are also mentioned. Furthermore, concrete figures and deadlines are given in the reports and set in relation to planning values. In this way, for example, delays and deviations compared to the project or economic plan can be identified directly.

The BMUV monitors and controls the BGE and BGZ as the representative of the sole shareholder, the Federation, and through the representation in the supervisory boards established at the companies. The responsibility for operational activities fundamentally lies with the respective management.

For controlling of the EWN GmbH, the targets are agreed upon by the Federal Ministry of Finance (BMF), assessed every six months and summarised in an annual report with plan/actual comparison and deviation analysis. In order to ensure uniform holdings management, EWN GmbH, as the shareholder, sets comparable (compatible) targets for its two subsidiaries JEN mbH and KTE GmbH. The assessment of the achievement of the

technical targets is carried out on a quarterly basis with the support of an external controller.

Shutdown of the nuclear power plants still in operation and completion of the decommissioning of the nuclear power plants

With the decision to phase out the use of nuclear energy for the commercial generation of electricity, all nuclear power plants were to be shut down permanently in stages by the end of 2022. Against the background of the geopolitical developments in 2022, it was decided to allow the remaining three nuclear power plants to continue operation for a limited period until 15 April 2023. Shutdown took place as scheduled on this date. Applications for decommissioning and dismantling were submitted for all German nuclear power plants. Thus, the first interim target has been met. According to the operators' plans, the decommissioning and dismantling of the nuclear power plants is expected to be completed by 2045 for the plants that are to be decommissioned and dismantled immediately pursuant to § 7(3) of the Atomic Energy Act.

The GRS has been commissioned as an independent expert organisation to support the BMUV in monitoring the progress of the decommissioning work, the state of the art in science and technology and, in particular, regarding technical issues. In this context, further uniform interim targets were defined which refer to important dismantling steps of the facilities. In addition to the data mentioned above, these include the removal of fuel, the dismantling of the reactor pressure vessel (RPV) and the RPV internals up to clearance measurements and the clearance of buildings and the site itself. The progress of the decommissioning work and the achievement of the interim targets are presented by a simplified traffic light system similar to the report presentation of the BGE. Direct supervision of the decommissioning of the individual facilities is the responsibility of the competent *Land* authorities.

Return of reprocessing waste

A total of 20 casks with vitrified high-level waste are to be returned from the reprocessing of spent fuel from Germany in the United Kingdom (UK). The first return transport of six casks to the spent fuel storage facility in Biblis took place with a delay in November 2020 due to the coronavirus pandemic (SARS-CoV-2). In 2025 und 2026, the remaining casks from the UK are to be returned to the spent fuel storage facilities Brokdorf and Isar (seven casks each). The completion rate for the return of reprocessing waste from the UK is thus currently 30 % and will rise to 100 % in 2026.

According to original planning, 108 casks with vitrified high-level waste of the CSD-V type, five casks with vitrified waste of the CSD-B type and 152 casks with compacted waste of the CSD-C type and thus a total of 265 casks were to be returned from reprocessing in France. The return in accordance with the agreements under international law is to be completed by 2024. The 108 casks with vitrified waste of the CSD-V type from France have already been completely returned and are stored in the spent fuel storage facility Gorleben. Thus, the completion rate for the return of reprocessing waste from France is around 41 %. In 2021, a new agreement was reached with France according to which, instead of the remaining 157 casks, only four casks with CSD-V type waste will

be returned as an activity equivalent to the Philippsburg spent fuel storage facility and 24 used empty, contaminated or activated transport casks ("end used cask" – EUC) will be returned for further utilisation as a mass equivalent, possibly after storage. According to current planning, the return from France to Germany will be completed in 2024. With the return of these casks, the completion rate – in relation to the activity inventory – will increase to almost 100 %. The transport of the 24 EUCs for further utilisation is also scheduled for 2024.

Storage

In Germany, spent fuel and high-level radioactive waste are kept in dry cask storage until they are delivered to a disposal facility. With the decision to phase out the commercial use of nuclear energy in Germany, the total quantity of spent fuel to be stored can be reasonably estimated. After decay storage in the spent fuel pools of the nuclear power plants, spent fuel is placed in transport and storage casks and kept in dry cask storage, where they remain until they are transferred to a disposal facility. With the aim of safe dry cask storage, central fuel storage facilities (Ahaus and Gorleben as well as the Storage Facility North, which is to be replaced in future by the ESTRAL replacement transport cask storage facility) are available. In addition, decentralised spent fuel storage facilities had been licensed, constructed and commissioned at twelve sites. The licence for one of these twelve decentralised storage facilities (Brunsbüttel) became invalid after commissioning due to a decision by the Federal Administrative Court of 8 January 2015. The legal basis for the current storage of the spent fuel in this storage facility is a supervisory order issued by the nuclear supervisory authority of the *Land* of Schleswig-Holstein. Work is underway to restore an authorised status; the relevant procedures are advanced but not yet completed.

Availability of sufficient storage capacity

The total licensed capacity for dry cask storage in the on-site storage facilities for spent fuel is 14,025 Mg HM, another 8,345 Mg HM are licensed in the central storage facilities. The expected total quantity of spent fuel to be stored is about 10,100 Mg HM. During the reprocessing of German fuel assemblies in Germany and abroad, 3,836 glass canisters were produced as high-level radioactive waste, which are and will be stored together with spent fuel in the spent fuel storage facilities. Based on this, sufficient storage capacity is available, both for the spent fuel from power reactors already existing and expected to arise as well as for the reprocessing waste to be returned from abroad.

For the proof of precautionary measures for waste management, the inventory of spent fuel as at 31 December as well as the expected volume in the two years after the reporting date and until final shutdown are queried annually on a site-specific basis. In this way, sufficient availability of storage capacity for spent fuel already existing and expected to arise is also checked and monitored annually for the individual sites.

No further emplacement of spent fuel is planned at the Storage Facility North and the Gorleben spent fuel storage facility. Around 25 % of the Ahaus spent fuel storage facility is occupied by transport and storage casks, and it is intended for the storage of further spent fuel from research reactors and possibly for the storage of 24 EUC from France.

BGZ regularly reports to the BMUV on the storage capacities and the activities stored there. The reports not only refer to the capacities and occupancy rates of the storage facilities, but also include, among other things, key figures in the area of staff development and staffing needs, budget expenditures, inspections and transports. Deviations from target figures are also listed. The BMUV checks these figures and can issue countermeasures if necessary.

Transfer of all spent fuel to dry cask storage

As at 31 December 2023, 8,138 Mg HM of spent fuel were already in dry cask storage. Another 1,896 Mg HM of spent fuel are already in the spent fuel pools of the power reactors and will be transferred to dry cask storage in the next few years. Thus, a total of 81 % of all expected spent fuel is already in dry storage.

Availability of licensed storage capacities until disposal

The storage licences for the spent fuel storage facilities are currently limited to 40 years and expire between 2034 and 2047. The site for the disposal facility for high-level radioactive waste is to be determined by the middle of the century. Once the site has been determined, the disposal facility for high-level radioactive waste is to be constructed, including receiving storage facility for the transport and storage casks and a conditioning facility. Against this background, it will be necessary to extend the licensed storage period for the individual spent fuel storage facilities. In § 6(5) AtG, sentence 2, the Atomic Energy Act subjects the extension of storage licences to the existence of imperative ground and requires prior referral to the German *Bundestag*.

Storage period extension requires a new licensing procedure with a fundamental reassessment of the safety demonstrations in the light of the state of the art in science and technology and with public participation. For timely licence extension, projects for national and international exchange of information and experience were initiated at an early stage in order to be able to assess safety-related issues in connection with the extended storage of spent fuel. BGZ has also published a comprehensive research programme. It is expected that the currently established concept of dry storage maintains its safety functions even for considerably longer periods than 40 years. This is to be demonstrated by the storage facility operators in a detailed and substantiated manner as part of comprehensive planning oriented to the primacy of safety.

Disposal facility for high-level radioactive waste

High-level radioactive waste, which also includes spent fuel, is to be disposed of in deep geological formations. In the implementation of such a repository, the completion of the site selection procedure with a site decision by law and the start of operation of the disposal facility are regarded as milestones. Further interim targets are defined in the site selection procedure for monitoring the implementation. The planned sequence for the realisation of such a disposal facility is shown in **Figure K-2**.

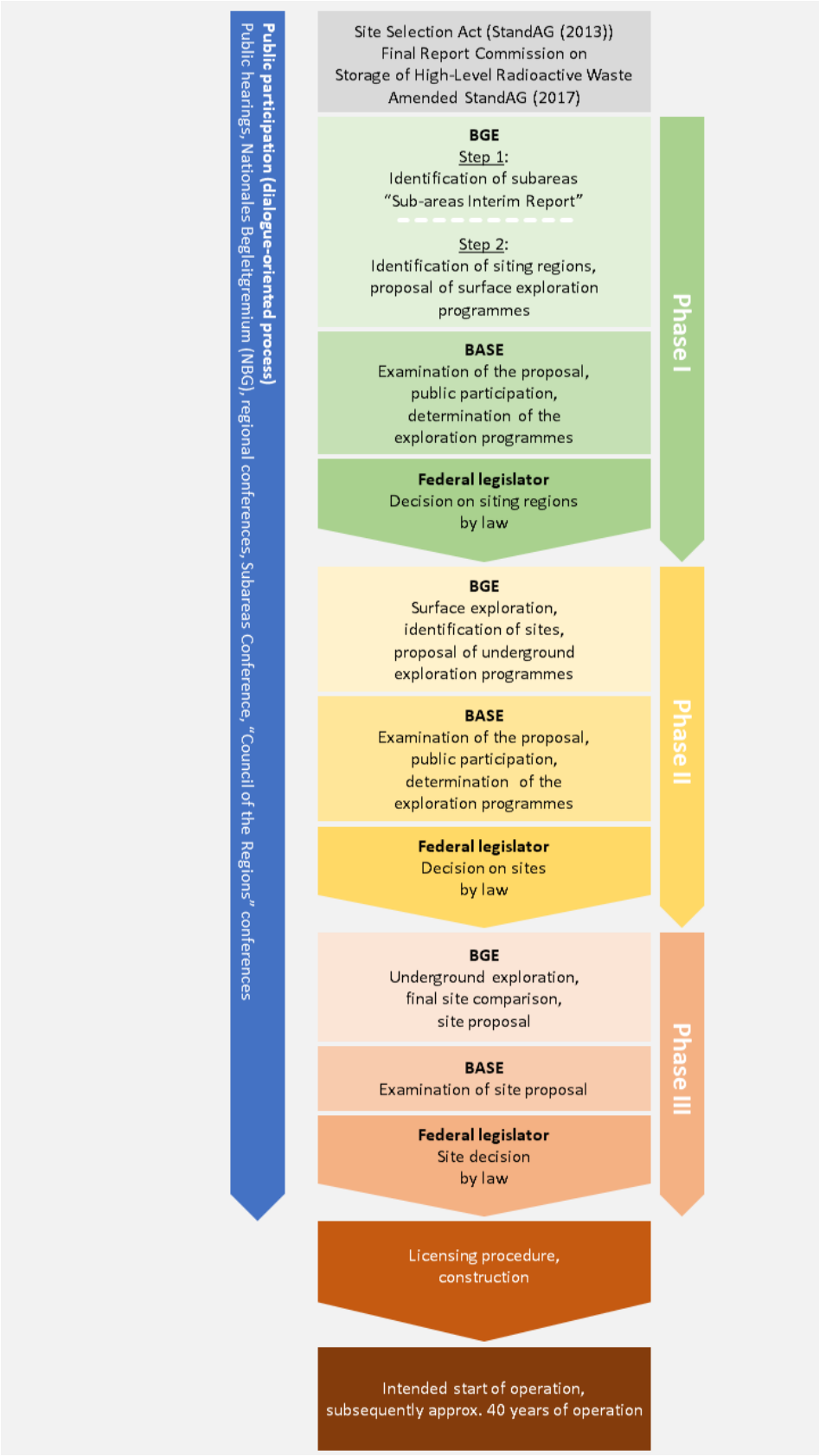

Figure K-2: Steps in the site selection of a disposal facility for high-level radioactive waste, including responsibilities

With the amendment of the Site Selection Act (StandAG) in 2017, the site selection procedure was started. The iterative procedure is accompanied by intensive involvement and participation of the public throughout Germany. It is divided into three phases, the completion of which represent the intermediate steps of deciding on siting regions, deciding on possible sites and deciding on a site in the site selection procedure. The results of each phase and the resulting specifications by the federal legislator determine the concrete scope of work of the subsequent phase.

The work of the BGE within the phases is subdivided into partial projects, the implementation of which is tracked and monitored by it using key performance indicators. Phase I was further divided into two steps, and the first step with the publication of the Sub-areas Interim Report was completed as planned in September 2020. The site selection procedure is now in Step 2 of Phase I, in which siting regions for surface exploration are identified.

Following the decision on the site, the next steps towards safe disposal of high-level radioactive waste are as follows:

- licensing and construction of a receiving storage facility at the selected site for the disposal facility for high-level radioactive waste,
- licensing of the disposal facility for high-level radioactive waste,
- conditioning of the high-level radioactive waste on the basis of the disposal concept to be developed for the waste,
- commissioning of the disposal facility for high-level radioactive waste
- removal of high-level radioactive waste from the existing storage facilities, and
- sealing of the disposal facility for high-level radioactive waste.

The timing of these steps will only be fixed when there is sufficient planning certainty as the procedure progresses.

On the basis of the developments in the performance targets and milestones, on which the BGE elaborates in the quarterly reports already mentioned, the BMUV can follow the procedural progress and, if necessary, react accordingly.

The objective of the StandAG to reach a rapid site decision meant that it was possible to achieve a rapid start of the site selection procedure and to build up the necessary capacities among all those involved. However, in the course of the procedure, which follows a self-questioning and learning approach, it has become apparent that the duration and scope of the individual partial steps are difficult to estimate and depend on many influencing factors, such as the number and size of siting regions to be explored or the duration of approvals for exploration work. After it became known that the originally set target date for the site decision might not be met, the BMUV instructed the BGE to submit a report on the time required and on optimisation possibilities. A first discussion paper was submitted by the BGE, in which two scenarios and time corridors for the upcoming work in the site selection procedure are presented, taking into account deadline risks and acceleration potentials. Scenario A assumes six siting regions to be explored above ground

in Phase II and two sites to be explored underground by drilling of boreholes in Phase III. Scenario B assumes ten siting regions to be explored above ground in Phase II and two sites to be explored underground by driving mines in Phase III.

In a thorough process, the BMUV dealt with the technical assessments and subsequently announced that the procedure cannot be completed by 2031, taking into account the high requirements for the selection of the site with the best possible safety. In this context, the BMUV emphasised that time constraints also have to be subordinated to the principle of the best possible safety and the comprehensive participation of citizens, but at the same time the objective of the StandAG must not be lost sight of. The BMUV will now hold talks with the BGE and the Federal Office for the Safety of Nuclear Waste Management (BASE), which supervises the selection procedure, on the conclusions to be drawn from this.

Part of a transparent, participatory and learning process is to have a fact-based discussion about the further timetable. The public will also be involved in the further discussions through BASE and the BGE, and the BGE will regularly publish and discuss milestones.

Konrad repository

Since 2007, a final plan approval decision has been in place for the Konrad repository and construction has begun. The main elements of the disposal facility are the two shafts Konrad 1 and Konrad 2 with their respective surface facilities. The mine workings in the immediate vicinity of the shafts (insets) also belong organisationally to the shafts. The two shafts are connected underground by galleries. The underground areas of the disposal facility comprise the transport galleries to the emplacement locations, the emplacement fields with the individual emplacement chambers as well as other so-called side chambers of the infrastructure. Shaft Konrad 1 is used for the entry and exit of miners (manriding), the transport of materials and the transport of debris to the surface (transportation) and the supply of fresh air. Shaft Konrad 2 will be used to transport waste packages underground and is already used as an upcast air shaft.

All of the buildings were built at the surface facilities of the Konrad 1 shaft. The hoisting machine for the shaft hoisting system was completed and installed in the northern winding engine house. In the shaft, the shaft bottom frame was installed at the 5th level (floor).

In the area of the Konrad 2 shaft, the construction of the mine water transfer station and the buildings of the depot was completed. In the mine water transfer station, the mine water that accumulates underground during repository operation is collected and radiologically monitored. After clearance measurement, the water is transferred to the buffer basin and discharged from there together with other treated wastewater from the facility.

The largest single contract awarded by the BGE was for the construction of the reloading hall in 2022. With a total length of 140 m, the reloading hall with its buffer hall is the largest building of the shaft Konrad 2 surface facilities to be erected. In the building complex, the delivered packages with low- and intermediate-level radioactive waste are lifted off trucks and railway wagons, radiologically examined and transported underground through the Konrad 2 emplacement shaft. The buffer hall directly adjacent to the reloading hall can receive packages at short notice in the event of unforeseeable standstills of the shaft hoisting system.

The BGE tracks and monitors the Konrad repository project through key performance indicators and reports to the BMUV on the progress on a quarterly basis.

Conditioning of the radioactive waste with negligible heat generation in preparation for emplacement in the Konrad repository

For emplacement in the Konrad repository, the entire licensed waste package volume of 303,000 m^3 must be provided in product-controlled waste packages. The production of such waste packages is a process that begins with process qualification and ends with the suitability of the packages for disposal. Compliance with the Konrad waste acceptance criteria is verified by means of the material and radiological product control and by container design testing. Upon fulfilment of all criteria, a notice on the suitability for disposal will be issued. In order to speed up the product control application process and achieve a higher throughput, the BGE has increased its personnel capacities in the area of product control. At least as many waste packages as can be emplaced in the disposal facility must be product-controlled annually. The prerequisite for this is that sufficient disposal facility documentation is submitted.

A basis for achieving a higher throughput in product control is the acceleration of administrative processes. To this end, internal processes are being extensively revised and optimised, and responsibilities are being more clearly delineated. The aim is to make processes more transparent, measurable and consistently controllable. Another important focus of product control is the establishment of a digital application management system ("nuclear waste logistics"), which is intended to improve the planning, control and cooperation of all those involved in the process. The implementation of the digital application management system was completed in 2023. For 2025, it is also planned to complete digitisation of the product control inventory documentation.

Sealing of the Konrad repository

The timing of the last step "sealing of the Konrad repository" will only be fixed when there is sufficient planning certainty as the procedure progresses.

Morsleben repository for radioactive waste

In 1971, the German Democratic Republic (GDR) built a disposal facility for radioactive waste in the former Bartensleben potash and rock salt mine near Morsleben (Saxony-Anhalt). The Morsleben repository has two shafts that are connected underground by galleries. The disposed of radioactive waste is located at a depth of around 480 metres in five separate emplacement areas.

The central objectives of the ERAM project are the safe operation for keeping the mine open and the implementation of the measures applied for in order to safely isolate the stored and disposed radioactive waste from the biosphere. Closure was applied for in a plan approval procedure under nuclear law.

The BGE operates the ERAM and is the applicant in the ongoing plan approval procedure for closure. It develops a closure concept and prepares the application documents required for the planning approval procedure under nuclear law. The documents will be submitted to the licensing authority successively by 2026. The current time schedule

provides for the approval of the closure plan in 2028 and the completion of all related measures in the mid-2040s. For this reason, construction measures are being carried out to preserve the substance of buildings and shafts for the corresponding period and to prepare them for closure.

The main technical measures of the closure concept for the long-term safe isolation of the radioactive waste from the biosphere are, according to the closure concept applied for, the backfilling and sealing of the existing shafts Bartensleben and Marie as well as extensive backfilling of the still existing cavities with salt concrete. Sealing structures will be erected at suitable locations. These will separate the emplacement areas from the rest of the mine workings in order to delay and limit contact with the radioactive waste and subsequent spread of pollutants for a long time in the event of groundwater inflow into the mine.

Demonstration structures are used to determine the special properties of drift seals and to collect data for the long-term safety analysis with the aim of demonstrating the technical feasibility.

In 2022, the research contract was awarded for the demonstration structure shotcrete/bitumen in anhydrite. Planning has begun. For the demonstration structure in the main anhydrite in the ERAM, which will be made of poured magnesia concrete, the semi-mobile building material facility was assembled and instrumentation started. For the demonstration structure in rock salt on the second level, the permeabilities determined for the entire structure were lower than the target value also in 2022.

Asse II mine

Since 2017, the BGE has been the operator of the Asse II mine and is responsible for the retrieval of the waste and closure of the mine. On 27 March 2020, the BGE published a retrieval plan in which all measures to be taken are described in a coherent manner. In preparation and for the subsequent realisation of the retrieval of waste from the Asse II mine, the sinking of the Asse 5 shaft, fact-finding, emergency planning and the construction of a building complex consisting of facilities for waste treatment and storage are required. The phases of the individual projects and their chronological sequence are shown schematically in **Figure K-3**.

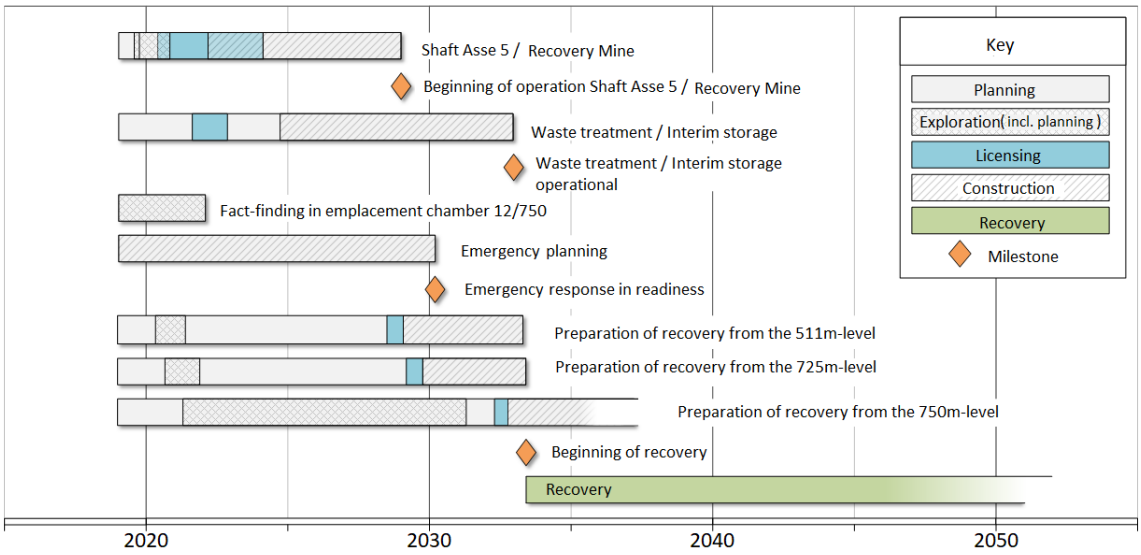

Figure K-3: Chronological sequence of the project phases for retrieval of the waste from the Asse II mine (as at 19 February 2020)

Shaft Asse 5 and the retrieval mine are to be constructed south-east of the existing mine. The planning, exploration, licensing and execution phases for the Asse 5 shaft are carried out in parallel as far as possible. In 2023, planning work began for the sinking of the Asse 5 retrieval shaft and the construction of the associated surface facilities.

Waste processing includes buffer storage, characterisation and conditioning of the retrieved waste, which creates the conditions for storage and transport to a disposal facility. Preliminary planning for the waste processing and storage facilities has been completed. Planning activities will be substantiated with the determination of the site for these facilities.

The emergency planning measures serve, on the one hand, to reduce the probability of occurrence and, on the other hand, to minimise the consequences of a beyond-design-basis solution inflow. Among other things, they aim to reduce deformations in the mine and to seal off potential weak points. All precautionary measures are continuously adapted to the current situation in the mine and planned until they are ready for implementation and implemented. The necessary approval procedures are carried out during the planning process. The precautionary measures include, for example, the continuation of the backfilling of mine workings that are no longer needed as a stabilisation measure.

The fact-finding at the emplacement chambers is aimed at eliminating essential knowledge gaps with regard to the condition of the packages and the emplacement chamber. By drilling into the chamber, the condition of the drums could be assessed visually for the first time and representative gas samples could be taken from the interior of the emplacement chamber. The retrieval of the radioactive waste is to be accompanied by further exploration activities specifically for the emplacement chambers. Cold testing of retrieval is provided for during the planning of licence application and planning of implementation.

The steps following the start of waste retrieval are as follows:

- completion of the retrieval of waste from the Asse II mine and implementation of the closure procedure, and
- sealing of the Asse II mine.

The timing of these steps will only be fixed when there is sufficient planning certainty as the procedure progresses.

K.3 Review and publication of the National Programme

On behalf of the Federal Government, the BMUV reviews the National Programme regularly, but at least every ten years, to ensure that it is up to date. The programme is currently being revised.

The national strategy for spent fuel and radioactive waste management is completed by or based on decisions that have been taken by the legislator and are reflected in the relevant regulations, such as the Atomic Energy Act.

In accordance with the principle of transparency in the field of waste management in the Federal Republic of Germany, the National Programme is published together with the supporting reports on the website of the BMUV. The environmental report, which was prepared as part of the Strategic Environmental Assessment (SEA) of the National Programme, as well as information on how the comments from participation of authorities and the public on the National Programme have been taken into consideration are also published there.

One part of the National Programme refers to the construction of the disposal facility for high-level radioactive waste. In this respect, the StandAG establishes chronological milestones and the framework conditions for the required information and participation of the public. For public information, the corresponding project information is provided, primarily by using the websites of the institutions involved.

L. Peer reviews and self-assessment

Article 14 – Reporting

Article 14.3

(3) Member States shall periodically, and at least every 10 years, arrange for self-assessments of their national framework, competent regulatory authority, national programme and its implementation, and invite international peer review of their national framework, competent regulatory authority and/or national programme with the aim of ensuring that high safety standards are achieved in the safe management of spent fuel and radioactive waste. The outcomes of any peer review shall be reported to the Commission and the other Member States, and may be made available to the public where there is no conflict with security and proprietary information.

In order to fulfil the requirements of Directive 2011/70/Euratom to periodically conduct a self-assessment of its national legislative, regulatory and organisational framework, competent regulatory authority, national waste management programme and its implementation every ten years, an IRRS (Integrated Regulatory Review Service) mission was carried out in the Federal Republic of Germany from 31 March to 12 April 2019 and an ARTEMIS (IAEA Radioactive Waste Management Integrated Review Service) mission from 22 September to 4 October 2019. In addition, an IRRS follow-up mission was carried out from 9 to 16 October 2023 and an ARTEMIS follow-up mission from 6 to 12 November 2022.

L.1 IRRS mission

The IRRS review mission covered all nuclear installations, facilities and activities in the Federal Republic of Germany with the exception of transports, radiation sources, interfaces with nuclear security and aspects of public and medical radiation exposure. This was the first German IRRS review mission to explicitly address issues related to spent fuel and radioactive waste management.

In the field of spent fuel and radioactive waste management, the international experts identified the increased requirements regarding the provision of necessary resources for the management of radioactive waste due to the concurrent decommissioning of numerous nuclear installations as a challenge. Further challenges mentioned in the final report were the retrieval of the radioactive waste from the Asse II mine and the site selection for the disposal facility for high-level radioactive waste.

In addition, the international experts made recommendations and suggestions with the aim of further promoting the implementation of the IAEA safety standards in the German rules and regulations and in the performance of regulatory functions.

A detailed presentation of the results of the German IRRS mission was submitted as a report in July 2019 and subsequently published on the website of the BMUV[9]. Appropriate measures were developed by the licensing and supervisory authorities of the Federation and the *Länder* for the implementation of the recommendations and suggestions.

At the invitation of Germany, a follow-up mission took place from 9 to 16 October 2023 to review the implementation of the recommendations and suggestions, made within the framework of the 2019 IRRS mission. The review mission covered all nuclear installations, facilities and activities in the Federal Republic of Germany with the exception of transports, radiation sources, interfaces with nuclear security and aspects of public and medical radiation exposure.

All six recommendations and 23 of the 25 suggestions from 2019 were considered as having been implemented to the satisfaction of the international team of experts. Progress made since 2019 includes the introduction of a national strategy for competence building and the development of future talent for nuclear safety as well as the strengthening of emergency preparedness and response through the adoption of a general federal emergency plan and the full functioning of the new Federal Radiological Situation Centre. The IRRS team encouraged Germany to continue its efforts to complete the integrated management system at some *Land* authorities and the Federal Office for the Safety of Nuclear Waste Management (BASE) and to revise the safety requirements and guidance documents for the development, operation and closure of disposal facilities for radioactive waste.

With the successful implementation of the IRRS follow-up mission, the second cycle of the peer review process, which is mandatory every ten years within the EU, has been completed for Germany.

L.2 ARTEMIS mission

A Radioactive Waste Management Integrated Review Service (ARTEMIS) mission was carried out in September 2019 to fulfil the obligation to conduct a peer review under Directive 2011/70/Euratom in the field of spent fuel and radioactive waste management. To demonstrate the progress made in implementing the recommendations and suggestions from this mission and to present it for review in an appropriate international framework, a follow-up mission was carried out in November 2022 at the invitation of the Federal Republic of Germany. It is the analogue to similar follow-up reviews after three years (such as in the case of the IRRS mission). The German follow-up mission is the first review conducted in this context worldwide. The initial ARTEMIS mission made a total of three recommendations and twelve suggestions in addition to the identification of one good practice. As a result of the follow-up mission, implementation progress was identified for eleven of these fifteen findings, meaning that the findings could be closed, in two cases with the proviso that already initiated implementations would be successfully continued in the manner described. Two recommendations in the area of cost estimates and

[9] https://www.bmuv.de/en/topics/nuclear-safety/overview-nuclear-safety/international/irrs-mission-2019-and-follow-up-mission-2023

reporting with regard to waste management and two suggestions in the area of planning the disposal at the disposal facility site in accordance with the StandAG and with regard to the demonstration of waste minimisation measures in the context of the Inventory of Radioactive Waste, with which the Federation publishes its waste inventory at the various sites in Germany at regular intervals, were considered to be still open.

A final presentation of the follow-up mission and its results was submitted as a report to the Federal Environment Ministry in November 2022 and published on the website of the ARTEMIS review service.

M. Measures planned to improve safety

In order to ensure safety in the area of spent fuel and radioactive waste management, legal and enforcement requirements are being steadily and consistently further developed.

The site selection procedure for a disposal facility for high-level radioactive waste was started in 2017 with the amendment of the Site Selection Act (StandAG). The iterative procedure is structured into three phases and Phase I was further subdivided into two steps. The first step of Phase I has been completed. In Step 2 of Phase I, siting regions for surface exploration are currently being determined on the basis of the previously identified subareas and the results of the consultations of the Subareas Conference. For this purpose, representative preliminary safety analyses are carried out for each subarea in accordance with the Site Selection Act.

For the closure of the ERAM, the submitted long-term safety case is to be adapted to the current state of the art in science and technology. According to the current estimate of the Bundesgesellschaft für Endlagerung mbH (BGE) on the further progress, the final application documents are to be submitted to the licensing authority successively by 2026, a decision on the application is expected for the beginning of 2028, and the completion of all decommissioning measures is planned to take place by the mid-2040s.

Since 2007, a final and incontestable plan approval decision has been in place for converting the Konrad mine into a disposal facility. The above-ground and underground construction measures are progressing. In a reassessment of the remaining construction activities, the BGE has come to the conclusion that the work is around two years behind schedule and that the Konrad repository cannot be completed before the end of 2029.

To demonstrate the progress made in implementing the recommendations and suggestions from the ARTEMIS mission in autumn 2019 and to present it for review in an appropriate international framework, a follow-up mission was carried out in November 2022 at the invitation of the Federal Republic of Germany. As a result of the follow-up mission, implementation progress was identified for eleven of these fifteen findings, meaning that the findings could be closed. Two recommendations in the area of cost estimates and reporting with regard to waste management and two suggestions in the area of planning the disposal at the disposal facility site in accordance with the StandAG and with regard to the demonstration of waste minimisation measures in the context of the Inventory of Radioactive Waste, with which the Federation publishes its waste inventory at the various sites in Germany at regular intervals, were considered to be still open.

N. List of abbreviations

ARTEMIS	IAEA Radioactive Waste Management Integrated Review Service
AtEV	Atomrechtliche Entsorgungsverordnung *Nuclear Waste Management Ordinance*
AtG	Atomgesetz *Atomic Energy Act*
AtSMV	Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung *Nuclear Safety Officer and Reporting Ordinance*
AtVfV	Atomrechtliche Verfahrensverordnung *Nuclear* Licensing *Procedure Ordinance*
AVK	Abfallfluss-Verfolgungs- und Produkt-Kontrollsystem *Waste flow tracking and product control system*
AVR	Arbeitsgemeinschaft Versuchsreaktor Jülich *Experimental nuclear reactor at Jülich*
BAFA	Bundesamt für Wirtschaft und Ausfuhrkontrolle *Federal Office for Economic Affairs and Export Control*
BAM	Bundesanstalt für Materialforschung und -prüfung *Federal Institute for Materials Research and Testing*
BASE	Bundesamt für die Sicherheit der nuklearen Entsorgung *Federal Office for the Safety of Nuclear Waste Management*
BfS	Bundesamt für Strahlenschutz *Federal Office for Radiation Protection*
BGE	Bundesgesellschaft für Endlagerung mbH *Federal Company for Radioactive Waste Disposal*
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe *Federal Institute for Geosciences and Natural Resources*
BGZ	BGZ Gesellschaft für Zwischenlagerung mbH *BGZ Company for Storage*
BMBF	Bundesministerium für Bildung und Forschung *Federal Ministry of Education and Research*
BMUV	Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz *Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection*
BMWK	Bundesministerium für Wirtschaft und Klimaschutz *Federal Ministry for Economic Affairs and Climate Action*
CSD-B	Colis Standard de Déchets – Boues *Standard package for intermediate-level vitrified waste*
CSD-C	Colis Standard de Déchets – Compactés *Standard package for waste compacted under high pressure*
CSD-V	Colis Standard de Déchets – Vitrifiés *Standard package for high-level vitrified waste*
EndlagerVIV	Endlagervorausleistungsverordnung *Repository Prepayment Ordinance*
EndlSiAnfV	Endlagersicherheitsanforderungsverordnung *Disposal Facility Safety Requirements Ordinance*

EndlSiUntV	Endlagersicherheitsuntersuchungsverordnung *Disposal Facility Safety Analyses Ordinance*
ENSREG	European Nuclear Safety Regulators Group
EntsorgÜG	Entsorgungsübergangsgesetz *Waste Management Transfer Act*
ERAM	Endlager für radioaktive Abfälle Morsleben *Morsleben repository for radioactive waste*
ESK	Entsorgungskommission *Nuclear Waste Management Commission*
EU	European Union
EUC	End-Used Casks
EWN	EWN Entsorgungswerk für Nuklearanlagen GmbH
GDR	German Democratic Republic
GG	Grundgesetz *Basic Law for the Federal Republic of Germany*
GNS	GNS Gesellschaft für Nuklear-Service mbH
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH
HLW	High-Level Waste
HM	Heavy Metal
IAEA	International Atomic Energy Agency
ILW	Intermediate-Level Waste
IMIS	Integriertes Mess- und Informationssystem zur Überwachung der Umweltradioaktivität *Integrated measurement and information system for monitoring environmental radioactivity*
INES	International Nuclear Event Scale
IRRS	Integrated Regulatory Review Service
KENFO	Fonds zur Finanzierung der kerntechnischen Entsorgung *Fund for the financing of nuclear waste management*
KTE	Kerntechnische Entsorgung Karlsruhe (KTE) GmbH
LAA	Länderausschuss für Atomkernenergie *Länder Committee for Nuclear Energy*
LLW	Low-Level Waste
MS	Member States
NBG	Nationales Begleitgremium *National Civil Society Board*
NORM	Naturally Occurring Radioactive Material
OECD/NEA	Organisation for Economic Co-operation and Development/Nuclear Energy Agency
PSR	Periodic Safety Review
REI	Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen *Guideline concerning Emission and Immission Monitoring of Nuclear Installations*

RSK	Reaktor-Sicherheitskommission *Reactor Safety Commission*
SEA	Strategic Environmental Assessment
SSK	Strahlenschutzkommission *Commission on Radiological Protection*
StandAG	Standortauswahlgesetz *Site Selection Act*
StGB	Strafgesetzbuch *Criminal Code*
StrlSchG	Strahlenschutzgesetz *Radiation Protection Act*
StrlSchV	Strahlenschutzverordnung *Radiation Protection Ordinance*
UIG	Umweltinformationsgesetz *Environmental Information Act*
UVPG	Gesetz über die Umweltverträglichkeitsprüfung *Environmental Impact Assessment Act*
VEK	Verglasungseinrichtung Karlsruhe *Karlsruhe vitrification facility*
VLLW	Very Low-Level Waste
ZLN	Zwischenlager Nord *Storage Facility North*