Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

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

(Member State Report)

(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 2021

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 third Member State Report must be submitted by 23 August 2021.

This report was prepared under the leadership of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), 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 2020 unless expressly specified otherwise. For some aspects in this report, more detailed information can be found in the *Report for the Seventh 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 different types of radioactive waste

Spent fuel has been generated and is being 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).

In Germany, six power reactors are currently in operation. With the entry into force of the Thirteenth Act Amending the Atomic Energy Act (AtG) on 6 August 2011 as a result of the events in Fukushima (Japan), fixed shutdown dates were introduced for all German power reactors. For the six nuclear power plants still in operation, the authorisation for power operation will expire successively between the end of 2021 and the end of 2022. In addition, two research reactors, three reactors for training purposes and one reactor for educational purposes are currently in operation in Germany. One power reactor and three non-power reactors are in the post-operational phase. Another 32 reactors (including the non-power reactors) are in the decommissioning phase and for 32 non-power reactors[1], decommissioning has been completed.

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

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 is no longer valid 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, radioactive waste with negligible heat generation 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 1967 and the end of 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 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 retrieving and conditioning of the radioactive waste and storing it until disposal.

In the period 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 Organisations in the field of spent fuel and radioactive waste management

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

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

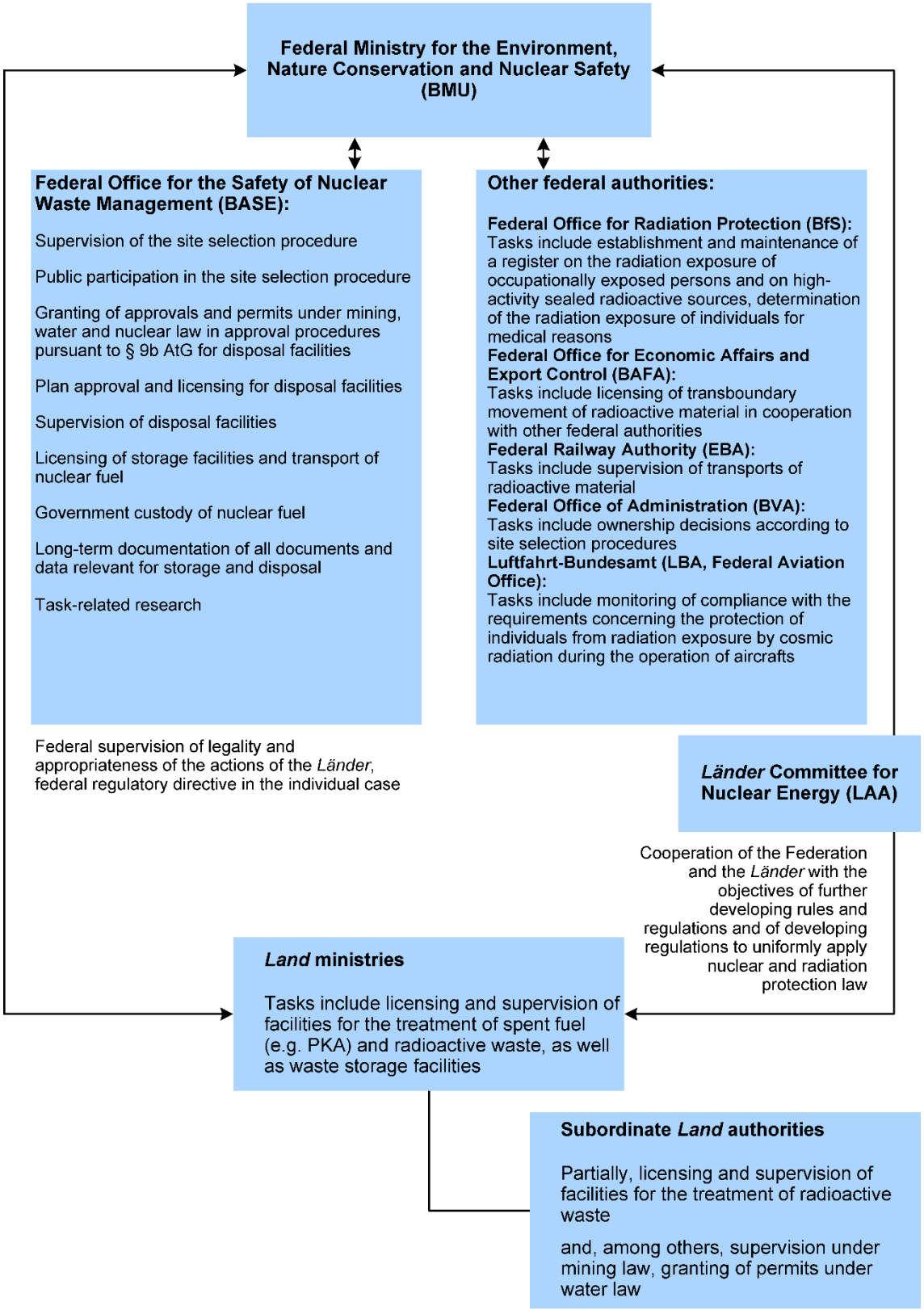

Figure A-1: Regulatory organisational framework in the field of spent fuel and radioactive waste management in the Federal Republic of Germany

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. The 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. Furthermore, the BASE examines licence applications under nuclear law for storage facilities and transports with nuclear fuel. In addition, the 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.

The Federation is responsible for the provision of disposal facilities and has transferred its tasks to the Federal Company for Radioactive Waste Disposal (BGE), organised under private law, under the shareholding management of the BMU, whose sole shareholder is the Federation. The operator and operational management tasks are bundled in the BGE, thus assuming the operational tasks of site selection, construction, operation and closure of disposal facilities and the Asse II mine, as well as product control of the waste to be emplaced.

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. In individual cases, subordinate authorities may also be entrusted with licensing and supervisory tasks.

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 Company for Storage (BGZ) who will then be responsible for further storage.

The operators of nuclear installations and facilities are responsible for carrying out decommissioning. EWN Entsorgungswerk für Nuklearanlagen GmbH (EWN) is responsible for decommissioning nuclear installations of the Federation.

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 will be terminated in the year 2022 at the latest.
- The delivery of spent fuel from installations for the commercial generation of electricity to reprocessing plants has become unlawful as of 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. The Federation shall establish facilities for the safekeeping and disposal of radioactive waste.
- The Federal Government plans to emplace all types of radioactive waste in deep geological formations. For radioactive waste with negligible heat generation, the Konrad mine in Salzgitter is currently being converted into a repository. The repository site for 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 with the objective to determine the disposal facility site by 2031.

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*).

A.4 Periodic self-assessment and peer review

With regard to an international peer review that meets the requirements of Directive 2011/70/Euratom, an IAEA IRRS (Integrated Regulatory Review Service) mission was conducted in the Federal Republic of Germany from 31 March to 13 April 2019 and an IAEA ARTEMIS (Radioactive Waste Management Integrated Review Service) mission from 22 September to 4 October 2019. Results of these reviews are presented in Chapter L.

B. Developments since the second Member State Report

Developments in the legal framework:

- The Fifteenth Act amending the Atomic Energy Act of 1 June 2017 transposed Council Directive 2014/87/Euratom amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations into German law. This includes the extension of the obligations of the licence holder – also for facilities for the disposal of spent fuel and radioactive waste – regarding the publication of certain minimum information on specified normal operation, reportable events and accidents, the clarification of the responsibility also for contractors and subcontractors, including the provision of adequate human resources, as well as the introduction of regulations on on-site emergency preparedness. In addition, provisions are included on the mandatory self-assessment and international reviews (peer reviews).

- The amendment of German radiation protection legislation that began with the Radiation Protection Act continued with the Ordinance on the further modernisation of radiation protection legislation of 29 November 2018. Of particular importance for the responsible and safe management of spent fuel and radioactive waste are the updated Radiation Protection Ordinance (StrlSchV) – to further improve the existing high standard of protection – and the new Nuclear Waste Management Ordinance (AtEV) – to describe requirements and procedures for the management of radioactive waste – which both entered into force on 31 December 2018.

- In order to specify the safety requirements for a disposal facility for high-level radioactive waste and the requirements for the performance of the preliminary safety analyses in the site selection procedure for this disposal facility, the Ordinance on Safety Requirements and Preliminary Safety Analyses for the Disposal of High-Level Radioactive Waste was prepared pursuant to § 26(3) and § 27(6) StandAG, which entered into force on 15 October 2020.

Developments in responsible and safe waste management:

- In 2017, the fuel assemblies from the wet storage facility of the Obrigheim nuclear power plant were transported in 15 casks by ship to the Neckarwestheim decentralised spent fuel storage facility in five batches.

- Since February 2018, five other nuclear power plants permanently shut down (Brunsbüttel, Unterweser, Grafenrheinfeld, Gundremmingen B, Philippsburg 2) have been granted decommissioning licences.

- The security requirements for the storage of nuclear fuel that have been increased since 2011 have prompted EWN Entsorgungswerk für Nuklearanlagen GmbH (EWN, formerly Energiewerke Nord GmbH) to plan a new building (Ersatztransportbehälterlager ESTRAL) for all transport and storage casks stored in the Storage Facility North (ZLN). On 29 May 2019, the operator submitted a correspond-

ing application for a licence. All documents that are to be laid open for public inspection, including an updated safety report, were submitted on 14 December 2020 and will be reviewed by the BASE prior to public display.

- After the spent fuel and radioactive waste storage facilities of GNS Gesellschaft für Nuklear-Service mbH had been transferred to the BGZ Company for Storage (BGZ) under company law in 2017, eleven spent fuel storage facilities followed with effect from 1 January 2019 on the basis of the Waste Management Transfer Act. Six storage facilities for radioactive waste with negligible heat generation were transferred to the BGZ on 1 January 2020 and three more by the end of 2020.

- On 27 March 2020, the Federal Company for Radioactive Waste Disposal (BGE), the operator of the Asse II mine, published a retrieval plan in which all measures to be taken for the retrieval of radioactive waste from the mine are described in a coherent manner.

- To improve the logistic process of emplacement in the Konrad repository, the BGZ is to plan and construct a logistics centre for the Konrad repository (LoK) with a central reception storage facility at the site of the former Würgassen nuclear power plant. The LoK is to accelerate emplacement in the Konrad repository by means of demand-oriented and continuous delivery of waste qualified for disposal, thus significantly shortening the operating times of both the repository and the radioactive waste storage facilities. The basic fundamentals for the requisite licences are being prepared.

- The site selection procedure was started in 2017 with the entry into force of the amended Site Selection Act (StandAG). Initially, the BGE applied the criteria and requirements of the StandAG to identify subareas that are expected to have favourable geological conditions for the safe disposal of high-level radioactive waste. First results were published and presented by the BGE on 28 September 2020. The so-called Sub-areas Interim Report presents all facts and considerations relevant for the decision-making process. The report forms the basis for the Subareas Conference, which is to be organised with the support of the BASE in the first half of 2021.

- In November 2020, six casks containing vitrified high-level radioactive waste from reprocessing of spent fuel from Germany in Sellafield (United Kingdom) were shipped to the Biblis spent fuel storage facility. The shipment was originally planned for spring 2020 but had to be postponed against the background of the emerging spread of the coronavirus (SARS-CoV-2) (see Chapter K.2 for details on the return of reprocessing waste).

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 material from nuclear installations and other handling licensed 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 exemption provisions) are principally different from requirements applicable to radioactive material from nuclear installations and 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 waste from its reprocessing), and
- radioactive waste with negligible heat generation.

This basic subdivision is also maintained if the waste packages to be disposed of are kept in extended surface storage prior to their transportation to a repository mine. Detailed information on the inventory of spent fuel and radioactive waste as at 31 December 2019 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 2019, about 9,100 Mg HM[2] 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, 2,539 Mg HM are stored in the spent fuel pools of the power reactors and 5,890 Mg HM

[2] 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.

are kept in dry storage. The remaining 675 Mg HM are kept in transport and storage casks in the central storage facilities in Ahaus and Gorleben (a total of 92 Mg HM in the form of light water reactor (LWR) fuel assemblies) and in the Storage Facility North (ZLN) in Rubenow near Greifswald (583 Mg HM of water-water energy reactor (VVER) fuel assemblies from Greifswald and Rheinsberg).

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 3,164 canisters in 113 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 (319.5 kg HM) and Mainz (764 g uranium) – a total of 422.3 kg HM – and in 479 casks (11 Mg HM, dry storage) in the spent fuel storage facilities in Ahaus, Jülich and Rubenow.

As at 31 December 2019, there were 19,401 Mg of raw and pretreated waste, and 124,934 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 retrieved, conditioned and stored. Current estimates assume a waste volume of approx. 175,000 to 220,000 m³ of conditioned waste for later disposal.

In addition, a total of approx. 37,241 m³ of radioactive waste and about 6,621 disused sealed radioactive sources with a total activity of around 10^{14} Bq were emplaced in the Morsleben repository for radioactive waste (ERAM) with the aim of disposal.

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.

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 for 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. The delivery of spent fuel to reprocessing plants has become unlawful as of 1 July 2005. The waste management objective is its direct 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.

- 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.

- Radioactive waste from medicine, industry and research must first be delivered to the collecting facility of the respective *Land* (*Land* collecting facility) and stored there. The *Land* collecting facilities deliver the radioactive waste stored in them to a disposal facility.

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

D.1 Minimisation principle

According to § 8 StrlSchG, any unnecessary radiation exposure or contamination of man and the environment shall be avoided, and any radiation exposure or contamination shall be minimised, even if below the respective limit, by taking into consideration the state of the art in science and technology. Accordingly, producing radioactive waste shall be kept to the minimum which is reasonably practicable both in terms of its activity and volume. 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. To achieve a condition adequate for the performance of decommissioning work, attention must be paid not only to reducing individual and collective doses, but also to reducing the volume and utilisation of residual material as harmlessly as possible, while also taking into account secondary waste volumes. The pretreatment of radioactive waste that cannot be cleared serves 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 and the requirements for recording, determination of activity and documentation. To reduce the need for storage and disposal volumes, special treatment methods for volume reduction are used for some waste types, such as compaction, melting or incineration (see also *Inventory of Radioactive Waste* for details). For this purpose, existing external facilities are used or mobile facilities are set up at the sites. In addition to the storage of radioactive waste, the path of decay storage is also pursued for residual radioactive material in order to enable simplified processing and, where applicable, clearance of the material at a later point in time and thus to reduce the need for disposal volumes.

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 some 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 nuclear power plants, spent fuel storage facilities were licensed, constructed and commissioned under nuclear law at twelve nuclear power plant sites.

The decommissioning of radioactive waste management facilities is taken into account already at the design stage and during their construction, applying mutatis mutandis the stipulations and recommendations contained in the statutory rules and regulations and non-mandatory guidance instruments 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 require-

ments 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) are also applicable (see also Chapter F regarding the ESK). 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 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 requirements. 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. Within the scope of its responsibility for the operation of the disposal facility, the Federal Company for Radioactive Waste Disposal (BGE) ensures that the waste acceptance requirements 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 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 requirements of the disposal facility. The measures required to ensure the safety of a disposal facility for radioactive waste are laid down in the respective licence of the disposal facility (plan approval decision or licence).

For the spent fuel and radioactive waste intended for emplacement in the disposal facility in accordance with the Site Selection Act (StandAG), waste acceptance requirements for disposal have not been defined yet since the disposal concept depends on the site

which is to be 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 requirements is possible.

Figure D-1 shows how it is ensured by a flow chart, approved by the BGE, in collaboration with the supervisory authorities of the *Länder* that storage takes place in a way that already corresponds to conditioning to meet the disposal requirements or allows later conditioning meeting the disposal requirements.

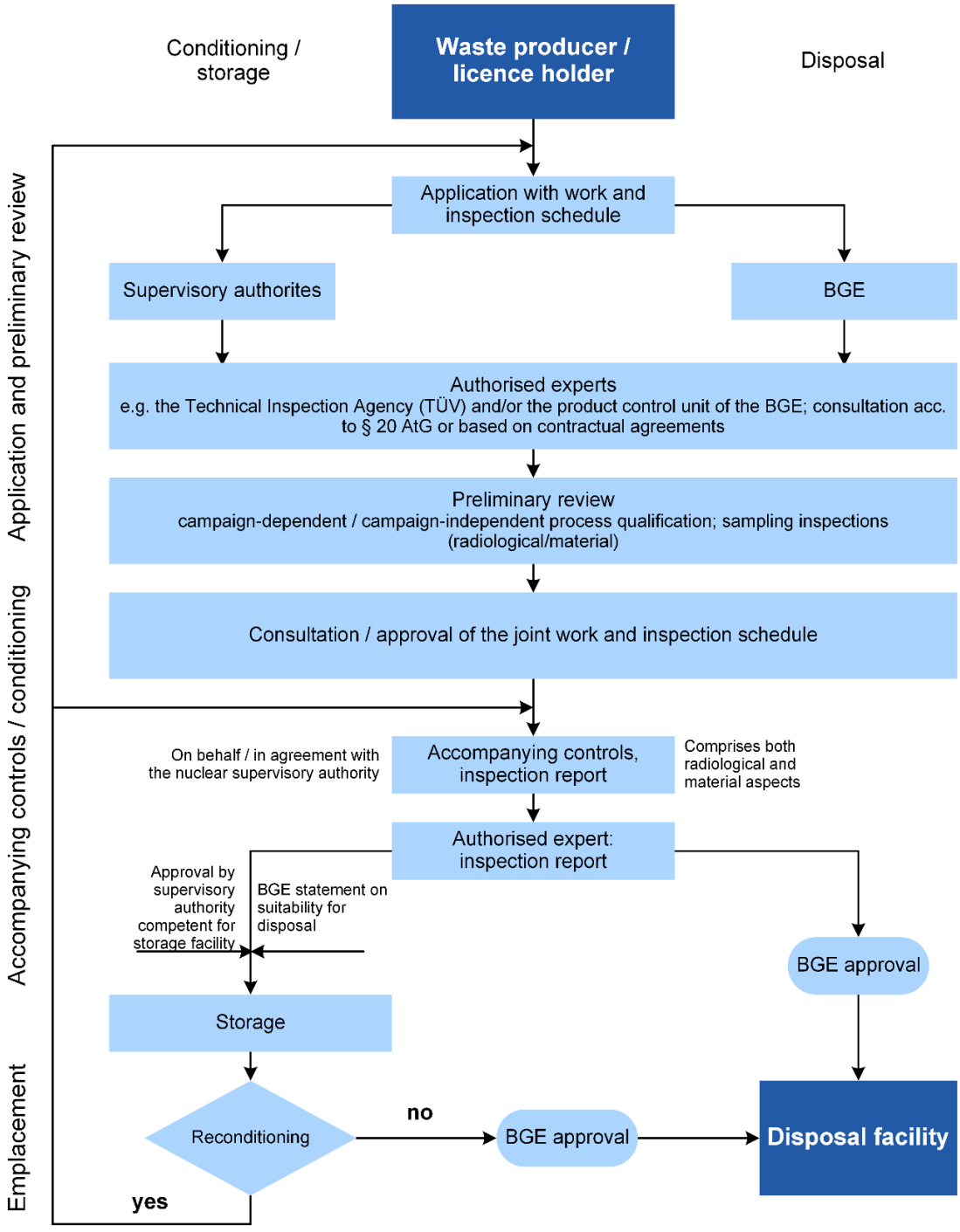

Figure D-1: Product control flow chart for waste packages regarding their conditioning, storage and disposal

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 radioactive 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 guarantee 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 radiation exposure resulting from incidents, or to ensuring protection against disruptive action or other interference by third parties.

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 repository.

The site for a high-level radioactive waste repository will be determined by a selection procedure. This selection procedure is to be concluded by 2031. In addition to spent fuel and waste from reprocessing, the planning for this disposal facility considers the radioactive waste with negligible heat generation that may not be suitable for emplacement in the Konrad repository. This concerns radioactive waste that owing to its nuclide inventory and/or its chemical composition or the time of its generation is not suitable for emplacement in the Konrad repository. Furthermore, it is intended to also consider the radioactive waste to be retrieved from the Asse II mine in the site selection for this disposal facility. The same applies to the depleted uranium that has been generated and will be generated from uranium enrichment if it should not be reutilised. A final decision on the disposal option for this waste – also considering all technical, economic and political aspects – cannot be made until the criteria for emplacement in the disposal facility in accordance with the StandAG have been established and until there will be sufficient information as regards quantity and nature of the waste to be retrieved from the Asse II mine and the date when it will be retrieved.

In the site selection procedure, the realisation of a disposal facility for high-level radioactive waste is given priority. Additional disposal of the above-mentioned radioactive waste at the same site must not lead to a safety level reduction for high-level radioactive waste or to an exclusion of sites due to the insufficient area size for radioactive waste with negligible heat generation.

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-level and intermediate-level radioactive waste in the Morsleben repository for radioactive waste (ERAM) has been concluded. This repository 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 nuclear power plants on the territory of the former German Democratic Republic (GDR), 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 and Nuclear Safety (BMU) 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 ensuring that nuclear law is enforced as uniformly as possible throughout Germany, the *Land* authorities are subject to the BMU's supervision of legality and appropriateness.

E.1.2 National safety provisions

The hierarchical structure of the national regulatory framework is shown in

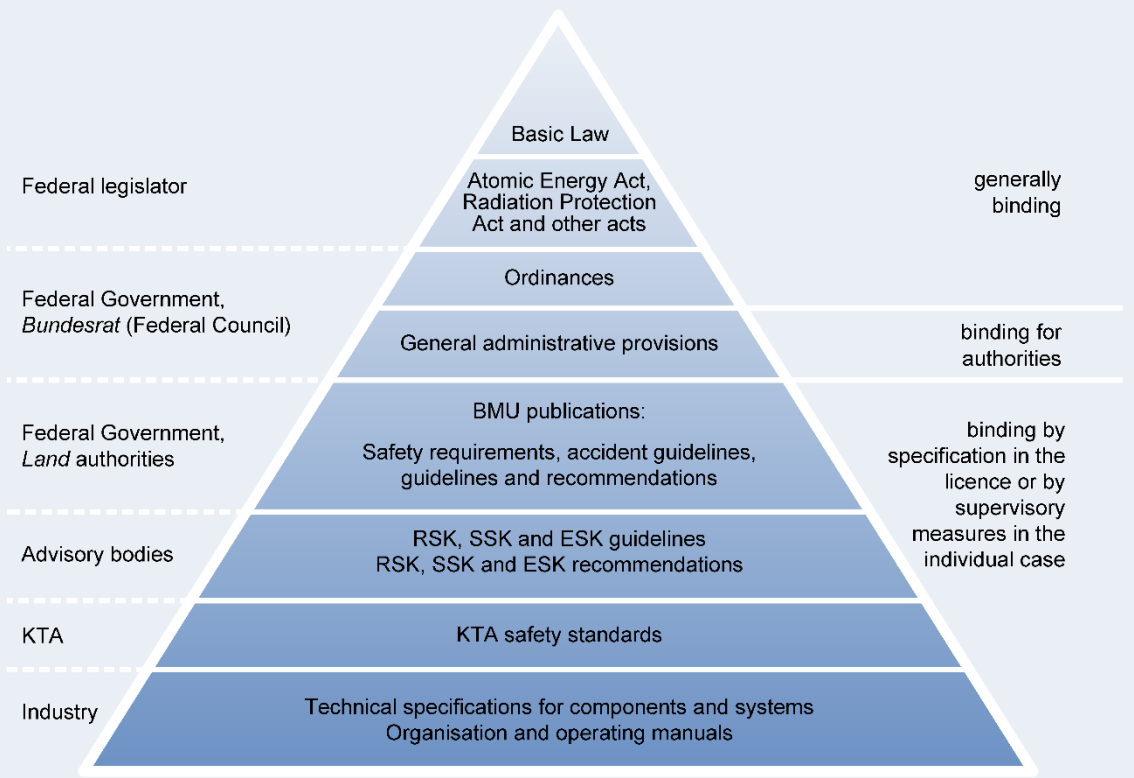

Figure E-1 together with the authority or institution adopting the regulation as well as its legal effect. The Basic Law (GG) contains fundamental principles that also apply to nuclear law. The Atomic Energy Act contains the general national provisions for protective and precautionary measures and the 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 non-mandatory guidance instruments. The non-mandatory guidance instruments 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.

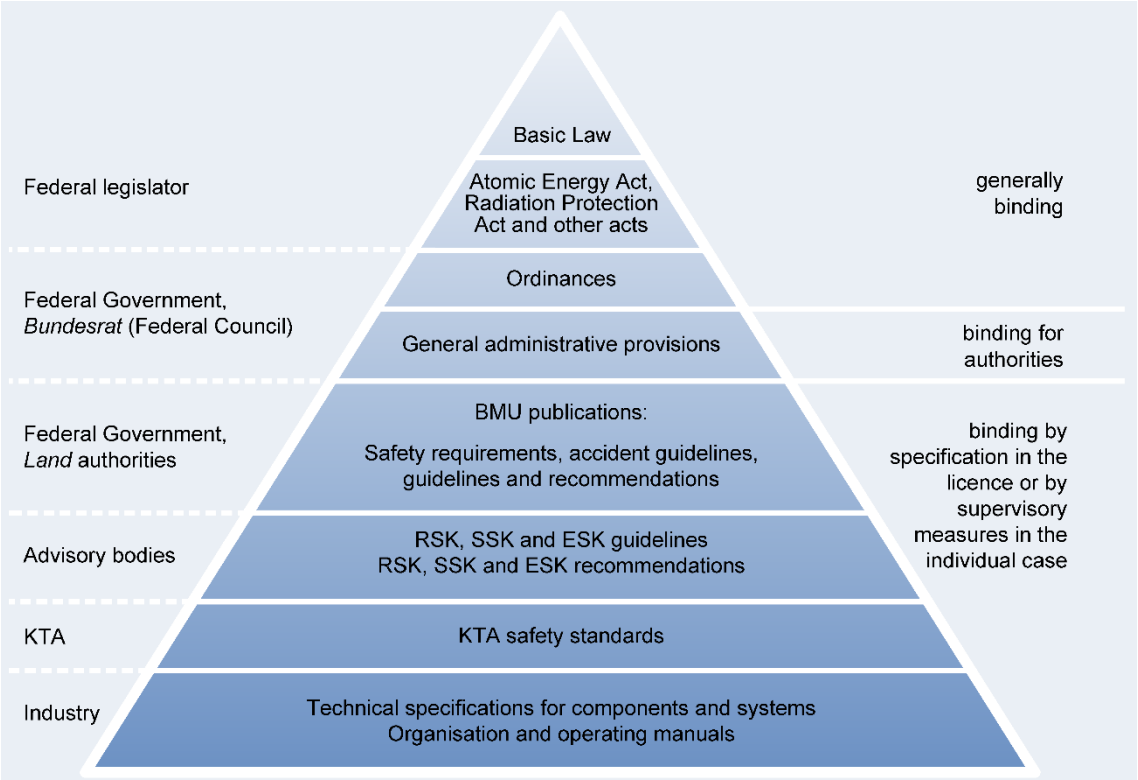

Figure E-1: Regulatory pyramid (hierarchy of the national regulations, the authority or institution adopting the regulation as well as its legal effect)

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 nuclear 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), sentence 1 GG are on the same level as formal federal law. As a matter of principle, rights and obligations under the treaty 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 (Annex 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, whose 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 facilities for 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 nuclear power plants 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 for research purposes)
	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
Radioactive waste with negligible heat generation	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 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 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 by documents containing all data relevant for the assessment. The documents to be enclosed depend on the type of installation or facility and handling. 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, animals, plants, biodiversity, soil, water, ambient air, the climate, the landscape and cultural goods. 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 BMU 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.

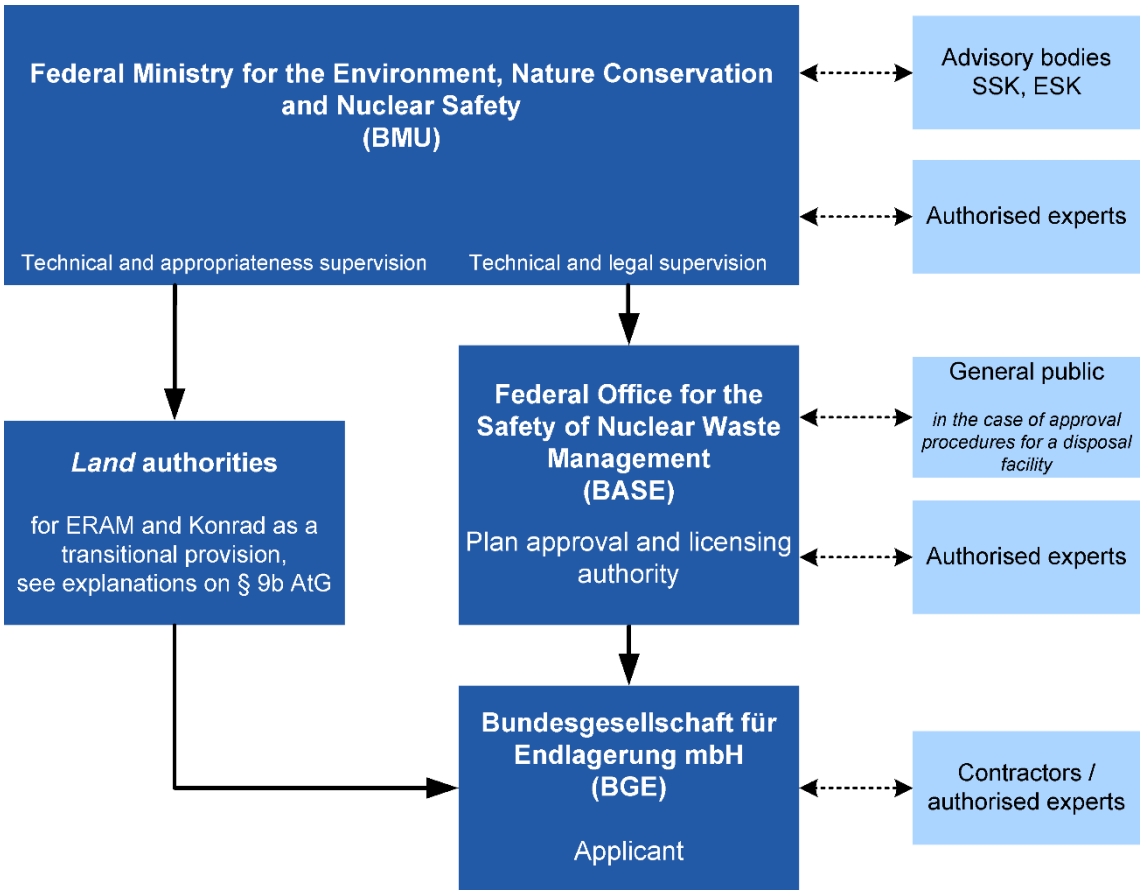

Figure E-2: Responsibilities in the approval and supervision of a disposal facility under nuclear and radiation protection law (solid lines represent supervision, dashed lines information exchange)

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). 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 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 technical experts, but the responsibility for the licensing decision remains 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. As a rule, approval is granted without any limitation in time with the exception of storage facilities for 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 nuclear power plants may only be renewed on imperative grounds and after prior referral to the German *Bundestag*.

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. Modifications are classified in terms of their significance and reported to the *Land* of Schleswig-Holstein as *Länder* representative. It reviews the modifications in cooperation with an authorised expert and the other *Länder* and approves the modifications as appropriate. According to §§ 1 and 2 AtEV, the operators and those handling nuclear fuel are required to document the arising and whereabouts of waste and to submit the documentation to the authorities.

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 and 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. 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. 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.

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 are described 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 BMU and the BASE in international committees, by evaluating the work results of the relevant international, multi- and bilateral bodies and institutions, from the results of research programmes funded by the BMU and the research carried out and supported by the BASE, as well as from other international specialist contacts and the international specialist literature. The results of site-independent, application-oriented basic research in the context of project funding by the Federal Ministry for Economic Affairs and Energy (BMWi), the work of its subordinate authorities – the Federal Institute for Geosciences and Natural Resources (BGR) and the Federal Institute for Materials Research and Testing (BAM) – and 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 BMU is supported in this by the subordinate authorities (e.g. BASE) and Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH.

In addition, the BMU 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 (learning processes) 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 and Nuclear Safety (BMU). The administrative tasks are performed by authorities of the Federation and the *Länder*.

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. The 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. Furthermore, the BASE examines licence applications under nuclear law for storage facilities and transports with nuclear fuel. In addition, the 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.

Other administrative tasks in the field of nuclear waste management are carried out by the *Länder* on behalf of the Federation.

More details on the organisational framework of the regulatory authority in the Federal Republic of Germany are given in chapters A.2 and E.1.1, and on responsibilities relating to approval and supervision in chapters E.2.1 and 0.

Länder Committee for Nuclear Energy

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*.

Advisory commissions

In addition to the Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK), the Nuclear Waste Management Commission (ESK) was founded in 2008 due to the increasing importance of nuclear waste management issues. With the ESK, an advisory body had been established whose members are experts from Germany as well as experts from abroad. The ESK thus brings together a broad spectrum of technical expertise and incorporates international experience and approaches in its work. The experts advise the BMU in all matters relating to nuclear waste management. For this purpose, the Commission has set up the committees on waste conditioning, transport and storage, on the disposal of radioactive waste and on decommissioning, where additional experts may also be involved. The members of the Commission are independent and not bound by any directives.

F.1 Principle of separation

The economic use of nuclear energy 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 BMU for all decisions relating to nuclear safety and radiation protection and the competence for energy industry policy lying with the Federal Ministry for Economic Affairs and Energy (BMWi).

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-law, the Federal Company for Radioactive Waste Disposal (BGE), which is subject to supervision under nuclear law by the BASE. According to § 9b AtG, the BASE is also responsible for plan approval and licensing of disposal facilities. In this case, the BGE acts as the applicant. The BMU is responsible for supervising the execution of tasks by the 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, within the area of responsibility of the Federal Ministry for Economic Affairs and Energy) is responsible for licensing of the import and export of radioactive materials as defined in § 3 AtG (technical supervision in this regard the BMU).

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 super-

vision of the administrative action of the *Land* authorities by the BMU, having competence for issues of nuclear safety and radiation protection at the highest federal level. 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 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 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 BMU.

The BMU has an annual budget of around 36 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 BMU, for scientific and technical support and for the participation of external 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.

As an authority subordinate to the BMU, the 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 million euros. This concerns research projects in the fields of nuclear safety, storage, transport, waste management and public participation. In addition, the BASE can conduct research via the BMU's departmental research plan.

For the decision on 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 BMU, the 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.

The Directorate-General Nuclear Safety, Radiological Protection 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. The BASE provides technical and scientific support to the BMU in these fields and also performs enforcement tasks for the Federation under the Atomic Energy Act. The BASE also supports the BMU in its responsibilities through scientific research. The BMU is also supported in the performance of federal supervision 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 experts.

The staffing needs of the BMU and the 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*). Since the BASE is currently undergoing further development, the number of staff will continue to increase successively also in the future.

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 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. Together with the radiation protection executive, 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 and in doing so must act 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 counter-measures 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. 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 any other 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).

The BASE may cause the private licence holders to (re-)assume their responsibility with regard to the handling of nuclear fuel by issuing orders stipulating that nuclear fuel under government custody is to be returned to the charge of the private owners.

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, which comprises the facility site, the facility and its operation, the radiation exposure in the environment, accident analyses and the effects of facility operation on the environment. In the licensing procedure for a disposal facility, a long-term safety case must also be prepared and submitted.

As a consequence of the events in Fukushima, Japan in March 2011, the Nuclear Waste Management Commission (ESK) has conducted a stress test for facilities for spent fuel and radioactive waste management in the Federal Republic of Germany. The investigations and reviews have shown that the storage facilities for spent fuel and radioactive waste with negligible heat generation fulfil the highest stress level and achieve the highest degree of protection in almost all load cases. Furthermore, the stress test did not reveal any deficiencies in design requirements of the facilities considered.

For a disposal facility for high-level radioactive waste – as for other nuclear installations – a comprehensive safety report for all operating states of the disposal facility is an essential part of the licensing documents. During the site selection procedure, preliminary safety analyses are carried out as defined in § 27 StandAG, based on the safety requirements specified in § 26 StandAG. The safety requirements and the requirements for the

performance of safety analyses are specified in ordinances. The ordinances were published in the Federal Law Gazette on 14 October 2020 and entered into force on the following day. The safety requirements are to be reviewed every ten years at the latest and, if necessary, adapted to the state of the art in science and technology.

In the preliminary safety analyses, the disposal facility system is considered in its entirety and its safety is assessed in accordance with the state of the art in science and technology. For this purpose, the behaviour of the disposal system is analysed under different stress situations and under consideration of data uncertainties, malfunctions as well as possible future developments with regard to the safe containment of the radioactive waste. The preliminary safety analyses are carried out on the basis of conservative assumptions as to the volume, type and properties of the radioactive waste, and the level of detail increases from phase to phase of the selection procedure.

According to the Disposal Facility Safety Analyses Ordinance (§ 9 EndlSiUntV), the long-term safety analysis 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 technical 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 long-term safety of the disposal 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 review and assess the safety (periodic safety review – PSR) of an installation or facility. During the operation of a disposal facility, a safety review is carried out every ten years, particularly taking into account the state of the art in science and technology.

The ESK has developed guidelines for the performance of periodic safety reviews and technical ageing management for storage facilities for spent fuel and heat-generating radioactive waste. 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 PSRs are conducted every ten years after the start of operation (emplacement of the first cask). Furthermore, 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.

Within the framework of the PSR, the safety report is also reviewed every ten years. In addition, the safety report is continuously reviewed within the framework of regulatory supervision. 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 heat-generating 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 construction, operation, decommissioning or a major modification 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 the obligations to secure/ensure 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 regarding the intended decommissioning option, which depends primarily on whether the radioactive waste management facility is constructed as part of a major nuclear facility, thus being integrated into the decommissioning procedure of this facility, or whether it constitutes a separate site, thus entailing an independent decommissioning procedure, 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. Since 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 gradual 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 unavailable disposal facility, the storage capacities for low- and intermediate-level 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 addition, the storage capacities at Neckarwestheim, Brunsbüttel, Krümmel and Grafenrheinfeld are to be increased by erecting new radioactive waste storage facilities. 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 importance of the societal task of competence building and the development of future talent for nuclear safety, as well as continuing to actively contribute the German understanding of safety at the international level, is underlined in the coalition agreement of the parties forming the Federal Government of March 2018 and is also set as a strategic goal in the 7th Energy Research Programme. Under the joint leadership of the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the federal ministries developed a concept for competence building and the development of future talent for nuclear safety, which was adopted by the Federal Cabinet on 26 August 2020. Based on analyses of needs and previous activities, the concept identifies six fields of action: education and teaching, advanced and continuing training, research and development, knowledge retention, committee work and networks, international networking and cross-border activities as well as career prospects and recognition in society and formulates concrete measures to maintain and expand expertise and specialist staff capacities. The concept forms the basis for further work and planning in the federal ministries.

The Federation ensures that the requirements for experts that are responsible for the safety of spent fuel and radioactive waste within the national framework are met with regard to education and training. The public vocational training system in Germany allows for the recruitment of skilled workers, foremen, technicians, engineers and scientists with the prerequisite technical background. This is usually documented by state-approved certificates, and proof of expertise and skills is provided on the basis of the relevant guidelines on technical qualification (e.g. Guideline Relating to the Technical Qualification of Responsible Personnel in Facilities for the Storage of Nuclear Fuel (Storage Facilities) of 11 September 2019). Expertise is demonstrated in a number of ways, including meeting educational and training requirements, undergoing measures for initial qualification and additional education, acquiring practical experience and, depending on the intended area of work, passing the required examinations. Technical qualifications are renewed by attending courses and advanced training at specified intervals.

With regard to the competent authorities, public service employees are required to have relevant academic qualifications and to have passed the corresponding examinations.

Seen in the long term and against the background of the time span of the realisation of a repository project, consistent and sustainable promotion of young researchers is of the utmost importance in Germany to ensure the maintenance of competence in the required disciplinary fields. In this context, the promotion of research at universities has a special

significance, also according to the concept for competence building and the development of future talent, through which a targeted promotion of young scientists in specific fields of knowledge takes place. The Federation makes a substantial contribution to building up, developing and maintaining scientific and technical competence – in part long-standing, as in the case of the expert organisations – but also to the diversity of the German research landscape as well as to promoting young researchers in the field of nuclear waste management. Moreover, it continuously updates the state of the art in science and technology through corresponding research and development in addition to providing the scientific and technical basis for the realisation of a repository.

In addition, the Federal Office for the Safety of Nuclear Waste Management (BASE) conducts scientific research in the areas of planning, licensing and supervision of federal facilities for the safekeeping and disposal of radioactive waste, the management of radioactive waste, the transport and storage of radioactive substances and waste, as well as nuclear safety and in socio-technical areas of nuclear waste management. The BASE research strategy also defines sustainable, long-term competence building as one of the key objectives of the research activities. This includes not only measures to maintain and build up competence within the BASE, but also measures to build up competence externally in research institutes, universities and technical expert organisations. In cooperation with universities, the 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. The respective on-the-job training plan comprises various measures for education and training in all relevant technical and legal areas. In addition, experienced staff are required to maintain or further develop their knowledge and skills and to continuously keep their expertise up to date.

Besides in-house education and training courses offered for authority staff by the supervisory bodies and the Federal Academy for Public Administration (BAköV), in principle, the same training opportunities are available to this staff as to the operating staff of nuclear waste management facilities. These are, in addition to courses at the KWS Power-Tech Training Center Essen and its simulator courses, education and training activities of the TÜV academies and Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH.

The BGZ Company for Storage (BGZ) has initiated the introduction of holistic knowledge management by drawing up a “balance sheet of knowledge” (Wissensbilanz – Made in Germany). Furthermore, the specialisation field “Nuclear Waste Management”, which is oriented towards the requirements of storage, will be established in the cooperation course European Master of Science in Nuclear Applications (EMiNA) at the FH Aachen University of Applied Sciences.

The Federal Company for Radioactive Waste Disposal (BGE) tries to meet the demand for qualified personnel by developing new, future-oriented concepts. For example, it also trains its own skilled staff in the form of a dual course of studies in safety engineering with a specialisation in radiation protection. In addition, own training covers the following occupational areas: electronics, industrial mechanics, mining technology, IT systems engineering and industrial management. 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 cooperative study courses. In addition, the BGE as well as the BGZ, the BASE and the Federal Office for Radiation Protection (BfS) were part of a project team set up by the BMU 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.

In addition to the advanced and continuing training courses offered by the Federal Republic of Germany, all staff of the authorities and technical expert organisations are also provided with the offers and training opportunities offered by the European Nuclear Safety Training and Tutoring Institute (ENSTTI). Participation in national and international conferences and initiatives (e.g. OECD/NEA, IAEA, WENRA) also serve to increase the knowledge and exchange of experience.

With regards to the operators, the licence holder is required to provide for and maintain adequate human resources. All licence applications for construction, operation, decommissioning or a major modification are accompanied by the proof of the qualification of the responsible persons and of the necessary knowledge of the staff otherwise engaged during operation of the facility, and are reviewed by the regulator. Furthermore, the licence holder is obliged to provide education and further training of their personnel. The safety management system must ensure that persons are only entrusted with tasks for which they are trained and competent. This applies to all levels of responsibility. Clear requirement profiles are prepared for all activities with safety relevance, including the criteria against which the respective competencies are to be assessed. This includes documentation of how the specific incumbents of the positions fulfil these requirements. For every safety-relevant task, an adequate number of suitable individuals must be available. For tasks relating to safe operation that are contracted out, it is to be ensured that the organisational unit responsible for the task is able to assess and check the commissioned task with the requisite technical competence. This also applies to the case that the knowledge is communicated by the contractor. Proof of this is to be submitted to the supervising body upon request.

H.2 Research and development

The respective current energy research programme of the Federal Government provides the guideline of the Federal Republic of Germany on research and development in the energy sector, thereby describing i.a. the priorities of research policy with respect to the funding area of nuclear safety and disposal research. With these programmes on research and development, the Federation ensures covering the needs of the *National Programme*.

Corresponding funding concepts and funding announcements for research and development of the competent ministries (Federal Ministry of Education and Research (BMBF) and Federal Ministry for Economic Affairs and Energy (BMWi)) substantiate these framework conditions and specify defined research priorities, including the promotion of young researchers. International cooperation plays an important role here. Currently, the 7th Energy Research Programme is being conducted. Supporting this ongoing research and

innovation process through the Energy Research Programme is a strategic element of the Federal Government's energy policy.

Further details on the implementation of the Energy Research Programme are set out in the current BMWi project funding programme on nuclear safety research 2021 – 2025. The objectives of the application-oriented, site-independent project funding for nuclear waste management research include the creation of the scientific and technical basis for the realisation of a repository for high-level radioactive waste and the development of the necessary methods and techniques for specific measures for the preparation of disposal. The constructor and operator of disposal facilities is thus provided with the necessary tools and the methodical basis. In addition, the insights gained are also used in the review and updating of the existing national regulations. For example, the research projects carried out as part of the BMWi project funding for safety analysis and safety demonstration methods for disposal concepts in clay and crystalline rock provide important information considered in the development of the ordinance relating to safety requirements for the disposal of high-level radioactive waste (Disposal Facility Safety Requirements Ordinance) pursuant to § 26 StandAG. In addition to disciplinary research funding, the promotion of interdisciplinary and transdisciplinary research approaches is becoming increasingly important and is increasingly being taken into account. Corresponding research projects envisage a joint consideration of scientific-technical and humanist-social science-based approaches (that is, sciences that are thematically far apart) as well as the reflection of scientific work beyond the circle of scientific actors, for example with civil society and also on questions of acceptance. The projects of nuclear waste management research funded by the BMWi thus make a substantial contribution to building up, further developing and maintaining the scientific and technical competence as well as to promoting young researchers in the field of nuclear waste management in Germany.

Details on the research priorities in connection with the safe and orderly management of spent fuel and radioactive waste are contained in Chapter 21.2 on nuclear waste management and 20.5 on the decommissioning of nuclear installations of the BMU's departmental research plan. An example of the studies carried out as part of its departmental research are the projects initiated by the BMU by way of precaution on extended storage of spent fuel and heat-generating radioactive waste. In these projects, basic information and data on national and international experience are compiled to be able to assess the safety issues related to the extended storage of fuel assemblies at an early stage and to be able to make competent assessments on corresponding concepts and strategies for their future storage.

The need for research with regard to extended storage not only includes the safety proofs for casks, inventories and building structures, but also investigations of their long-term behaviour. Another research focus is the investigation of social-science and socio-technical aspects. These issues are already being investigated within the framework of national research programmes.

At the international level, the issue of inaccessible cask components and inventories is being pursued together with the International Atomic Energy Agency (IAEA) through strategic and targeted research and development activities, particularly by the American side

(US-NRC, EPRI, US-DOE). When evaluating international findings and data, the transferability to the German storage systems, including cask inventories, is to be examined in particular with regard to the specific boundary conditions in Germany.

Since the duration of storage of spent nuclear fuel in Germany is currently limited to 40 years and complete removal from the storage facilities is not possible during this period, the storage facility operator BGZ has taken initial measures to ensure continued safe storage. For the extension of storage, the safety of storage beyond 40 years is to be proven in public licensing procedures in accordance with the then applicable state of the art in science and technology. The BGZ has already set the course for extended storage by setting up its own specialist department and developing a research programme with the aim of securing the demonstration of safety by means of a reliable database. In addition, it is working to answer current and future research questions by participating in various national and international research programmes. The BGZ research programme is a central instrument in the performance of its tasks. It serves to identify research issues and provides an overview of research projects and their progress. In addition, further research projects are currently being developed with partners from research and industry. Furthermore, the BGZ has initiated a technical workshop to discuss research results in dialogue with the expert public and to ensure a transparent exchange of knowledge.

Another research focus is the investigation of social-science and socio-technical aspects. These research topics are particularly relevant since comprehensive public participation in the site selection procedure lies within the remit of the BMU and is conducted by the BASE.

In order to fulfil its legal mandate, the BASE conducts task-related research in the context of the site selection procedure and on topics related to the safety in nuclear waste management. Here, the BASE is guided by its research agenda, which is regularly updated and was developed in a participatory process. Projects on reactor safety, decommissioning and dismantling are considered, as well as safety issuers in the context of storage, extended storage and transport of radioactive waste. Research projects within the framework of the site selection procedure concern public participation in the search for a disposal facility as a cross-generational, self-questioning and learning process. Furthermore, they also deal with percolation mechanisms in the host rock salt, measurement methods for surface explorations as well as the systematic investigation of the requirements and criteria of the Site Selection Act and explanations on the geoscientific assessment parameters. In order to enable research work in underground laboratories and international networking, BASE is also a member of underground laboratories and other international projects on storage (DECOVALEX and SCIP IV).

International cooperation is an important component in the context of research and development activities and thus constitutes a central part of the programmes. As regards the scientific cooperation, in particular, the cooperation in the European underground laboratories plays a central role. The cooperation between German research institutions and international partners is based on bilateral agreements with disposal facility organisations or on agreements with state institutions, e.g. also for scientific and technical cooperation. In addition, contributions are made for the participation of German research institutions in OECD/NEA activities. Furthermore, co-financing of EU research projects takes place.

Participation in international activities to further develop the regulatory requirements and to evaluate experiences, e.g. via the Western European Nuclear Regulators Association (WENRA), contributes to further developing the technical and scientific basis with focusses especially on the assessment of the state of the art in science and technology and long-term safety of disposal facility sites.

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.

According to § 7c(2)(2) AtG in conjunction with § 9h AtG, for nuclear installations and facilities, the respective licence 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. Thus, the polluter-pays principle also applies to the financing of spent fuel and radioactive waste management, i.e. waste processing, storage and disposal as well as decommissioning of facilities. § 9a(1) AtG stipulates in particular the fundamental obligation to dispose of spent fuel and radioactive waste in a controlled manner and thus to subject it to direct disposal.

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 (see also below for details on “KFK”). 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 refinanced 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 paid directly to the Federation.

The Commission to Review the Financing for the Phase-out of Nuclear Energy (KFK) was appointed by the Federal Government in October 2015. The task of this expert commission was to develop a proposed solution for appropriate implementation of the nuclear phase-out. The commission agreed on a fund solution for financing the storage and disposal of radioactive waste. The decommissioning of the nuclear installations and the proper packaging of radioactive waste, on the other hand, remain the responsibility of the corporations. The Waste Management Transfer Act regulates the transfer of the implementation and financing of the storage and disposal of spent fuel and radioactive waste in the area of power reactors to the federally-owned BGZ Company for Storage (BGZ) (see Chapter A.2 for details). This transfer of responsibility became effective

through the payment of contributions of around 24.1 billion euros to the Fund for the financing of nuclear waste management (KENFO) as stipulated in the Waste Management Fund Act. The BGZ is financed from the State Budget, which is reimbursed by the KENFO on an annual basis.

The amount paid in includes a so-called basic amount as well as a risk premium of 35.47 % (around 6.3 billion euros), which is intended to cover cost and interest rate risks beyond the calculated waste management costs.

As a result of the Waste Management Transfer Act, the EndlagerVIV was amended. Accordingly, the Fund is now obliged to provide advance payments instead of the operators of power reactors. This also applies to the site selection procedure, which is financed by cost allocations to the waste producers according to §§ 28 et seq. StandAG, following an amendment to the StandAG. 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 legal purpose of the KENFO is to ensure the financing of the costs incurred for the safe management of present and future arisings of radioactive waste from the commercial use of nuclear energy for electricity generation in Germany. To this end, the KENFO invests the funds transferred by the nuclear power plant operators at the highest possible interest rate and safely and reimburses the Federation for the costs arising from storage and disposal.

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. 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 proper 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 2019. 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 2019, 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 22 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 2020. 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”[3] issued by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) 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 technical 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 Ordinance and in the Radiation Protection Act. Here, a distinction is made between the information to be pro-

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

vided to the public in advance as general preparation for a radiological emergency 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.

The Federal Company for Radioactive Waste Disposal (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. On 27 March 2020, the BGE published a retrieval plan in which all measures to be taken for the retrieval of radioactive waste from the mine are described in a coherent manner. The retrieval plan was presented in a livestream and questions could be asked via the chat function, mail, in the livestream or by telephone. The catalogue of questions and answers is also publicly available.

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 safeguard 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* and in case of future major changes to it, a Strategic Environmental Assessment (SEA) has been and will be carried out by the BMU according to the Environmental Impact Assessment Act[4]. 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.

[4] https://www.bmu.de/en/download/national-programme/

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 the BASE. Since the start of the site selection procedure, the BASE has offered numerous opportunities for public information and participation that go beyond the legal requirements. This so-called “informal” participation includes, for example, online consultations, the status conference on disposal 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 in October 2020 and at the subsequent Subareas Conference pursuant to § 9 StandAG, which is organised with the support of the BASE. This conference is the first formal participation format and will consult on the report until summer 2021 and then submit the results of its consultations to the BGE.

At the national level, the National Civil Society Board (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 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 National Civil Society Board 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 and commission external experts or scientific opinions.

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 are 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 concerned by the repository site selection procedure including communities of the existing storage facilities for high level radioactive waste and spent fuel, 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.

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 (BMU) (see chapters A.3 and E for details).

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 will also be 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)* will also be 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*.

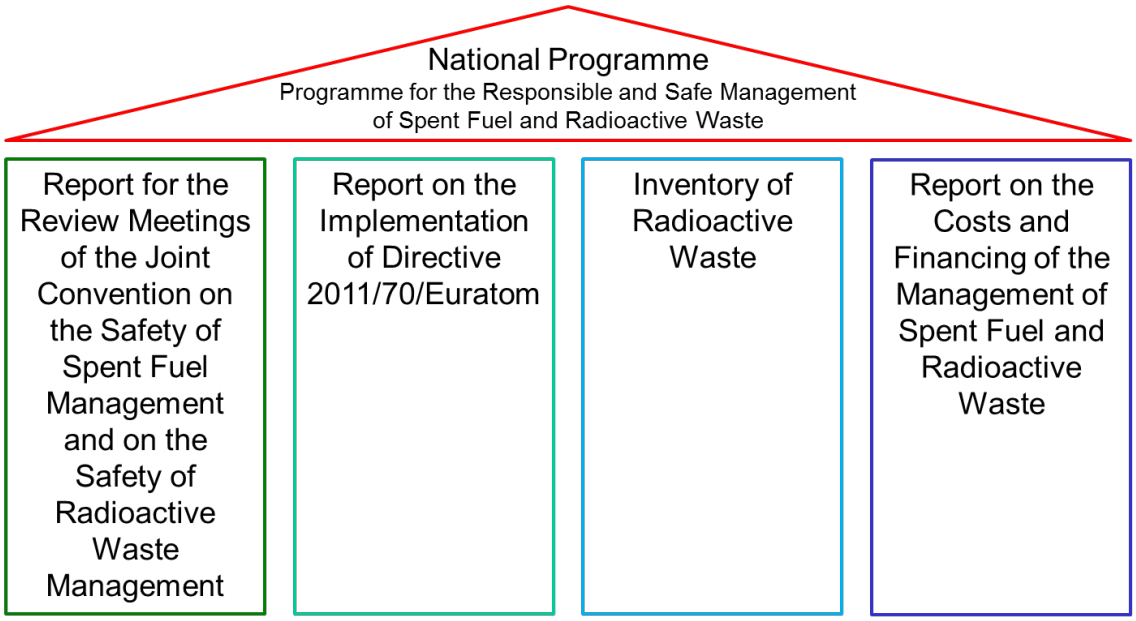

Figure K-1: Concept of the Federal Government to fulfil its reporting obligation within the framework of Directive 2011/70//Euratom

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

This chapter presents the key performance indicators for the implementation of the National Programme according to subheadings in which the milestones to be achieved are clearly scheduled. The progress of the implementation of these milestones (corresponding to the key performance indicators) is addressed in the text and graphically. Milestones and key performance indicators that cannot be scheduled yet are listed at the end of the respective subchapters.

Shutdown of the nuclear power plants still in operation by the end of 2022 and completion of the decommissioning of the nuclear power plants by presumably 2045

After the scheduled shutdown of the Philippsburg 2 nuclear power plant on 31 December 2019 (see

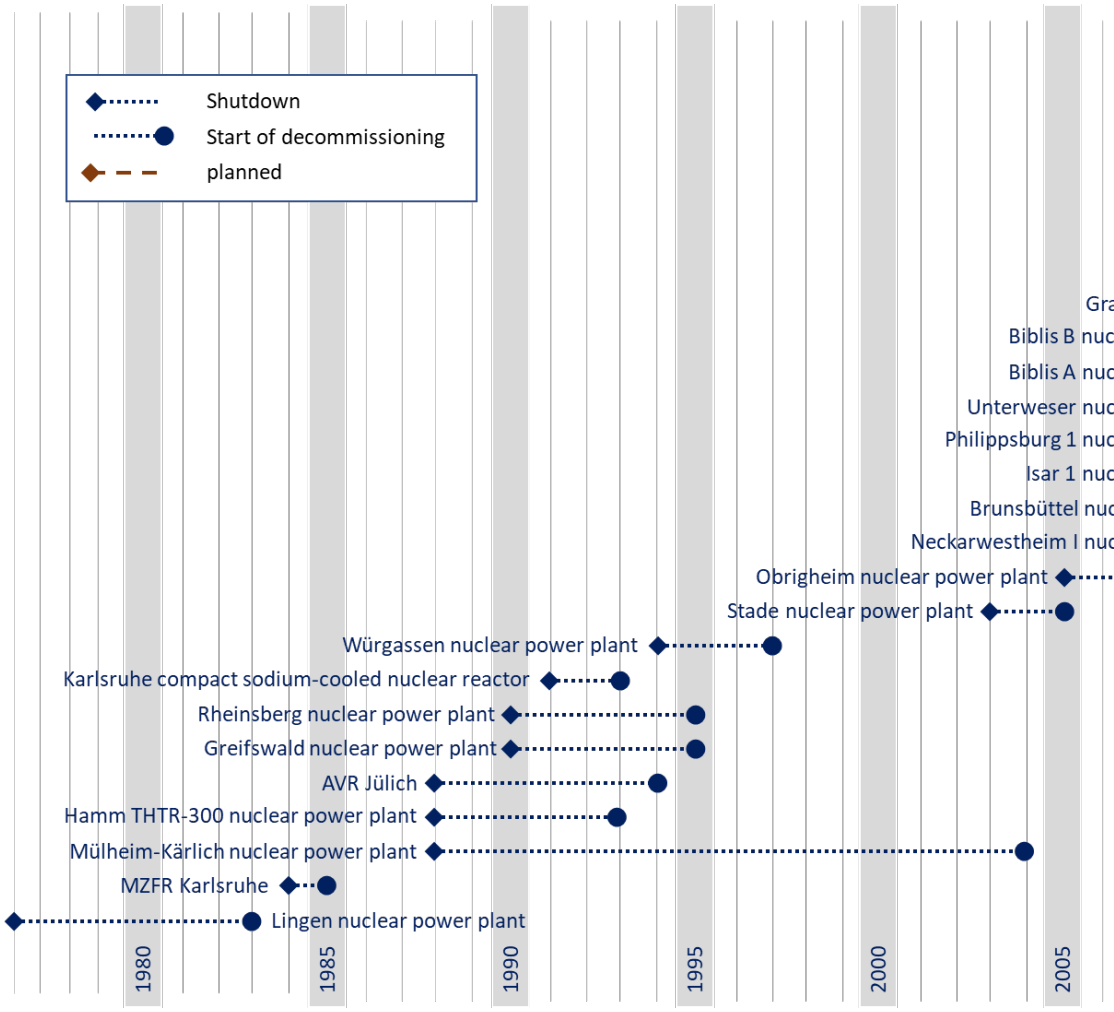

Figure K-2), six power reactors remain in operation in Germany. According to the Atomic Energy Act, the three older ones will be shut down by the end of 2021 at the latest, and the three newest ones by the end of 2022 at the latest.

The decommissioning of reactors also requires a licence (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** for details). Since the amendment of the Atomic Energy Act in June 2017, power reactors are to be shut down and dismantled immediately. With the exception of the Krümmel reactor, which is in the post-operational phase, decommissioning licences were granted for all power reactors that have been permanently shut down to date. In addition, decommissioning licences have meanwhile been applied for all power reactors still in operation (Emsland and Neckarwestheim II in 2016, Grohnde and Brokdorf in 2017 and Isar 2 and Gundremmingen C in 2019) so that decommissioning can begin promptly after having been permanently shut down and thus it is assumed that decommissioning can be completed by 2045.

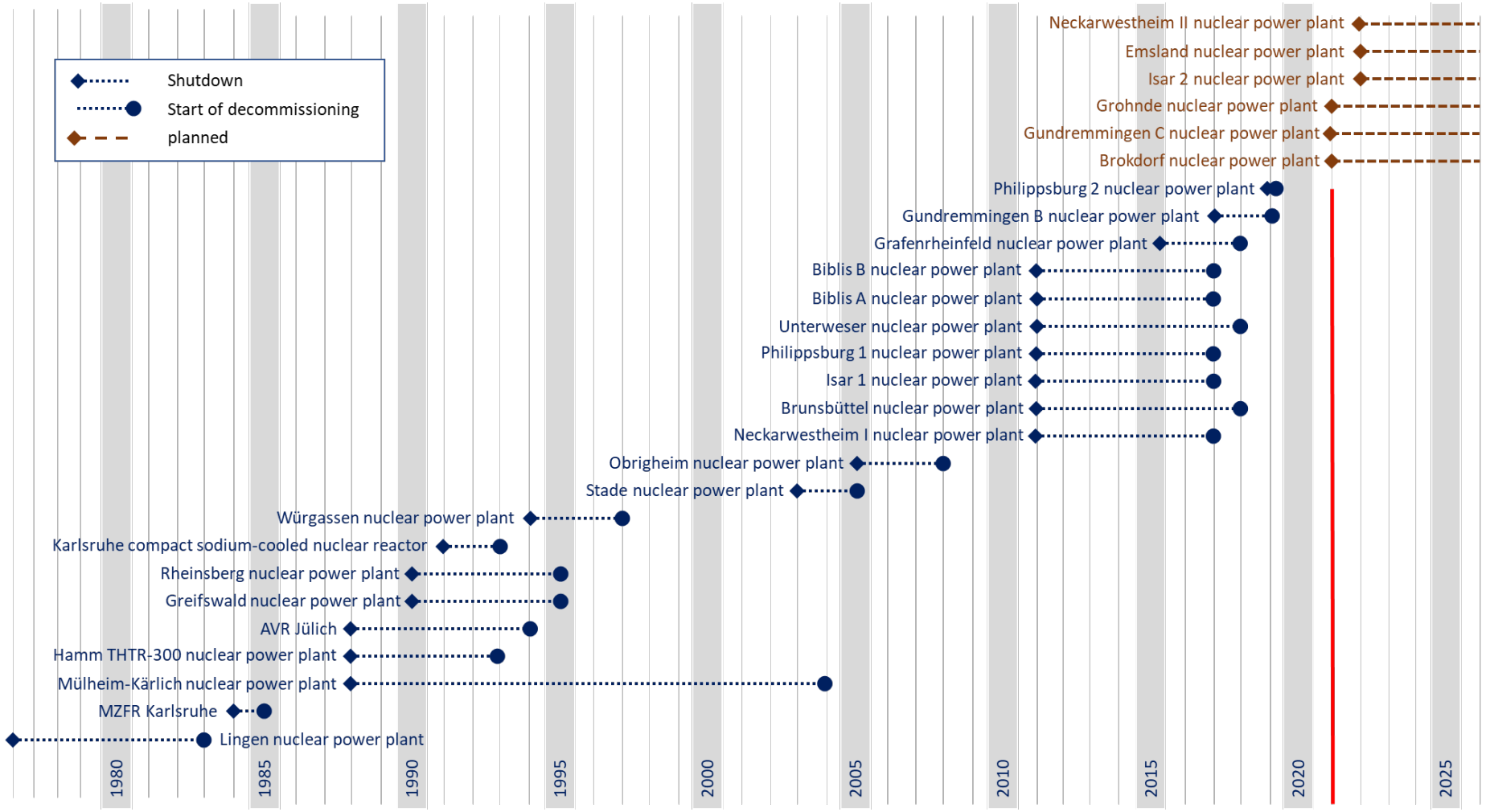

Figure K-2: Shutdown and decommissioning of German reactors

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.

Return of reprocessing waste

For the timely return and balanced distribution of the five casks from France and 20 casks from the United Kingdom with vitrified radioactive waste across the country, an overall concept, which is also regionally guided by the polluter pays principle, was presented in 2015 by the BMU. After completion of the return operation, this vitrified radioactive waste from reprocessing will be temporarily stored in the five *Länder* of Lower Saxony, Hesse, Schleswig-Holstein, Bavaria and Baden-Wuerttemberg. Corresponding storage licences have been applied for by the electric power utilities. Since 1 January 2019, the nuclear licensing procedures for storage have been carried out by the BGZ Company for Storage (BGZ).

The return of the vitrified waste of the CSD-V type from France has been completed. The waste is stored in 108 casks at the spent fuel storage facility in Gorleben. Five casks with vitrified waste (decontamination and rinsing water) of the CSD-B type and 152 casks with compacted waste of the CSD-C type still have to be returned. The compacted CSD-C waste from France is to be shipped to the Ahaus spent fuel storage facility. The return of the reprocessing waste of type CSD-B (five containers) is to be stored in the Philippsburg spent fuel storage facility. Corresponding applications for the storage of the casks have been submitted. According to current planning, the return of the CSD-B waste from France is scheduled for 2022. From 2024, the return of the CSD-C waste (152 casks) is planned.

From 2020, the vitrified high-level radioactive waste (fission product solutions) from reprocessing in the United Kingdom is also to be returned in three shipments (20 casks). The first return shipment of six casks to the Biblis spent fuel storage facility took place in November 2020 and was therefore delayed due to the coronavirus (SARS-CoV-2) pandemic. For the decentralised Biblis spent fuel storage facility, the storage licence pursuant to § 6 AtG was granted on 19 December 2019 and the transport licence on 14 February 2020. In 2024 and 2025, the remaining casks from the United Kingdom are to be returned to the spent fuel storage facilities Brokdorf and Isar (seven casks each).

Extended 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 objective of safe storage, decentralised spent fuel storage facilities had been licensed, constructed and commissioned at twelve sites between 2002 and 2007. The total licensed capacity is 14,025 Mg HM. As at 31 December 2019, 5,890 Mg HM of spent fuel were in storage, corresponding to an average occupancy rate of about 46 %. Among the individual sites, the current occupancy varies between 25 % and 76 %.

In addition to 2.539 Mg HM of spent fuel in the wet storage pools of the power reactor sites a residual amount of 1,009 Mg HM is expected from the power reactors still in operation until their decommissioning, which will increase the average occupancy rate of the decentralised spent fuel storage facilities to about 49 %. Thus, 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.

The annual inventory reported as at the reporting date for proof that adequate waste management provisions have been made and the forecast of the expected volume in the two years after the reporting date and until final shutdown serve to verify and ensure that sufficient storage capacity is available, both in the short term and in the long term. Sufficient storage capacity is available at each site for both the spent fuel already existing and expected to arise.

In the central spent fuel storage facilities in Ahaus, Gorleben and the Storage Facility North, the storage of 7,345 Mg of spent fuel had been licensed between 1995 and 1999 on a total of 920 cask storage positions. As at 31 December 2019, 248 storage positions were occupied by spent fuel from power and research reactors as well as by reprocessing waste. The occupancy rate of the Storage Facility North is about 92 %, but no further storage is planned here. At the site of the Storage Facility North, a new storage building is planned (ESTRAL) to replace the existing storage facility. The licence application was submitted to the BASE on 14 December 2020. The occupancy rate at Gorleben is around 27 %, and no further storage of spent fuel or high-level radioactive waste is planned here either. The occupancy rate of the Ahaus spent fuel storage facility is about 15 %. Further spent fuel from research reactors and CSD-C waste from France are to be stored here.

The storage licences for the spent fuel storage facilities are currently limited to 40 years and expire between 2034 and 2047, but commissioning of a disposal facility is not expected before 2050. Against this background, it will be necessary to extend the licensed storage period. In § 6(5) AtG, sentence 2, the Atomic Energy Act subjects the renewal of storage licences to the existence of imperative ground and requires prior referral to the German *Bundestag*.

For timely licence renewal, projects for national and international exchange of information and experience were initiated at an early stage (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** for details) in order to be able to assess safety-related issues in connection with the extended storage of spent fuel. It is expected that the currently established concept of dry storage (storage buildings and casks) maintains

its safety functions even for considerably longer periods than 40 years. This is to be demonstrated by the operator in a detailed and substantiated manner within the framework of the licensing procedures required for licence renewal as part of comprehensive planning oriented to the primacy of safety.

Disposal facility for high-level radioactive waste

The Site Selection Act (StandAG) for the selection of a site for a disposal facility for high-level radioactive waste entered into force on 27 July 2013. In preparation for the site selection procedure, the Commission on the Storage of High-Level Radioactive Waste, which was formed in April 2014, examined and assessed relevant fundamental issues for the management of radioactive waste, evaluated the Site Selection Act and submitted proposals for its further development. In July 2016, the Commission submitted the results of its work to the German *Bundestag* in the form of a report.

Following the work of the Commission, the National Civil Society Board (NBG) was constituted at the national level in December 2016, with 18 members. Its central task is to accompany the site selection procedure as a mediating and independent body until reaching a decision on a site, in particular with regard to public participation.

The site selection procedure for a disposal facility for high-level radioactive waste was started in 2017 with the amendment of the StandAG. The procedure is to take place in three phases, which will be accompanied by intensive involvement and participation of the public.

The planned steps in the realisation of a facility for deep geological disposal of high-level radioactive waste with interim targets is shown in Figure K-3. According to the StandAG, the Subareas Conference is to hold three meetings in six months. The kick-off event of the Subareas Conference 2020 in Kassel should not be counted. Therefore, the three meeting dates are set in the first half of 2021.

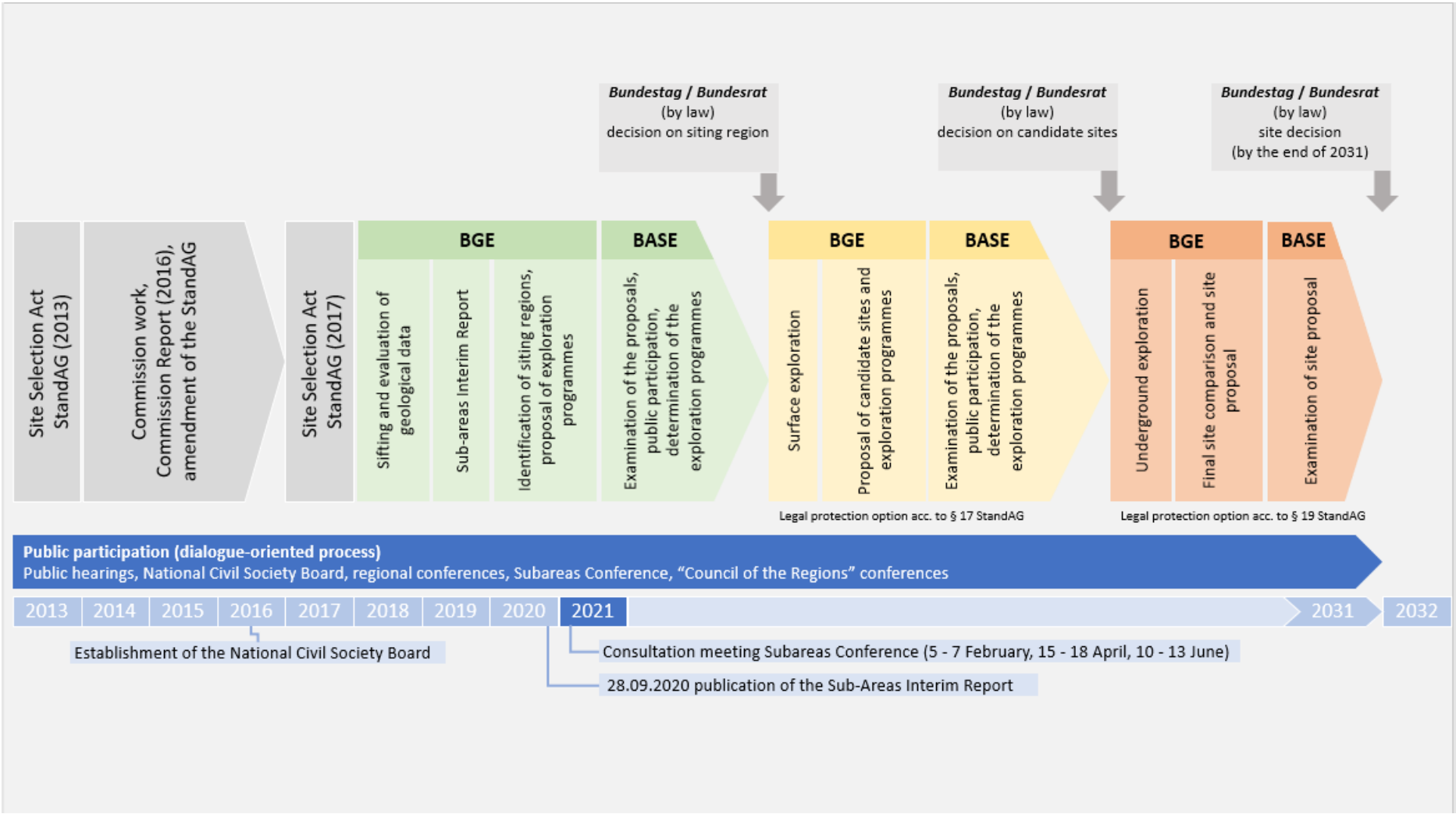

Figure K-3: Steps in the site selection of a disposal facility for high-level radioactive waste, including responsibilities

In the last few years, geoscientific criteria and requirements according to the StandAG have been applied to identify subareas that are expected to provide favourable geological conditions for the safe disposal of high-level radioactive waste. The results were published as scheduled on 28 September 2020 and submitted to the Federal Office for the Safety of Nuclear Waste Management (BASE). The interim report presents all facts and considerations relevant for the selection of subareas. Thus, the first step of phase 1 in the site selection procedure has been completed and another interim target in the search for a site achieved within the scheduled time frame.

In accordance with § 9 StandAG, the BASE convened a Subareas Conference meeting after receipt of the interim report, which now discusses the interim report and will submit its results to the project implementer within one month after the last meeting.

In the next step, representative preliminary safety analyses will be carried out for the subareas, having to comply with the provisions of the Disposal Facility Safety Requirements Ordinance (EndlSiAnfV) and the Disposal Facility Safety Analyses Ordinance (EndlSiUntV), which came into force on 15 October 2020. On the basis of the findings from the safety analyses, siting regions are determined for surface exploration, applying again geoscientific weighing criteria as well as applying planning-scientific weighing criteria for the first time. Based on the results of the surface exploration (end of phase 2), sites are identified for underground exploration (phase 3). From these, the site with the best possible safety is determined (end of phase 3).

The decision on the site for a disposal facility for high-level radioactive waste is sought by 2031. The next steps towards safe disposal of spent fuel are as follows:

- licensing of the disposal facility for high-level radioactive waste,
- licensing and construction of a receiving storage facility for spent fuel and waste from reprocessing at the selected site for 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 spent fuel and reprocessing 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.

There are currently no delays in implementing the site selection procedure in the *National Programme*.

Konrad repository

Completion of the Konrad repository by 2027

Since 2007, a final and incontestable plan approval decision has been in place for the Konrad repository and construction has begun. During the reporting period, construction work on the winding engine house Konrad 1 North and the administration and social building was completed. At the Konrad 2 shaft site, construction of the ventilation building and the depot was started. Underground, most of the excavation work for the inset on the second level ("transfer station" from the shaft into the drift) was carried out. Before that, the extension of the shaft had been completed there. Based on a TÜV Rheinland expert opinion commissioned by the Federal Company for Radioactive Waste Disposal (BGE), it was estimated that the Konrad repository could be expected to be completed in the first half of 2027. Within the framework of this report, all information and data across the organisations involved in the construction of the repository to date was examined for their schedule relevance. The TÜV experts have assessed the uncertainties in the construction of the repository.

Conditioning of low- and intermediate-level radioactive waste generated during the operation and decommissioning of nuclear power plants in preparation for emplacement in the Konrad repository

For emplacement in the Konrad repository, the entire licensed waste 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 requirements is verified by means of the material and radiological product control, and compliance with the waste acceptance requirements by the containers is confirmed by container design testing. Upon fulfilment of all requirements, a notice on the suitability for disposal will be issued. In order to achieve this goal, product control is to be increased to such an extent that at least as many waste packages are controlled annually as can be emplaced in the Konrad repository (one-shift operation corresponds to an average waste package volume of 10,000 m^3 annually).

In order to be able to provide a sufficient volume of waste packages produced according to qualified procedures for disposal in the Konrad repository, conditioning capacities have been and are being built up at the waste producers as needed. The expert organisations TÜV NORD EnSys GmbH & Co. KG and TÜV SÜD AG have already carried out significantly more process qualifications in 2019. In addition, the number of waste packages for which product control is applied for is increasing.

In order to be able to react adequately to this development, the personnel capacities at the BGE have been and will continue to be increased in order to speed up product control and achieve a higher throughput. As part of a tendering procedure, the technical assessment of radioactive waste in the area of product control was also put out to tender externally to build up additional capacities for the consultation of experts. Since January 2019, TÜV NORD EnSys GmbH & Co. KG, TÜV SÜD AG, the Product Control Group for Radioactive Waste Jülich and the Federal Institute for Materials Research and Testing (BAM) have been commissioned to provide expert services.

In the meantime, a clear increase in the number of test reports on the suitability for disposal has been observed. The processing of these reports in the BGE's product control division is also keeping pace with this increase. This is a visible sign that the resource build-up that has begun has led to initial increases in the speed with which applications are processed.

Another 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.

According to previous plans, an average of 10,000 m³ of radioactive waste was to be emplace in the Konrad repository per year in one-shift operation. The BGE has now been asked to examine a two-shift operation for emplacement to shorten the total operating time and to compensate for part of the delay in construction.

Optimisation of delivery logistics

The establishment of a logistics centre for the Konrad repository (LoK) at the site of the former Würgassen nuclear power plant is intended to ensure efficient just-in-time delivery to the Konrad repository as needed and thus to create the prerequisites for continuous and faster emplacement operations. The BGZ is responsible for the planning, construction and operation of the LoK. At present, the basic fundamentals for the requisite licences are being prepared.

From 2027 on, the low- and intermediate-level radioactive waste intended for the Konrad repository is to be collected in the LoK at Würgassen and buffered for disposal. As the LoK will provide access to a larger number of waste containers, it will be possible to combine the waste into precisely fitting batches for emplacement in terms of quantity and time. From the LoK, the batches intended for emplacement can then be transported just-in-time to the Konrad repository. This would not be ensured in the various radioactive waste storage facilities due to the storage situation there and their spatial distribution in the Federal Republic of Germany.

The planned logistics centre is to accelerate the emplacement in the Konrad repository by a demand-oriented and continuous delivery of the waste packages qualified for disposal and thus significantly shorten the operating times of both the repository and the radioactive waste storage facilities.

The first interim target – the search for a site for the central storage facility – was achieved. The next steps include the licensing and commissioning of the storage facility by 2027.

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

The Federal Office for Radiation Protection (BfS), which was responsible for the closure of the Morsleben repository for radioactive waste (ERAM) until April 2017, has developed a closure concept on the basis of extensive investigation programmes, which is to ensure the containment of the stored waste for more than 1 million years.

The inspection by experts focuses on the verifications of the sealing of shafts and drifts, the integrity of the geological barrier, and the reliability of the waste inventory data. The expert review has shown that the application documents still need to be supplemented.

The BGE, which has been in charge of continuing the closure procedure since April 2017, has to complete all final application documents for closure by 2026. For this purpose, the safety demonstrations and planning for closure will be restructured. The focus is on the work on the demonstration structures for the construction of sealing structures in anhydrite rock and salt rock. These will be completed by about 2024. Preparatory measures to convert the technical facilities of the repository for closure have been started.

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

Asse II mine

The BGE has been the operator of the Asse II mine since 2017 and is responsible for the retrieval of the waste and closure of the mine. On 27 March 2020, the BGE published a retrieval plan that coherently describes all measures to be taken. In addition to the preparation and implementation of the retrieval of the waste from the Asse II mine, the planning and sinking of the Asse 5 shaft, the emergency planning and the construction of facilities for waste processing and storage are required as accompanying projects. The phases of the individual projects and their chronological sequence are shown schematically in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

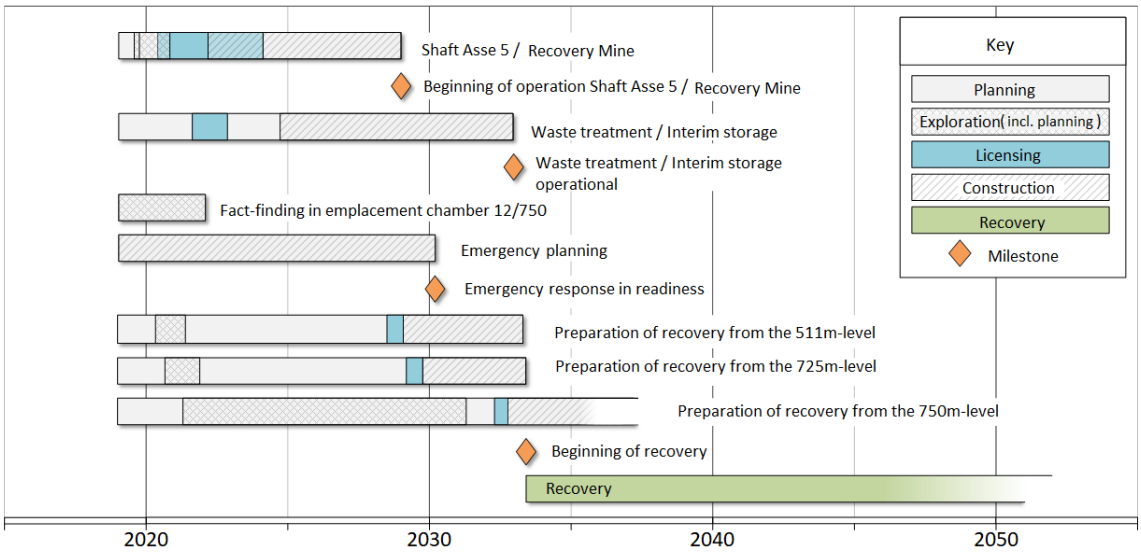

Figure K-4: Chronological sequence of the project phases for retrieval of the waste from the Asse II mine

The retrieval mine and the Asse 5 shaft 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. The conceptual planning has been completed, and the accompanying surface and underground exploration is being continued to clarify specific issues. A planning notification by the BGE outlining how the necessary licences for retrieval are to be concentrated and applied for, taking into account the legal areas involved, was submitted in 2020. The first application complex presented in the planning notification describes in particular the sinking of the Asse 5 shaft and the excavation of the retrieval mine, both of which are to be applied for in a first step.

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 already been completed. Planning will continue with the determination of a concrete site for these facilities. All waste processing facilities must be ready for operation when retrieval starts in 2033.

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. Some of the measures within the scope of the emergency planning are already being implemented and expected to be completed by 2030. 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 an emplacement 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 next steps after the start of retrieval of the radioactive waste are as follows:

- completion of the retrieval of the waste from the Asse II mine, and
- closure 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

The BMU, on behalf of the Federal Government, reviews the *National Programme* regularly, but at least every ten years, to ensure that it is up to date. At present, the reviews have not revealed any fundamental need for amendment.

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 BMU. 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 IAEA IRRS (Integrated Regulatory Review Service) mission was carried out in the Federal Republic of Germany from 31 March to 13 April 2019 and an IAEA ARTEMIS (Radioactive Waste Management Integrated Review Service) mission from 22 September to 4 October 2019.

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 radiation exposure of the public. 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 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)[5]. Appropriate measures are currently being developed by the licensing and supervisory authorities of

[5] Report of the Integrated Regulatory Review Service (IRRS) Mission to Germany (nuklearesicherheit.de)

the Federation and the *Länder* for the implementation of the recommendations and suggestions and are to be completed until the planned follow-up mission.

L.2 ARTEMIS mission

At the invitation of the Federal Republic of Germany, an ARTEMIS review mission for the responsible and safe management of radioactive waste and spent fuel took place. The agreed thematic focal points of the mission were the reorganisation of the financing and action responsibilities for the management of radioactive waste, the commissioning of the Konrad repository, the site selection procedure for the disposal facility for high-level radioactive waste, the concepts for the decommissioning of the German nuclear power plants and the management of the resulting radioactive waste, as well as the management plans regarding the radioactive waste to be retrieved from the Asse II mine. In addition, the results of the IRRS review mission carried out in April 2019 were also to be taken into account within the ARTEMIS mission.

In addition to the technical discussions between the international team of experts and representatives of the German side, visits to the Konrad repository currently under construction and to the facilities of the Kerntechnische Entsorgung Karlsruhe GmbH (KTE) entrusted with the management of radioactive waste completed the review mission. A final report on the review mission and its findings was submitted to the BMU in December 2019 and published[6].

The international experts identified the establishment of an independent advisory board for public participation, the National Civil Society Board (NBG), as an internationally recognised “Good Practice”.

In addition, the team of experts drew attention to future challenges that Germany will face, not least due to the gradual phase-out of nuclear energy by the end of 2022 and the associated tasks. A total of three recommendations and 12 suggestions were made. These related to the areas of detailed monitoring of progress in the large number of tasks to be performed as well as increasing transparency with regard to some aspects of granting licences and informing the public.

The ARTEMIS review team concluded that Germany meets the internationally applicable safety standards of the International Atomic Energy Agency (IAEA) for radioactive waste management and has a well-developed framework for the safe and responsible management of radioactive waste and spent fuel. According to the results of the review team, the *National Programme* and the organisational changes that have taken place in this area have set the right course.

The BMU has started developing proposals for the implementation of the recommendations and suggestions and is currently coordinating activities with the *Länder* participating in the ARTEMIS mission and the subordinate authorities involved. The aim is to discuss the developed proposals within the *Länder* Committee for Nuclear Energy. Once this

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[6] https://www.iaea.org/sites/default/files/documents/review-missions/final_artemis_report-germany.pdf

process has been adopted, concrete implementation will follow with the aim of an ARTEMIS follow-up mission in 2023.

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. Since the second Member State Report, conditioning capacities have been increased at some sites as needed. In addition, storage capacities have been increased at the Philippsburg, Biblis and Unterweser sites and operations started in 2018 and 2020, respectively; additional radioactive waste storage facilities are under construction at Neckarwestheim, Brunsbüttel and Grafenrheinfeld.

No decision has yet been made regarding the removal of the nuclear fuel from the AVR cask storage facility and three options are still being pursued. The currently planned measures concern the following aspects:

1. For the closure of the Morsleben repository for radioactive waste (ERAM), the submitted long-term safety case is to be adapted to the state of the art in science and technology. According to the current estimate of the Federal Company for Radioactive Waste Disposal (BGE) on the further progress, the final application documents are to be submitted to the licensing authority by 2026; a decision on the application is expected for early 2029.

2. 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. To improve the logistic process of emplacement in the Konrad repository, the BGZ Company for Storage (BGZ) is to plan and construct a logistics centre with a central reception storage facility.

N. List of abbreviations

ARTEMIS	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*
BAKöV	Bundesakademie für die öffentliche Verwaltung *Federal Academy of Public Administration*
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	Bundes-Gesellschaft 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*
BMU	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety*
BMWi	Bundesministerium für Wirtschaft und Energie *Federal Ministry for Economic Affairs and Energy*
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*
EMiNA	European Master of Science in Nuclear Applications
ENSREG	European Nuclear Safety Regulators Group
EndlagerVIV	Endlagervorausleistungsverordnung *Repository Prepayment Ordinance*
EndlSiAnfV	Endlagersicherheitsanforderungsverordnung *Disposal Facility Safety Requirements Ordinance*
EndlSiUntV	Endlagersicherheitsuntersuchungsverordnung *Disposal Facility Safety Analyses Ordinance*
ENSTTI	European Nuclear Safety Training and Tutoring Institute
EntsorgÜG	Entsorgungsübergangsgesetz *Waste Management Transfer Act*
EPRI	Electric Power Research Institute
ERAM	Endlager für radioaktive Abfälle Morsleben *Morsleben repository for radioactive waste*
ESK	Entsorgungskommission *Nuclear Waste Management Commission*
EU	European Union
EWN	EWN Entsorgungswerk für Nuklearanlagen GmbH *(formerly Energiewerke Nord 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*
KFK	Kommission zur Überprüfung der Finanzierung des Kernenergie-ausstiegs *Commission to Review the Financing for the Phase-out of Nuclear Energy*
KTE	Kerntechnische Entsorgung Karlsruhe (KTE) GmbH

LAA	Länderausschuss für Atomkernenergie *Länder Committee for Nuclear Energy*
LLW	Low Level Waste
LoK	Logistikzentrum für das Endlager Konrad *Logistics Centre for the Konrad repository*
MS	Member States
NBG	Nationalen 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*
US-DOE	United States Department of Energy
US-NRC	United States Nuclear Regulatory Commission
UVPG	Gesetz über die Umweltverträglichkeitsprüfung *Environmental Impact Assessment Act*
VEK	Verglasungseinrichtung Karlsruhe *Karlsruhe vitrification facility*
VLLW	Very Low Level Waste
WENRA	Western European Nuclear Regulators Association
ZLN	Zwischenlager Nord *Storage Facility North*