

Nuclear Regulatory Issues and Main Developments in Germany

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



Federal Office
for the Safety of
Nuclear Waste Management

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Abbreviations

ARTEMIS	Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation
BASE	Federal Office for the Safety of Nuclear Waste Management
BDEW	Federal Association of the Energy and Water Industry
BfS	Federal Office for Radiation Protection
BGE	Federal Company for Radioactive Waste Disposal
BGZ	Federal Company for Interim Storage
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
ENSREG	European Nuclear Safety Regulators Group
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit
HAW	High-level Radioactive Waste
IAEA	International Atomic Energy Agency
IRS	International Reporting System for Operating Experience
IRRS	Integrated Regulatory Review Service
JEN	Jülicher Entsorgungsgesellschaft für Nuklearanlagen mbH
KTA	German Nuclear Safety Standards Commission
MWe	Megawatt electrical power
NAR	National Assessment Reports
NBG	National Civil Society Board

NPP	Nuclear Power Plant
OECD/NEA	Organisation for Economic Co-operation and Development / Nuclear Energy Agency
PFE	Planning Team of the Repository Search Forum
TPR	Topical Peer Review
TWh	Terawatt hour
ZLN	Storage Facility North

1. General Topics

a) Nuclear Power Phase Out

The nuclear power phase out in Germany is completed. According to the legal framework of 2011, the last three nuclear power plants (NPPs) Isar 2, Emsland, and Neckarwestheim 2 should have been shut down by the end of 2022 at the latest. However, due to the unexpected energy crisis in Europe following the Russian war against Ukraine, on 11 November 2022, the German parliament decided that these three NPPs were allowed to continue stretch-out operation until 15 April 2023 at the latest. Stretch-out operation means that only those fuel assemblies could be used which were present in the reactor core or in the spent fuel pool at the time the amended law came into force. The need for this continued operation for a limited period of time was identified in a special analysis of the four transmission system operators who are responsible for the control areas for the power supply for winter 2022/23 as a further pillar for energy supply security in Germany. Furthermore, the continued operation of the three NPPs in winter 2022/23 was also meant to strengthen the stability of the German and the European power grid in the event of impending power deficits. More information about the stretch-out operation can be found on the website of the Bundestag:

<https://www.bundestag.de/dokumente/textarchiv/2022/kw45-de-atomgesetz-freitag-917474>

The corresponding 19th amendment of the Atomic Energy Act came into force on 9 December, 2022, and can be found at:

https://www.bgbl.de/xaver/bgbl/start.xav?start=//%5B%40attr_id%3D%27bgbl122s2153.pdf%27%5D#_bgbl_%2F%2F%5B%40attr_id%3D%27bgbl122s2153.pdf%27%5D_1678434309977

The Atomic Energy Act required a yearly publication of the generated, transferred, and remaining electricity volumes. The status as of 31 December 2022 was published by the Federal Office for the Safety of Nuclear Waste Management (BASE) in the Federal Gazette (*Bundesanzeiger*, BAnz AT 17.04.2023 B4) on 17 April 2023, and on the BASE website: <https://www.base.bund.de/SharedDocs/Downloads/BASE/DE/berichte/kt/elektrizitaetsmenge-2022.html>

This publication for the year 2022 was the last one required. Due to the 19th amendment of the Atomic Energy Act mentioned above, the continued operation of the three NPPs in 2023 has been independent of the electricity quantities generated, transferred, and remaining.

b) Electricity Production and Nuclear Share

The gross electricity production in Germany reached 508.1 Terawatt hours (TWh) in 2023 (569.2 TWh in 2022). The nuclear share of the gross electricity production in 2023 was 1.4 %, compared to 6.1 % in 2022 and 11.8 % in 2021. The shares of the different energy sources are shown in Table 1.

Table 1: Gross electricity production – 2021 - 2023 [TWh]

	2021		2022*		2023*	
	TWh	%	TWh	%	TWh	%
Nuclear	69.1	11.8	34.7	6.1	7.2	1.4
Lignite	110.4	18.9	116.2	20.4	87.5	17.2
Hard Coal	54.9	9.4	63.7	11.2	44.1	8.7
Oil	4.9	0.8	5.7	1.0	4.9	1.0
Gas	90.0	15.4	79.0	13.9	80.0	15.7
Renewables	237.1	40.5	251.8	44.2	267.0	52.5
Others	18.6	3.2	17.9	3.1	17.3	3.4
Total	585.0	100	574.0	100	508.1	100

[Data from BDEW Annual report 2023 on Energy Supply, 18.12.2023]

* preliminary data

2. Laws and Regulations

a) *Matters under International Law*

Germany is a Contracting Party to the Convention on Nuclear Safety (CNS). The eighth Review Meeting was planned to be held from 23 March to 3 April 2020. Due to the spread of COVID-19, it was first decided to postpone the meeting to 2021 and then to merge the eighth and ninth Review Meeting in one meeting from 20 to 31 March 2023. All German National Reports for the CNS are published on the website of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV): <http://www.bmuv.de/WS4630-1>
For more information, see: https://www.base.bund.de/EN/ns/safety/co-operation/cns/cns_node.html

Germany is a Contracting Party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (JC). The seventh Review Meeting was planned to be held in May 2021. Due to the spread of COVID-19, it was postponed to 27 June – 8 July 2022. The German National Report was published on the website of the BMUV: www.bmuv.de/DL2577-1

With regard to the discussion about the taxonomy in the European Union, BASE conducted an Expert Response to the report by the EU Commission's Joint Research Centre "Technical assessment of nuclear energy with respect to the 'Do No Significant Harm' criteria in Regulation (EU) 2020/852, the 'Taxonomy Regulation'". The Expert Response questions the sustainability of nuclear power. It is available on the website of BASE: https://www.base.bund.de/SharedDocs/Downloads/BASE/EN/reports/2021-06-30_base-expert-response-jrc-report.pdf.pdf?__blob=publicationFile&v=8

b) *National Legislation*

Numerous amendments and revisions of regulatory documents in the field of emergency preparedness and response were carried out, based in particular on the experience gained from the reactor accidents in Fukushima and the transposition of Directive 2013/59/Euratom into German law. Particularly important in this context are the Radiation Protection Act (*Strahlenschutzgesetz*), the Radiation Protection Ordinance (*Strahlenschutzverordnung*), the Emergency Dose Value Ordinance (*Notfall-Dosiswerte-Verordnung*), and the Nuclear Waste Management Ordinance (*Atomrechtliche Entsorgungsverordnung*).

For more information, see: https://www.base.bund.de/EN/bfe/laws-regulations/hns/mrs_node.html

c) *National Regulation and KTA safety standards*

For information on currently valid regulatory documents see:

https://www.base.bund.de/EN/bfe/laws-regulations/hns/mrs_node.html

In order to further develop the safety culture, the nuclear licensing and supervisory authorities of the Federation and the Länder developed a common understanding of their safety culture and put it down in a policy paper. It covers the fields of nuclear safety, nuclear security, and radiation protection in nuclear installations and of nuclear fuel transports. The policy paper considers current international developments in this area. In particular, the principles of the Organisation for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA) on safety culture in supervisory authorities published in 2016 were applied. The policy paper adopted by the Länder Committee for Nuclear Energy at its meeting on 6/7 June 2019 forms the basis for further development and concretisation of the safety culture in the individual authorities. In addition to the policy paper on safety culture, the BMUV published a guideline on security culture on 30 June 2023.

In May 2023, the German Nuclear Safety Standards Commission (*Kerntechnischer Ausschuss*, KTA) issued 31 revised KTA standards (published in the Federal Gazette on 25 July 2023):

- KTA 1301.1 Radiation Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants; Part 1: Design
- KTA 1301.2 Radiation Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants; Part 2: Operation
- KTA 1403 Ageing Management in Nuclear Power Plants
- KTA 1501 Stationary System for Monitoring the Local Dose Rate within Nuclear Power Plants
- KTA 1502 Monitoring Volumetric Activity of Radioactive Substances in the Inner Atmosphere of Nuclear Power Plants

- KTA 1503.1 Monitoring the Discharge of Radioactive Gases and Airborne Radioactive Particulates; Part 1: Monitoring the Discharge of Radioactive Matter with the Stack Exhaust Air During Specified Normal Operation
- KTA 1503.2 Monitoring the Discharge of Radioactive Gases and Airborne Radioactive Particulates; Part 2: Monitoring the Discharge of Radioactive Matter with the Vent Stack Exhaust Air During Design-Basis Accidents
- KTA 1503.3 Monitoring the Discharge of Radioactive Gases and Airborne Radioactive Particulates; Part 3: Monitoring the Non-stack Discharge of Radioactive Matter
- KTA 1504 Monitoring and Assessing the Discharge of Radioactive Substances with Water
- KTA 1505 Suitability Verification of the Stationary Measurement Equipment for Radiation Monitoring
- KTA 1507 Monitoring the Discharge of Radioactive Substances from Research Reactors
- KTA 1508 Instrumentation for Determining the Dispersion of Radioactive Substances in the Atmosphere
- KTA 2103 Explosion Protection in Nuclear Power Plants with Light Water Reactors (General and Case-Specific Requirements)
- KTA 2206 Design of Nuclear Power Plants against Damaging Effects from Lightning
- KTA 2501 Structural Waterproofing of Nuclear Power Plants
- KTA 3101.1 Design of Reactor Cores of Pressurized Water and Boiling Water Reactors; Part 1: Principles of the Thermohydraulic Design
- KTA 3101.3 Design of Reactor Cores of Pressurized Water and Boiling Water Reactors; Part 3: Mechanical and Thermal Design
- KTA 3401.4 Steel Containment Vessels; Part 4: Inservice Inspections
- KTA 3402 Airlocks on the Reactor Containment of Nuclear Power Plants - Personnel Airlocks
- KTA 3403 Cable Penetrations through the Reactor Containment Vessel
- KTA 3407 Pipe Penetrations through the Reactor Containment Vessel
- KTA 3409 Airlocks on the Reactor Containment of Nuclear Power Plants - Equipment Airlocks
- KTA 3504 Electrical Drive Mechanisms of the Safety System in Nuclear Power Plants
- KTA 3507 Factory Tests, Post-Repair Tests and the Certification of Proven Performance of Modules and Devices of the Instrumentation and Control System Important to Safety
- KTA 3601 Ventilation Systems in Nuclear Power Plants
- KTA 3603 Facilities for Treating Radioactively Contaminated Water in Nuclear Power Plants
- KTA 3605 Treatment of Radioactively Contaminated Gases in Nuclear Power Plants with Light Water Reactors
- KTA 3702 Emergency Power Generating Facilities with Diesel-Generator Units in Nuclear Power Plants
- KTA 3703 Emergency Power Facilities with Batteries and AC/DC Converters in Nuclear Power Plants
- KTA 3704 Emergency Power Facilities with Static and Rotary AC/DC Converters in Nuclear Power Plants
- KTA 3705 Switchgear, Transformers and Distribution Networks for the Electrical Power Supply of the Safety System in Nuclear Power Plants

Following a written ballot, the KTA issued one revised KTA standard on 15 December 2023 (to be published in the Federal Gazette in January 2024):

- KTA 1404 Documentation During the Construction and Operation of Nuclear Power Plants

A revision process is ongoing for

- KTA 2201.2 Design of Nuclear Power Plants against Seismic Events; Part 2: Subsoil.

The KTA plans to hold its 75th meeting in November 2024.

For detailed information on the KTA and its safety standards, see the KTA website:

http://www.kta-gs.de/welcome_engl.htm

d) *"National Programme" - Programme for the responsible and safe management of spent fuel and radioactive waste*

In accordance with Directive 2011/70/Euratom, the BMUV set out Germany's strategy for the responsible and safe management of spent fuel and radioactive waste in its national programme. This programme was adopted by the German cabinet on 12 August 2015. The BMUV carried out agency and public participation on the programme before its adoption. The national programme is not legally binding, but has to be considered by all actors in the planning of waste management and administrative decisions. The national programme consists of an overarching document giving a programmatic overview of German waste management policy and four appendices: The national programme is subject to potential revision in view of ongoing deliberations by the German parliament's Commission on the Storage of Highly Radioactive Materials.

The National Programme and supplementary documents can be found on the website:

<https://www.bmu.de/en/download/national-programme/>

e) *Recommendations by RSK, ESK and SSK*

The BMUV is supported by three advisory committees regarding nuclear safety, waste management, and radiation protection.

The Reactor Safety Commission (*Reaktor-Sicherheitskommission*, RSK) recently issued the following recommendations or statements:

- Planning and assessment of works during residual operation (12/2023)
- Requirements for the cooling of the fuel assemblies in the spent fuel pool during residual operation (revised version as of 12/2023)
- Assessment of the technical contribution of the possibly expanded THAI test facility with regard to the safety assessment of research and power reactors as well as competence building and development of future talent for nuclear safety (02/2023)

The complete list of recommendations and statements by RSK is available on the website:

<https://www.rskonline.de/en/results>

The Nuclear Waste Management Commission (*Entsorgungskommission*, ESK) recently issued the following recommendations, statements, or information papers:

- Assessment of the necessity of the Konrad logistics centre, the site selection by BGZ and the finally selected Würgassen site (07/2023, in German)
- Guideline on the safe operation of a repository for high-level radioactive waste (05/2023, in German)
- Extended storage of spent fuel and other high-level radioactive waste depending on the selection of the repository site (03/2023, in German)
- Clearance of radioactive material and removal of non-radioactive material from the dismantling of nuclear power plants (09/2022)
- Comparison of the mass flows from decommissioning of nuclear power plants in Germany and France (06/2022)
- The 100 degrees Celsius criterion in § 27(4) of the Site Selection Act (05/2022, in German)
- ESK guidelines for the performance of periodic safety reviews and on technical ageing management for storage facilities for spent fuel and heat-generating radioactive waste (03/2022)
- Guidelines for the storage of radioactive waste with negligible heat generation (12/2021, in German)
- Guideline on safety management in waste management organisations (09/2021, in German)

Further information can be found on the ESK website:

<https://www.entsorgungskommission.de/en/consultationresults>

The Commission on Radiological Protection (*Strahlenschutzkommission*, SSK) recently issued the following recommendations or publications:

- Dose-response relationship for the association of UV radiation and skin cancer (02/2023, in German)
- Protection strategies in case of a nuclear detonation - Use of respirators to protect the population after the explosion of a nuclear weapon (02/2023)
- Annual report 2022 of the SSK (02/2023, in German)
- Basic principles of determining radiation exposure limits for the general public (05/2023)
- Proposals of the SSK for the revision of ICRP 103 (05/2023)

- Medical management of radiation emergencies – Requirements and organisational matters (09/2023)
- Long-term maintaining and expanding expertise in the field of radiation research and application in Germany – Measures (09/2023)
- Risks of using far-UVC radiation for disinfection in the presence of people (12/2023)

A listing of recommendations and statements, annual reports, and other publications are available on: http://www.ssk.de/EN/Home/home_node.html

3. Operation and Decommissioning of German Nuclear Power Plants

Due to the nuclear power phase out in Germany, the last three NPPs Isar 2, Emsland, and Neckarwestheim 2 were shut down on 15 April 2023. Consequently, there are no more operating NPPs in Germany.

a) Event Registration

In 2023, a total number of 35 events were reported from German NPPs; 15 events from NPPs in operation or permanent shut-down, and 20 events from NPPs in decommissioning.

The national Incident Registration Centre is organised at BASE. BASE carries out an evaluation of the events reported from the German nuclear installations, including the classification of the events according to the Nuclear Safety Officer and Reporting Ordinance (*Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung*), lists all information in a database, and reports to the BMUV in monthly reports. The current reportable events are discussed in the committees of the RSK and ESK on the basis of the monthly reports of BASE.

The monthly as well as annual reports on reportable events of German NPPs and research reactors are available on the BASE website: https://www.base.bund.de/EN/ns/events/reports/reports_node.html

b) Evaluation of operating experience

On behalf of the BMUV, the expert organisation *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) evaluates national and international operating experience on a holistic basis, partly involving further independent experts. In particular, the international events reported within the International Reporting System for Operating Experience (IRS) of the International Atomic Energy Agency (IAEA) and in the Working Group on Operating Experience of the OECD/NEA are systematically evaluated with regard to their applicability to German nuclear installations.

If the analysis of the events with safety significance reported by German or foreign nuclear installations reveals an applicability to German nuclear installations, the GRS prepares information notices (*Weiterleitungsnachrichten*) on behalf of the BMUV. These are released by the BMUV and transmitted by the GRS to the nuclear licensing and supervisory authorities of all Länder with nuclear installations, the expert organisations, the licence holders of the nuclear installations, the manufacturers, and other specialised institutions.

In addition, the GRS also prepares statements at short notice on behalf of the BMUV in the case of special events or all events rated as INES 2 or higher at foreign nuclear installations. The released statements are systematically transmitted by the BMUV to the nuclear licensing and supervisory authorities of all Länder with nuclear installations.

Recently evaluated international events:

- INES 2 at Penly 1 Power Station (F) – Stress corrosion: presence of a deep crack on the safety injection system of reactor 1 of the Penly NPP

c) Licensing, Supervisory Issues and Decommissioning Licenses

Germany had a total of 36 NPPs and prototype reactors. Three prototype reactors have been fully dismantled and released from nuclear regulatory control.

Table 2 gives an overview of the applications for decommissioning and the licences granted for decommissioning for German NPPs since 2011.

At the two NPP sites in Philippsburg and Neckarwestheim both new storage facilities for low and intermediate level radioactive waste and new waste treatment facilities were built. The licences for the handling of radioactive substances according to § 7 StrlSchV for all four facilities were granted on 17 December 2018. The two storage facilities were taken into operation in 2020 and the two waste treatment facilities were taken into operation at the beginning of 2021. Furthermore, storage facilities for low and intermediate level radioactive waste were taken into operation at the NPP-locations Biblis (2018), Unterweser (2020), and Grafenrheinfeld (2021).

Table 2: Applications and licences for decommissioning due to nuclear phase-out (since 2011)

NPP		Permanent shutdown	First application for decommissioning	First licence granted for decommissioning
Isar 1	KKI 1	2011-08-06	2012-05-04	2017-01-17
Unterweser	KKU	2011-08-06	2012-05-04	2018-02-05
Biblis A	KWB A	2011-08-06	2012-08-06	2017-03-30
Biblis B	KWB B	2011-08-06	2012-08-06	2017-03-30
Brunsbüttel	KKB	2011-08-06	2012-11-01	2018-12-21
Neckarwestheim 1	GKN 1	2011-08-06	2013-04-24	2017-02-03
Philippsburg 1	KKP 1	2011-08-06	2013-04-24	2017-04-07
Krümmel	KKK	2011-08-06	2015-08-24	–
Grafenrheinfeld	KKG	2015-06-27	2014-03-28	2018-04-11
Gundremmingen B	KRB B	2017-12-31	2014-12-11	2019-03-19
Philippsburg 2	KKP 2	2019-12-31	2016-07-18	2019-12-17
Grohnde	KWG	2021-12-31	2017-10-26	2023-12-06
Gundremmingen C	KRB C	2021-12-31	2019-07-31	2021-05-26
Brokdorf	KBR	2021-12-31	2017-12-01	–
Isar 2	KKI 2	2023-04-15	2019-07-01	–
Emsland	KKE	2023-04-15	2016-12-22	–
Neckarwestheim 2	GKN 2	2023-04-15	2016-07-18	2023-04-04

d) Safety Reviews and Peer Reviews

In accordance with national law, nuclear installations are subject to continuous regulatory supervision over their entire lifetime, from the start of construction to the end of decommissioning. In addition to the continuous regulatory supervision, comprehensive periodic Safety Reviews are performed every ten years. Due to the nuclear power phase-out no safety reviews will have to be performed for NPPs.

Germany participates in EU Topical Peer Reviews (TPR). The EU TPR is coordinated by the European Nuclear Safety Regulators Group (ENSREG). The process of the TPR comprises three phases: a national self-assessment performed by the member states as well as Switzerland, Türkiye, Ukraine, and the United Kingdom, a Peer Review including workshops, and a follow-up. The TPR is planned to take place every six years, beginning with the first TPR in 2017, whose topic was "Aging management of nuclear power plants". The planning for the second TPR (TPR-II), focussing on the topic of "Fire protection at nuclear installations", started in 2019. Preparatory work was conducted from 2020 until 2023. As of 1 November 2023, all participating countries submitted their National Assessment Reports (NAR) to ENSREG to start the review phase. From then on national experts, nominated by the member states as well as other interested stakeholders review the NARs. The review phase, containing questions and answers as well as site visits, will mainly take place in 2024 followed by the follow-up phase, containing ENSREG and National Action Plans, from 2025 onwards.

For more information, including the publicly available reports of TPR-I, see: www.bmu.de/DL1926-1

For more information, including the publicly available German NAR of TPR-II, see: <https://www.bmu.de/en/topics/nuclear-safety/overview-nuclear-safety/europe/ensreg/translate-to->

[english-zweites-themenbezogenes-peer-review-tpr-ii-2022-2024](#)

For more information on the process and all NARs, see: <http://www.ensreg.eu/eu-topical-peer-reviews>

Council Directives 2009/71/Euratom as amended by Council Directive 2014/87/Euratom and 2011/70/Euratom require EU Member States to carry out a self-assessment every ten years of the national legislative, regulatory, and organisational framework for the nuclear safety of nuclear installations and national waste management programme, including the competent regulatory authorities, and to invite them to a subsequent peer review. In order to support the EURATOM Member States in fulfilling these obligations, the IAEA offers them the possibility of carrying out corresponding review missions using the Integrated Regulatory Review Service (IRRS) and the Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS).

The second IRRS Mission to Germany took place from 31 March to 12 April 2019, the first ARTEMIS Mission from 22 September to 4 October 2019. The subsequent follow-up missions were carried out in 2022 and 2023.

The ARTEMIS follow-up mission to Germany from 7 to 12 November 2022 was the first of its kind carried out by the IAEA. The purpose was to review the implementation of the findings identified during the initial ARTEMIS mission and, where appropriate, to address areas of significant change since the last mission.

The follow-up mission was performed by a team of five senior international experts in the field of decommissioning, radioactive waste, and spent fuel management, from multiple IAEA Member States, with three IAEA staff. Representatives of German organizations during the mission itself were from the BMUV, BASE, the Federal Company for Radioactive Waste Disposal (*Bundesgesellschaft für Endlagerung mbH*, BGE), the Company for Interim Storage (*Gesellschaft für Zwischenlagerung mbH*, BGZ), and the GRS on the level of senior management and professional staff.

The ARTEMIS team concluded that Germany had successfully implemented one of the three recommendations as well as ten of the 12 suggestions. Two recommendations and two suggestions will remain open at the moment, until further progress can be demonstrated. The final mission reports of the initial ARTEMIS mission can be found here: <https://www.iaea.org/node/41872>. For the report on the ARTEMIS follow-up mission see: https://www.iaea.org/sites/default/files/documents/review-missions/final_report_artemis_fu_germany.pdf

The IRRS follow-up mission of the initial IRRS Mission took place from 9 to 16 October 2023 and focused on the implementation of the findings identified during the initial mission in 2019. With the follow-up mission the second IRRS review cycle in Germany was completed.

The IRRS follow-up mission was conducted by a team that comprised seven senior regulatory experts from six IAEA Member States and three IAEA staff members. Germany was represented by professional and senior management staff from the BMUV, BASE, BfS and Länder authorities.

The IRRS Review Team confirmed Germany's commitment to improving and further developing the national supervisory system for the nuclear safety of nuclear facilities and installations. As a result, all six recommendations and almost all of the 25 suggestions from the initial mission 2019 are considered implemented.

For more information, including the publicly available report on the initial IRRS mission, see: <https://www.bmuv.de/WS7162-1>

Moreover, to inform the German public, the final mission report was also published on the information portal of the Federal government and the Länder: <https://www.nuklearesicherheit.de/PG172-1>.

4. Research Reactors

In Germany six research reactors are in operation. Among these reactors, there are two with a continuous thermal power above 50 kW, FRM-II in Munich and FRMZ in Mainz. Additionally, four homogenous zero-power reactors with a thermal power of maximum 2 W are in operation.

Three research reactors are permanently shut down, but so far, no decommissioning licence has been granted for them. Six research reactors are under decommissioning and 31 research reactors have already been decommissioned, totally dismantled, and released from regulatory control. The latest status changes were:

- The research reactor BER-II in Berlin was permanently shut down on 11 December 2019. An application for decommissioning was filed on 24 April 2017.
- For the homogenous zero-power reactor in Aachen SUR AA a decommissioning licence was granted on 26 June 2020.
- Two research reactors, SUR-H and RFR, were released from regulatory control in 2019.

5. Site Selection for Disposal of High-Level Waste

The Site Selection Act (*Standortauswahlgesetz*) stipulates a participative, science-based, transparent, self-questioning, and learning procedure for the search and selection of a site for the safe disposal of high-level radioactive waste. The aim is to determine a site offering the highest possible degree of safety for a period of one million years.

In addition, the Site Selection Act stipulates the establishment of a pluralistically composed National Civil Society Board (*Nationales Begleitgremium – NBG*). The central task of the NBG is the conciliatory and independent monitoring of the site selection procedure, in particular the implementation of public participation. The NBG started its work in December 2016. The NBG consists of recognized personalities and randomly selected members of the public. Scientists, students, interested citizens – the board consists of a diverse spectrum of members.

The search started out by considering the entire state territory and progressively narrows down based on a set of rules laid out in the Site Selection Act and the underlying ordinances.

As the implementer, the BGE develops proposals for subareas, regions and sites, and site-related exploration programmes and test criteria. BASE supervises the search for a site and organises the participation of the public on the national and regional levels. In three consecutive phases, the search areas for the disposal site are narrowed down:

- Phase 1: Determination of siting regions for surface exploration
- Phase 2: Surface exploration and proposal for regions for underground exploration
- Phase 3: Underground exploration, siting proposal and decision on the site

At the end of each phase, the BGE proposals are examined by BASE. Each phase is concluded by a parliamentary decision in the form of a federal act naming the siting regions, the sites for underground exploration, and finally the disposal site.

Currently, the site selection procedure is in its first phase. The BGE requested and collected data concerning the exclusion criteria and the minimum requirements defined in the Site Selection Act, such as data on boreholes, tectonic, mining, and hydrogeological data from the geological services of the Länder. Subsequently, the BGE applied geological weighting criteria to identify so-called "sub-areas". On this basis, BASE convened the first formal participation format, the Subareas Conference. All stakeholders (i.e., citizens, scientists, members of NGOs, or local authorities) were able to discuss the findings with the BGE during three meetings, which were held between February and August 2021. After thorough debates with more than 4,000 registered participants, the Subareas Conference submitted its results to the BGE on 7 September 2021. The BGE has to take these results into account in its ongoing work.

In order to accompany the progress of work of the BGE on its way to the proposal of siting regions, BASE, together with representatives from civil society and from the BGE, has elaborated a joint concept for public participation. The resulting Planning team of the Repository Search Forum (*Planungsteam Forum Endlagersuche*, PFE) consists of a smaller group of representatives from civil society as well as BASE and the BGE. It will continuously accompany the implementer's progress and periodically convene public discussion forums that are open to all interested stakeholders. The first "Repository Search Forum" organised by PFE took place on 20 May and 21 May 2022. The second Repository Search Forum was held on 17 and 18 November 2023. Designed as a prototype in an "Adaptive System", the participation concept will be continuously evaluated and adapted to the needs of the public.

In autumn 2022, the BGE for the first time provided a more detailed estimate of the time required for the individual steps of the whole site selection procedure. According to this communication, the site selection procedure is only expected to be completed between 2046 and 2068. Moreover, the BGE has announced that it plans to finalize its proposal for siting regions for surface exploration in the end of 2027 and to publish first interim results in 2024 and 2025.

BASE as the supervisory authority has reviewed the time schedule of the BGE and published a statement in March 2023. In view of the new time estimates and interdependencies with other safety-related aspects such as interim storage, intergenerational challenges, and financing, BASE advocates for a thorough reflection of the site selection procedure with the aim of fixing a clear time target in a reasonable time span. The statement can be found here:

<https://www.base.bund.de/SharedDocs/Kurzmeldungen/BASE/EN/2023/0324-base-statement.html>

In April 2023, the BMUV initiated an evaluation process with BASE with the aim of evaluating and potentially accelerating the site selection procedure. Moreover, BASE has initiated a dialogue on the further progress in the site selection procedure with the BGE, the BGZ and the NBG. The work will focus on a roadmap for the new, common time schedule.

Further information on the site selection procedure can be found on the BASE web page:

https://www.base.bund.de/EN/soa/siteselectionprocess/siteselectionprocess_node.html

The information platform of BASE containing all publicly available documents concerning the site selection procedure can be found here:

<https://www.endlagersuche-infoplattform.de/webs/Endlagersuche/EN>

The BGE interim report on subareas is available at:

<https://www.bge.de/en/sitesearch/sub-areas-interim-report/>

For more information on the NBG, please refer to:

https://www.nationales-begleitgremium.de/EN/Home/home_node.html

6. Nuclear Fuel and Waste Management

a) Disposal Facilities and Projects for Radioactive Waste

The Konrad mine is currently being converted into a disposal facility for radioactive waste with negligible heat generation. The plan approval decision (licence) for the Konrad repository was issued on 22 May 2002 and became unappealable on 26 March 2007.

The Morsleben mine was used as disposal facility for low- and intermediate-level radioactive waste from 1971 until 1998. The Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz – BfS*) applied for the decommissioning of the Morsleben facility under nuclear law on 9 May 1997. The plan-approval procedure for the closing is currently ongoing.

In the Asse II mine low- and intermediate-level radioactive waste was stored from 1967 to 1978. According to the Atomic Energy Act, the Asse II mine shall be decommissioned immediately. Decommissioning is to take place once the radioactive waste has been retrieved from the facility.

For further information on the disposal projects, see:

<https://www.base.bund.de/EN/nwm/repositories/introduction/introduction.html>

b) Storage of Spent Nuclear Fuel

In Germany three central storage facilities are in operation at Gorleben, Ahaus, and Lubmin. On 1 August 2017, the operator responsibilities for the Gorleben and Ahaus storage facilities were transferred from the Gesellschaft für Nuklear-Service mbH to the new, state-owned operator BGZ.

At the Gorleben Transport Cask Storage Facility (TBL Gorleben), nuclear fuel is stored in the form of spent fuel elements from light water reactors as well as vitrified high-level radioactive waste (HAW) from the reprocessing of German fuel elements. The Transport Cask Storage Facility Ahaus (TBL Ahaus) is a storage facility for the storage of nuclear fuels and other radioactive materials. The Storage Facility North near Lubmin (*Zwischenlager Nord, ZLN*) is a facility for the storage of spent fuel and vitrified HAW from the reprocessing of fuel elements in the Karlsruhe Vitrification Facility (*Verglasungseinrichtung Karlsruhe, VEK*). ZLN is operated by the EWN Entsorgungswerk für Nuklearanlagen GmbH (EWN). As replacement for the storage in the ZLN, EWN applied on 29 May 2019 for a new storage facility (ESTRAL) for the spent fuel and vitrified HAW stored in the ZLN. For more information on the central storage facilities, see:

https://www.base.bund.de/EN/nwm/interim-storage/central/central_node.html

In addition, twelve on-site storage facilities are in operation at the sites of the nuclear power plants. On 01 January 2019 the operator responsibilities for eleven of these storage facilities was transferred from the NPP operators to the BGZ (not yet for the Brunsbüttel storage facility, see below).

The storage of waste from reprocessing plants in Sellafield, Great Britain and La Hague, France, which is still to be returned to Germany, shall take place at four on-site storage facilities. On 29 September 2017 licence applications were filed by the operators of the on-site storage facilities Philippsburg, Biblis, Brokdorf, and Isar in this matter. On 19 December 2019 BASE issued the licenses for storage of up to seven Type B(U) transport and storage casks CASTOR® HAW28M with vitrified HAW from Sellafield at the storage facilities in Biblis, Isar and Philippsburg. Six transport and storage casks CASTOR® HAW28M with vitrified HAW from Sellafield arrived in Biblis on 4 November 2020. The other licensing procedures for the storage facility in Brokdorf are ongoing. The preliminary environmental impact assessment has already been completed for Philippsburg and Biblis.

The licence of the Brunsbüttel storage facility was revoked by the Federal Administrative Court in January 2015. The legal basis for the current storage of spent fuel at the Brunsbüttel storage facility is an unlimited, supervisory order from the competent authority of Schleswig-Holstein. In November 2015, the operator applied for a new licence for the facility. This licensing procedure is currently ongoing. For further information, see:

<https://www.base.bund.de/EN/nwm/interim-storage/decentralised/licence/kkb-en.html>

The Jülicher Entsorgungsgesellschaft für Nuklearanlagen mbH (JEN) operates a storage facility for spherical fuel elements from the former AVR experimental reactor in Jülich. The licence for the JEN storage facility was limited to June 2013. The licensing procedure for the storage of the fuel elements in Jülich for a short-term period is still ongoing. In 2016, a license was granted for the storage of these fuel elements in the TBL Ahaus. A license application for the transport of the fuel elements to Ahaus has been filed. For more information, see:

<https://www.base.bund.de/EN/nwm/interim-storage/decentralised/licence/kkj-en.html>

c) *Nuclear Fuel Fabrication and Reprocessing*

Currently, there are two front end Fuel Cycle Facilities in operation in Germany.

The Uranium Enrichment Plant is operated by Urenco Deutschland GmbH. It is located in Gronau in the north west of Germany. Natural uranium in form of uranium hexafluoride (UF₆) is enriched in centrifuge cascades to a maximum concentration of U-235 isotope of 6 percent by weight. The facility has a licenced capacity of 4500 tSW/a. The Fuel Fabrication Plant is operated by ANF Advanced Nuclear Fuels. It is located in Lingen in the north west of Germany and produces uranium fuel elements for major use in light water reactors with uranium-235 enriched up to 5 percent. The facility has a capacity for uranium conversion of 800 t/a.

The only German reprocessing plant in Karlsruhe (*Wiederaufarbeitungsanlage Karlsruhe – WAK*) is in decommissioning. The first decommissioning licence was granted in 1993. The 26th licence for decommissioning from 6 July 2018 includes the dismantling of equipment in the process cell of the Karlsruhe vitrification facility (VEK), belonging to the WAK decommissioning project. In 2021, the following three decommissioning license for the WAK were granted: The 27th license was granted on 4 March 2021, the 28th license on 1 June 2021, and the 29th license was granted on 14 October 2021. These licenses include additional amendments to dismantle the process building and support the entire dismantling of the WAK plant.

d) *Transports*

On 3 April 2018, a licensing application was submitted to BASE for the transport of waste from the reprocessing plant in La Hague, France, to the on-site storage facility in Philippsburg. Due to a change in the form of the waste to be returned to Germany in October 2022, this application was revised by the applicant. A licensing application for the transport of waste from Sellafield to the on-site storage facility Isar was submitted in November 2022. Both applications are currently being assessed by BASE.

As part of the dismantling of the NPPs, large surface contaminated components are planned to be shipped to external service companies for further dismantling. Two applications for associated transport licenses are currently being assessed by BASE: one application for the transport of four steam generators from the Unterweser nuclear power plant (KKU) to Sweden and one application for the transport of three lower parts of steam generators from Fessenheim in France via Germany, the Netherlands, and

Belgium to Sweden. BASE further expects to receive an application for the transport of two steam converters from the nuclear power plant in Lingen (KWL) to the USA and an application for the transport of another three lower parts of steam generators from Fessenheim in France to Sweden.