State and Development of Nuclear Energy Utilization in the Federal Republic of Germany 2008

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ZUSAMMENFASSUNG

Der vorliegende Bericht mit dem Stand 31.12.2008 gibt einen Überblick über die Nutzung der Kernenergie in der Bundesrepublik Deutschland. Im Bericht aufgeführt sind die wesentlichen Daten aller Kernkraftwerke, Forschungsreaktoren mit einer thermischen Dauerleistung größer als 50 kW_{th} und der Anlagen der Kernbrennstoffver- und -entsorgung. Zum Berichtszeitpunkt 31.12.2008 waren 17 Kernkraftwerksblöcke in Betrieb. Sie erbrachten mit einer Stromerzeugung von insgesamt 148,8 TWh (140,5 TWh in 2007) einen Anteil von 23,3 % (22,0 % in 2007) der allgemeinen Gesamt-Brutto-Stromerzeugung (einschließlich Einspeisungen)*. Für die Kernkraftwerke enthält der Bericht in zusammengefasster Form die wesentlichen Betriebsergebnisse und Hinweise auf die im Berichtsjahr erteilten atomrechtlichen Genehmigungen. Zu den abgeschalteten bzw. stillgelegten Kernkraftwerken sowie den eingestellten Vorhaben wird eine Kurzbeschreibung des gegenwärtigen Status gegeben. Für die Forschungsreaktoren mit einer thermischen Dauerleistung größer als 50 kW_{th} sind die wesentlichen Angaben zum Typ, den Kenndaten (thermische Leistung, thermischer Neutronenfluss) und dem Nutzungszweck der Anlage dargestellt. Des Weiteren wird ein Überblick über die Genehmigungs- und Betriebshistorie sowie den aktuellen Betriebszustand gegeben. Zu den Anlagen der Kernbrennstoffver- und -entsorgung werden Angaben zu Zweckbestimmung und Leistungsgröße gemacht. Dargestellt werden weiterhin die Genehmigungshistorie und der momentane Betriebs- und Genehmigungszustand. Die Informationen sind am Ende des Berichts zu einer Übersicht in Tabellenform zusammengefasst. Der Bericht wird jährlich in aktualisierter Form herausgegeben.

SUMMARY

This report describes the use of nuclear energy in the Federal Republic of Germany as of December, 2008. It contains the essential data of all nuclear power plants, research reactors with a continuous thermal power larger than 50 kW_{th} and the facilities of the nuclear fuel cycle. At the reporting moment 31st of December in 2008, 17 nuclear power plants were in operation. With 148,8 TWh (in 2007 - 140,5 TWh) altogether they provided 23,3 % (22,0 % in 2007) of the total gross electricity production (incl. electricity transfers)*. The report summarises the essential operational results of the nuclear power plants and information on granted licenses. A short description of the present state of the nuclear power plants that have been shut down or decommissioned and of the stopped projects is given. Concerning research reactors with a continuous thermal power larger than 50_{th} kW, essential data on type, characteristics (thermal power, thermal neutron flux) and purpose of the facility are represented. Furthermore, an overview about the licensing and operation history and the present state of the operating condition is given. For the facilities of the nuclear fuel cycle data on purpose and capacity, the licensing history and the present state of operation and licensing are given. To give a survey, the data are summarised in tabular form in the report annexes. The report will be updated and published once a year.

* vorläufige Schätzwerte Februar 2009/ preliminary estimated values as of February 2009;
Quelle / source: Bundesverband der Energie- und Wasserwirtschaft e.V. Federal Association of Energy and Water Economy e.V. (BDEW – former VDEW e.V.)

LIST OF ABBREVIATIONS

AG Energie-bilanzen	Consortium for energy statistics
AGO	Comparison of Options Working Group
ANF	Advanced Nuclear Fuel GmbH
AtG	Atomic Energy Act
AtVfV	Nuclear Licensing Procedure Ordinance
AVR	Jülich Experimental NPP
B	Berlin
BB	Brandenburg
BDEW	Federal Association of Energy and Water Economy e.V.
BER II	Berlin Experimental Reactor Unit II
BfS	Federal Office for Radiation Protection
BGR	Federal Institute for Geosciences and Natural Resources
BLG	Gorleben Fuel Element Storage Facility
BMBF	Federal Ministry of Education and Research
BMFT	Federal Ministry of Research and Technology
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BNFL	British Nuclear Fuels Ltd.
BStMLU	Bavarian State Ministry of State Development and the Environment
BStMUGV	Bavarian State Ministry of the Environment, Health and Consumer Protection
BVerwG	Federal Administrative Court
BW	Baden-Württemberg
BWR	Boiling Water Reactor (BWR)
BY	Bavaria
BZA	Ahaus Interim Storage Facility for Spent Fuel Elements
CASTOR®	Cask for Storage and Transport of Radioactive material
CDU	Christlich-Demokratische Union
CEA	Commissariat à l'Energie Atomique
CLAB	Central storage facility for spent fuel elements in France
COGEMA	Compagnie Générale des Matières Nucléaires
DBE	German Company for the Construction and Operation of Waste Repositories
DBG	Permanent operating licence
DIDO	Heavy-water Moderated and Cooled Research Reactor (derived from D_2O, the chemical formula of heavy water) in the Forschungszentrum Jülich GmbH
DKFZ	German Cancer Research Center
DL	Decommissioning Licence
DWK	German Company for the Reprocessing of Nuclear Fuels
EnBW	Energiewerke Baden-Württemberg AG
E.ON	E.ON Kernkraft GmbH
ERAM	Endlager für radioaktive Abfälle Morsleben, Morsleben Repository for Radioactive Waste
ERU	Enriched-Uranium (angereichertes Uran)
EWN	Energiewerke Nord GmbH
FBR	Sodium-cooled Fast Breeder Reactor
FDR	Advanced Pressurised Water Reactor
FMRB	Research and Measuring Reactor Braunschweig
FR 2	Research Reactor Karlsruhe Unit 2
FRF 1	Research Reactor Frankfurt Unit 1
FRF 2	Research Reactor Frankfurt Unit 1
FRG-1	Research Reactor Geesthacht Unit 1
FRG-2	Research Reactor Geesthacht Unit 2
FRH	Research Reactor of the Hannover Medical School
FRJ-1	Research Reactor Jülich Unit 1
FRJ-2	Research Reactor Jülich Unit 2
FRM	Research Reactor Munich
FRM-II	Munich High-flux Neutron Source in Garching Unit II
FRMZ	TRIGA Mark II Research Reactgor of the Mainz University
FRN	Research Reactor Neuherberg
FZJ	Forschungszentrum Jülich GmbH
FZK	Forschungszentrum Karlsruhe GmbH
GDR	German Democratic Republic
GKN 1	Neckarwestheim NPP Unit 1
GKN 2	Neckarwestheim NPP Unit 2
GKSS	Research Center Geesthacht
GNS	Gesellschaft für Nuklear Service mbH
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit mbH
GWh	Giga-Watt hour
HAW	High Active Waste
HAWC	High Active Waste-Concentrate
HDB	Central Decontamination Department of the Forschungszentrum Jülich GmbH
HE	Hesse
HEU	High Enriched Uranium
HKG	Hochtemperatur-Kernkraftwerk GmbH
HM	Heavy Metal
HMGU	Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH

HOBEG	Hochtemperatur-Brennelement Gesellschaft
HTR	High-temperature Gas-cooled Reactor
HWL	High-level Active Waste Storage Facility
KBR	Brokdorf NPP
KGR	Greifswald NPP
KKB	Brunsbüttel NPP
KKE	Emsland NPP
KKG	Grafenrheinfeld NPP
KKI 1	Isar NPP Unit 1
KKI 2	Isar NPP Unit 2
KKK	Krümmel NPP
KKN	Niederaichbach NPP
KKP 1	Philippsburg NPP Unit 1
KKP 2	Philippsburg NPP Unit 2
KKR	Rheinsberg NPP
KKS	Stade NPP
KKU	Unterweser NPP
KMK	Mülheim-Kärlich NPP
KNK II	Karlsruhe, Karlsruhe Sodium-cooled Reactor
KRB A	Gundremmingen NPP Unit A
KRB-II-B	Gundremmingen NPP Unit B
KRB-II-C	Gundremmingen NPP Unit C
KWB A	Biblis NPP Unit A
KWB B	Biblis NPP Unit B
KWG	Grohnde NPP
KWL	Lingen NPP
KWO	Obrigheim NPP
KWU	Siemens AG, Fachbereich Kraftwerk-Union
KWW	Würgassen NPP
LAGB	State Office for Geology and Mining of Saxony-Anhalt
LAVA	Facility for the Storage and Vaporisation of High-level Waste Liquids
LAW	Low Active Waste
LBEG	State Office for Mining, Energy and Geology in Hannover
LEU	Low Enriched Uranium
LWR	Light Water Reactor
MAW	Middle Active Waste
MERLIN	Medium Energy Research Light Water Moderated Industrial Nuclear Reactor in the Forschungszentrum Jülich GmbH (FZJ)
MEU	Medium Enriched Uranium
MLU	Saxony-Anhalt Ministry for Agriculture and the Environment
MOX	Mixed-oxide (fuel)
MTR	Materials Testing Reactor
MV	Mecklenburg-Western-Pomerania
MWe	Megawatt electrical power
MWd	Megawatt Day
MWh	Megawatt Hour
MWth	Megawatt Thermal Power
MZFR	Multipurpose Research Reactor Karlsruhe
NI	Lower-Saxony
NMU	Lower Saxony Ministry for the Environment and Climate Protection
NPP	Nuclear Power Plant
NRW	North Rhine-Westphalia
NUKEM	NUKEM GmbH Alzenau
OH	Otto Hahn
oHG	General Partnership
OVG	Higher Administrative Court
RDB	Reactor Pressure Vessel
PFB	Plan-approval Decision
RFR	Research Reactor Rossendorf
PKA	Pilot Conditioning Plant
RP	Rhineland-Palatinate
RR	Research Reactor
PTB	Federal Institute of Physics and Metrology
RWE	Rheinisch-Westfälische Elektrizitätsgesellschaft
PWR	Pressurised Water Reactor (PWR)
SAAS	Federal Office for Nuclear Safety and Radiation Protection (of the GDR)
SE	Safe Enclosure
SH	Schleswig-Holstein
SN	Saxony
ST	Saxony-Anhalt
SMUL	Saxony State Ministry for the Environment and Agriculture
SSR	Großwelzheim Superheated Steam Reactor
StrlSchV	Radiation Protection Ordinance
SZL	On-site Interim Storage Facility
TBL-A	Ahaus Transport Cask Storage Facility
TBL-G	Gorleben Transport Cask Storage Facility
THTR-300	Hamm-Uentrop Gas-cooled High-temperature Pebble Bed Reactor
TRIGA	Training Research Isotope General Atomics
TRIGA HD I	TRIGA HD I Research Reactor Heidelberg
TRIGA HD II	TRIGA HD II Research Reactor Heidelberg
TUM	Technische Universität München
TWh	Terawatt Hour
U-235	Uranium Isotope 235
UAG	Gronau Uranium Enrichment Plant
VAK	Kahl Experimental NPP
VDEW	Verband der Elektrizitätswirtschaft e.V., now BDEW e.V.
VEK	Karlsruhe Vitrification Facility
VKTA	Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V.
WAK	Karlsruhe Reprocessing Plant
WAW	Wackersdorf Reprocessing Plant

WWER	Water-cooled Water-moderated Energy Reactor (Russian Type PWR)
WWR-S (M)	Water-cooled water-moderated reactor of the Russian type, S stands for serial production and M for modification (RFR: Modifications of core and fuel)
w/o	English term for Weight Percent
ZAB	Greifswald Interim Storage Facility for Spent Fuel
ZLN	Interim Storage Facility North Rubenow

1. ELECTRICITY PRODUCTION FROM NUCLEAR ENERGY IN GERMANY

In 2008, altogether 636.5 TWh of electric energy were produced in the Federal Republic of Germany (gross electricity production including electricity transfers, BDEW February 2009). Nuclear power plants contributed approximately 23.3 % to the total gross electricity production, which corresponds to 148.8 TWh (2007 – 140.5 TWh). In comparison with electricity production from lignite, the share is, thus, about the same. Compared with the preceding year, the total gross electricity production in Germany slightly increased by approximately 1.7 TWh (cf. Table 1.1).

	2006		2007*		2008*	
	TWh	%	TWh	%	TWh	%
Nuclear energy	167.4	26.3	140.5	22.0	148.8	23.3
Lignite	151.1	23.7	155.1	24.3	150.0	23.5
Hard coal	137.9	21.7	142.0	22.3	128.5	20.1
Mineral oil	10.5	1.7	9.7	1.5	10.5	1.6
Natural gas	73.4	11.5	75.9	11.9	83.0	13.0
Water	26.8	4.2	28.1	4.4	27.0	4.2
Wind	30.7	4.8	39.7	6.2	40.2	6.3
Others (total)	39.1	6.1	46.4	7.3	51.1	8.0
TOTAL	636.8	100.0	637.4	100.0	639.1	100.0

* all figures relating to the years 2007 and 2008 are preliminary estimations
[Source: BDEW e.V. February 2009]

Table 1.1: Share of energy sources in the total gross electricity production in % incl. transfers

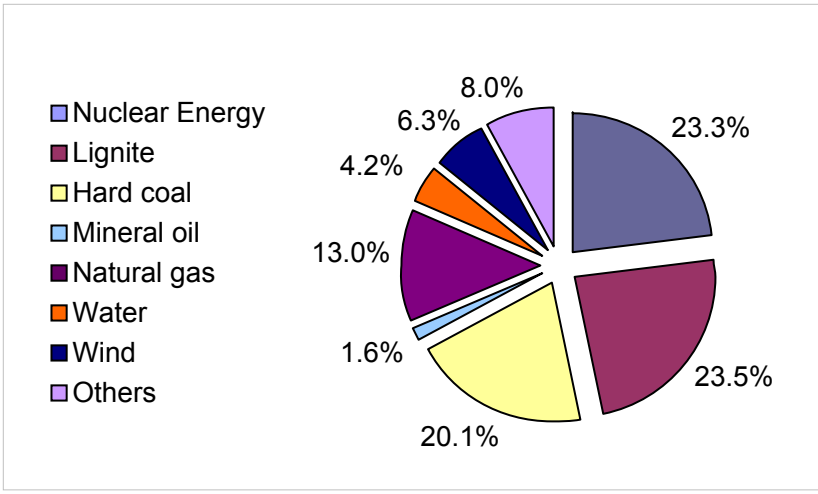


Figure 1: Total gross electricity production in 2008

The share of nuclear power plants in the total gross electricity production in the general (public) electricity supply (i. e. without private suppliers such as industry, railways etc.) amounted to 28.8 % in 2008 (26.7 % in 2007) [source: BDEW]. The share of nuclear energy in the total final energy consumption is estimated to have been approximately 5 % in 2007.

Renewable Energy

The increased utilisation of renewable energy is a component of the German climate protection strategy. According to an EU Directive, the share of renewables is to be increased to 12.5 % until 2010. In 2008, the share of the gross electricity production from renewable energy was approximately 14.6 % [source: BDEW]. Thus, the EU Directive for 2010 is complied with ahead of schedule. The federal government aims at achieving a portion of 25 % to 30 % by 2020. Today, wind energy, water power (regenerative contribution,

i. e. without pump storage plant), and biomass energy are the most essential renewables. Altogether, energy production from renewable energy such as wind, water, biomass, photovoltaics, and biogenic waste amounted to approximately 93.0 TWh in 2008 (87 TWh in 2007). Thus, compared with the preceding year, electricity production from regenerative energy increased by approx. 6 % year.

The installed capacity of the windmill-powered plants was increased by 1,610 MW to 23,900 MW. Despite of the larger number of wind power stations, electricity production from wind energy only slightly increased on account of there being less wind than in the preceding year. It amounted to 40.2 TWh (all data provided by BDEW).

	2006*		**2007***		**2008***	
	TWh	**%**	**TWh**	**%**	**TWh**	%
Water**	20.0	3.1	21.2	3.3	20.8	3.3
Wind	30.7	4.8	39.7	6.2	40.2	6.3
Solar	2.2	0.3	3.1	0.5	4.0	0.6
Biomass	15.5	2.4	19.4	3.0	23.0	3.6
Refuse**	3.7	0.6	4.5	0.7	5.0	0.8
TOTAL	72.1	11.2	87.9	13.7	93.0	14.6

***** all figures are preliminary values, part of them have been estimated [source: BDEW February 2009]

** only regenerative share (50 %)

Table 1.2: Share of renewable energy in the total gross electricity production in %

Phase-out of Electricity Production from Nuclear Energy

On 11 June, 2001, an agreement between the federal government and the largest utilities was signed concerning the phase-out of electricity production from nuclear energy. With the amendment to the Atomic Energy Act of April 2002, this agreement was implemented into law.

One central item of the amendment is that the authorisation for power operation of the existing electricity producing reactors expires when certain electricity volumes have been produced. The electricity volumes that can still be produced from 1 January 2000, (residual electricity volumes) have been laid down in Annex 3 column 2 to § 7 para. 1a Atomic Energy Act for every single nuclear power plant. In the provisions of this Annex it has also been set out that the electricity volume given for the Mülheim-Kärlich NPP can only be transferred to the NPPs Emsland, Neckarwestheim Unit 2, Isar Unit 2, Brokdorf, Gundremmingen Unit B and Unit C as well as Biblis Unit B. According to § 7 para. 1b AtG, it is possible to transfer electricity volumes from older plants to newer plants without consent given by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The other way around, this can only be done with the approval of BMU in consultation with the Federal Chancellery and the Federal Ministry of Economics and Technology.

The currently still pending administrative court action concerning the applications for approval of electricity production right transfers has made clear that BMU and licensees are of different opinions regarding the appropriate interpretation of the relevant regulations under nuclear law. For details click on http://www.bmu.de/atomenergie.sicherheit.

Since May 2002, the licencees of the German nuclear power plants report once a month the produced electricity volumes to the Federal Office for Radiation Protection (BfS) according to the provisions set out in § 7 para. 1c AtG.

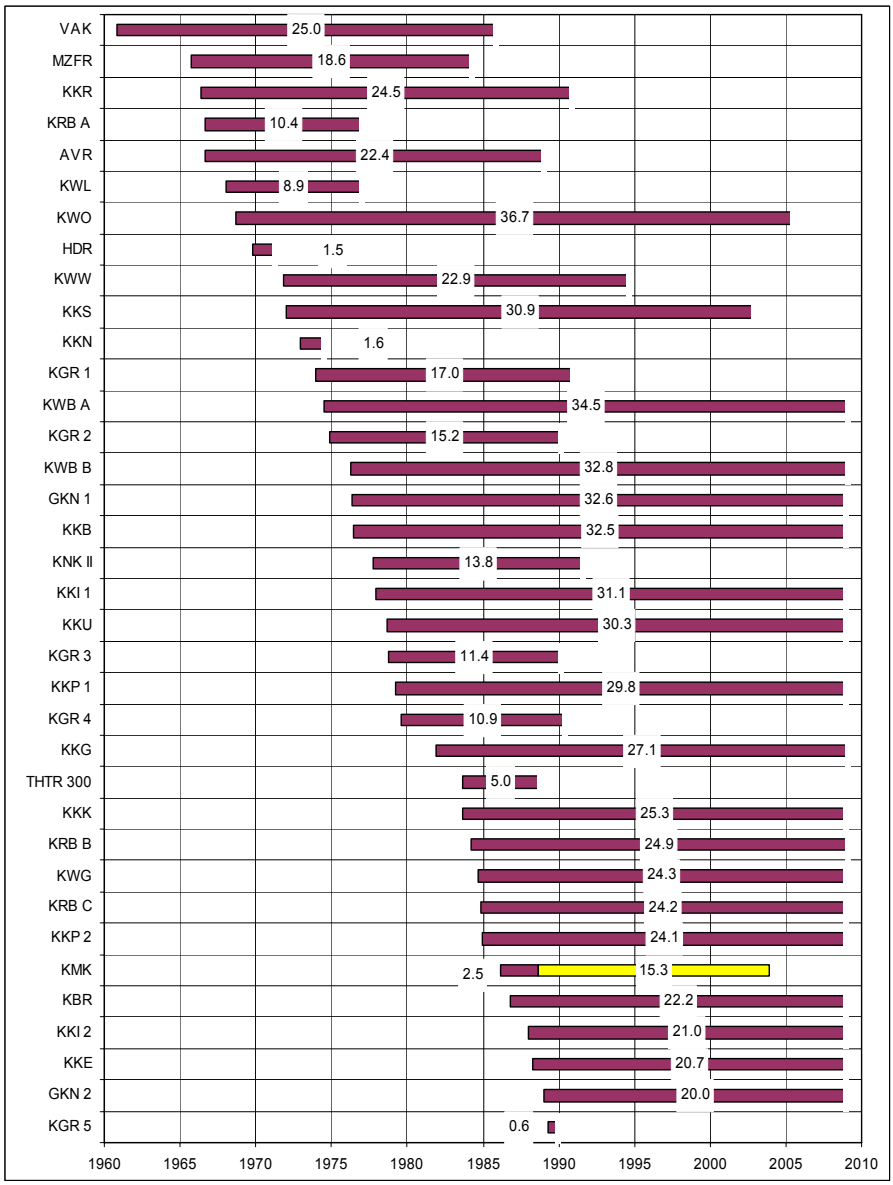
At least once a year, BfS announces the residual electricity volumes in the Bundesanzeiger (Federal Gazette). The BfS announcements can be found in the Bundesanzeiger or at the BfS website at http://www.bfs.de/kerntechnik/strommengen.html. Table 1.3 shows the published status as at 31 December 2008. Apart from the produced electricity volumes in the period under report 2008, it also provides data about the produced volumes in the preceding years 2006 and 2007 and the residual electricity volumes at the reference date 31 December 2008.[1]

[1] After editorial deadline: In its judgement of 26 March 2009 (ref.no. BVerwG 7C8.08 and 7C12.08) the Federal Administrative Court finally decided that the operators of the Brunsbüttel and Biblis Unit A NPPs were not entitled to the transfer of residual electricity volumes of the shut-down Mülheim-Kärlich NPP.

Electricity Volumes (GWh net) produced from 1 January 2000 to 31 December 2008 and Residual Electricity Volumes							
Nuclear Power Plant	Residual Electricity Volume as of 1 January 2000 (Annex 3 of the Atomic Energy Act)	Net Electricity Volume produced from 1 January 2000 to 31 December 2005	Net Electricity Volume produced in 2006	Net Electricity Volume produced in 2007	Net Electricity Volume produced in 2008***	Transfer of Electricity Volumes (Production Rights) until 2008	Residual Electricity Volumes as of 31 December 2008
Stade*	23,180.00	18,394.47					4,785.53
Obrigheim**	8,700.00	14,199.89				5,499.89	0.00
Biblis Unit A	62,000.00	41,323.71	6,995.31	0.00	8,472.13		5,208.85
Neckarwestheim Unit 1	57,350.00	36,206.37	6,182.17	4,713.53	3,786.95		6,460.98
Biblis Unit B	81,460.00	49,320.34	8,300.58	884.46	10,355.20		12,599.42
Brunsbüttel	47,670.00	28,215.08	5,967.39	2,487.86	0.00		10,999.67
Isar Unit 1	78,350.00	40,537.10	6,808.10	6,755.77	7,582.63		16,666.40
Unterweser	117,980.00	54,916.74	10,391.46	9,076.27	9,295.52		34,300.01
Philippsburg Unit 1	87,140.00	39,105.96	6,911.89	6,966.11	6,148.10	-5,499.89	22,508.05
Grafenrheinfeld	150,030.00	60,705.96	9,424.88	10,311.47	9,763.01		59,824.68
Krümmel	158,220.00	54,007.28	10,177.78	5,454.86	0.00		88,580.08
Gundremmingen Unit B	160,920.00	60,588.45	10,085.79	10,496.50	9,669.91		70,079.35
Philippsburg Unit 2	198,610.00	62,951.35	10,967.39	11,180.64	10,844.03		102,666.59
Grohnde	200,900.00	65,243.81	10,995.69	10,818.40	10,545.95		103,296.15
Gundremmingen Unit C	168,350.00	58,803.03	10,542.96	9,888.31	9,928.98		79,186.72
Brokdorf	217,880.00	66,893.48	11,201.33	11,425.65	11,450.40		116,909.14
Isar Unit 2	231,210.00	68,935.80	11,755.26	11,377.49	11,456.15		127,685.30
Emsland	230,070.00	66,109.45	11,147.60	10,989.22	10,896.15		130,927.58
Neckarwestheim Unit 2	236,040.00	62,537.41	10,877.47	10,411.09	10,702.15		141,511.88
Sum	2,516,060.00	948,995.68	158,733.05	133,237.63	140,897.26	5,499.89	1,134,196.38
Mülheim-Kärlich	107,250.00						107,250.00
Total	2,623,310.00						1,241,446.38

* The Stade NPP was shut down on 14 November 2003 and was decommissioned on 7 September 2005. A decision on the remaining residual electricity volume for KKS has not yet been made.
** The Obrigheim NPP was shut down on 11 May 2005 and was decommissioned on 28 August 2008.
*** The data in column 6 "Total 2008" contain the values checked by certified accountants according to § 7 para. 1a AtG.

Table 1.3: Produced electricity volumes (net) of the German nuclear power plants, transfer of production rights, and compilation of residual electricity volumes



Shortcuts used in the diagram:

VAK	Kahl Experimental NPP	KWB A	Biblis NPP Unit A	THTR	Hamm-Uentrop Gas-cooled High-temperature Pebble Bed Reactor
MZFR	Multipurpose Research Reactor Karlsruhe	KGR 2	Greifswald NPP Unit 2	KKK	Krümmel NPP
KKR	Rheinsberg NPP	KWB B	Biblis NPP Unit B	KRB B	Gundremmingen NPP Unit B
KRB A	Gundremmingen Unit A	GKN 1	Neckar NPP Unit 1	KWG	Grohnde NPP
AVR	Jülich Experimental NPP	KKB	Brunsbüttel NPP	KRB C	Gundremmingen NPP Unit C
KWL	Lingen NPP	KNK II	Karlsruhe Sodium-cooled Reactor	KKP 2	Philippsburg NPP Unit 1
KWO	Obrigheim NPP	KKI 1	Isar NPP Unit 1	KMK	Mülheim-Kärlich NPP
SSR	Großwelzheim Superheated Steam Reactor	KKU	Unterweser NPP	KBR	Brokdorf NPP
KWW	Würgassen NPP	KGR 3	Greifswald NPP Unit 3	KKI 2	Isar NPP Unit 2
KKS	Stade NPP	KKP 1	Philippsburg NPP Unit 1	KKE	Emsland NPP
KKN	Niederaichbach NPP	KGR 4	Greifswald NPP Unit 4	GKN 2	Neckar NPP Unit 2
KGR 1	Greifswald NPP Unit 1	KKG	Grafenrheinfeld NPP	KGR 5	Greifswald NPP Unit 5

Figure 2: Operating times of nuclear power plants in Germany since first criticality, as at 31 December 2008

2. NUCLEAR POWER PLANTS IN GERMANY

In the Federal Republic of Germany there are currently (as at 31 December 2008)

17 Nuclear power plants in operation

17 Nuclear power plant units under decommissioning or decommissioning was decided

2 Nuclear power plants entirely dismantled and released from regulatory control

6 Nuclear power plant projects that were stopped.

Status	PWR Number	PWR MWe (gross)	BWR Number	BWR MWe (gross)	Others Number	Others MWe (gross)	TOTAL Number	TOTAL MWe (gross)
In operation	11	14,763	6	6,734	—	—	17	21,497
Under decom-missioning, decom-missioning decided	10	4,658	4	1,188	3	344	17	6,190
Entirely dismantled	—	—	—	—	2	131	2	131
Project stopped	5	3,320	—	—	1	327	6	3,647

Table 2.1: Nuclear power plants in Germany in 2008

The individual NPPs are described in chapters 2.1 to 2.4 and in the corresponding tables in Annex I according to their operational status.

A survey of the sites of all NPPs in the Federal Republic of Germany is given in Figure I at the end of the report in Annex I.

2.1 NUCLEAR POWER PLANTS IN OPERATION

A list of the 17 nuclear power plants in operation with their essential features is given in Table 1.2.a in Annex I.

2.1.1 OPERATIONAL CHARACTERISTICS AND AVAILABILITY OF NUCLEAR POWER PLANTS

Compared with the preceding years, the nuclear power plant units operated in 2008 in Germany showed the following availabilities:

Year	Time availability [%]	Energy availability [%]	Capacity availability [%]
2008	80.0	77.9	74.9
2007	76.0	76.4	74.4
2006	91.1	90.8	89.1
2005	88.8	88.0	86.3

Source: Technische Vereinigung der Großkraftwerksbetreiber e.V. (VGB 2008)

Table 2.2: Average availabilities of nuclear power plants in %

In 2008, nuclear power plant availabilities were slightly above those of the preceding year. The Krümmel and Brunsbüttel NPPs were further shut down.

2.1.2 PLANT AND LICENSING STATUS OF THE NUCLEAR POWER PLANTS

In the following section a short description is given of the nuclear power plants in operation and the essential licences according to § 7 AtG – granted by the competent federal state authorities under nuclear law according to Table I.1 (Annex I) – are dealt with. Details on the electric and nuclear power of each NPP and their uprating are shown in Table 1.2.b in the Annex.

Neckarwestheim NPP Unit 1 (GKN 1) and Unit 2 (GKN 2)

The Neckarwestheim NPP Unit 1 is a pressurised water reactor (PWR) of the 2nd generation and was commissioned in 1976 with a capacity of 855 MWe. The current reactor output of 840 MWe results from a power decrease due to an exchange of condenser pipes in 1990.

The Neckarwestheim NPP Unit 2, a Convoy plant, is a PWR of the 4th generation and was commissioned in 1988 with a capacity of 1,316 MWe. The current reactor output of 1,400 MWe (from January 2007) results from several thermal and electric power changes.

On 25 April 2000, the operator filed applications according to § 7 AtG for thermal capacity increases for both plants. Further applications require licensing under nuclear law, concerning the improvement of electrical engineering, instrumentation and control and systems engineering, and the replacement of the reactor protection instrumentation and control by a digital system.

Commissioned in December 1988, the Neckarwestheim NPP Unit 2 is the youngest NPP operated in Germany. Similar to the Neckarwestheim NPP Unit 1, electricity is also produced for Deutsche Bahn AG in the Neckarwestheim NPP Unit 2, apart from electricity for the national grid.

In the year under report, a licence according to § 7 AtG for the construction and operation of a 5-storeyed agency staff building was granted for Neckarwestheim Unit 2 on 2 April 2008.

Philippsburg NPP Unit 1 (KKP 1) and Unit 2 (KKP 2)

The Philippsburg NPP Unit 1, together with the Isar NPP Unit 1, Brunsbüttel NPP and Krümmel NPP, belongs to the boiling water reactors (BWR) of design series 69 and was commissioned in 1979 with a capacity of 900 MWe. The current reactor output of 926 MWe is due to two electrical capacity increase measures.

The adjacent unit Philippsburg NPP Unit 2 is a PWR of the 3rd generation, a pre-Convoy plant. The plant was commissioned in 1984 with a capacity of 1,349 MWe. The current reactor output of 1458 MWe is due to several thermal and electrical capacity increase measures. In the process of the 2008 outage, an increase in efficiency was achieved by exchanging the high-pressure turbine. The electrical capacity that can now be achieved can only be measured at a receiving water temperature of 8 °C.

No licences under nuclear law were granted for either plant in the year under report.

Isar NPP Unit 1 (KKI 1) and Unit 2 (KKI 2)

The Isar NPP Unit 1 also belongs to the boiling water reactors (BWR) of design series 69 and was commissioned in 1977. On account of an electrical capacity increase, the current reactor output is now 912 MWe. Application for an increase in thermal reactor capacity to 2,704 MWth has been filed but is not further pursued by the operator.

Being one of the five dual-unit plants in the Federal Republic of Germany, there is a PWR of the fourth generation at the Isar NPP site, a Convoy plant which was commissioned as the first one of the three Convoy plants (Neckarwestheim 2, Emsland) in 1988 with a capacity of 1,370 MWe. The current reactor output of 1,475 MWe results from two thermal capacity increases and several electrical capacity increase measures.

No licences according to § 7 AtG were granted for either plant in the year under report.

Grafenrheinfeld NPP (KKG)

The Grafenrheinfeld NPP is a PWR of the 3rd generation (pre-Convoy plant) and was commissioned in 1981 with a capacity of 1,299 MWe. The current reactor output of 1,345 MWe is due to two electrical capacity increase measures. Application for an increase in thermal reactor capacity to 3,950 MWth has been filed to the licensing authority.

No licences according to § 7 AtG were granted in the year under report.

Gundremmingen NPP Unit B and Unit C (KRB-II-B and KRB-II-C)

Gundremmingen is a dual-unit plant with the two units KRB-II-B and KRB-II-C, which are of identical design. Each of them is a BWR of design series 72. Both units were commissioned in 1984, each of them with a capacity of 1,310 MWe. The current reactor output of 1,344 MWe results from two electrical capacity increase measures in either unit. With respect to electrical capacity, the Gundremmingen NPP is the largest German nuclear power plant. Application for an increase in thermal reactor capacity for both units to 4,000 MWth has been filed and is currently in the licensing procedure.

No licences according to § 7 AtG were granted for the Gundremmingen plant in the year under report.

Biblis NPP – Unit A (KWB A) and Unit B (KWB B)

The Biblis NPP Unit A is a PWR of the 2nd generation and was commissioned in 1974 with a capacity of 1,204 MWe. The current reactor output of 1,225 MWe results from the last electrical capacity increase measure carried out in 1995. The Biblis NPP was designed as a dual-unit plant with Unit B (PWR of the second generation, too, with currently 1,300 MWe due to two electrical capacity increases – commissioned in 1976).

Three licences according to § 7 AtG were granted for the Biblis NPP Unit A in the year under report. Subject matter of the licence granted on 20 August 2008 is the operation of the auxiliary programmer at boron concentrations < 2,550 ppm and at cooling boron concentrations ≥ C_{H-K} + 500 ppm. Furthermore, a licence was granted on 13 October 2008 for carrying out fuel element repairs in the storage rack of the fuel pool. The licence for the construction and operation of catalytic recombinators for hydrogen reduction was granted on 12 November 2008.

On 28 February 2008, Biblis Unit B was granted a licence under nuclear law for the conversion of the hydrogen gassing of the reactor coolant in the volume control surge tank.

Unterweser NPP (KKU)

The Unterweser NPP is a PWR of the 2nd generation. It was commissioned in 1978 with a capacity of 1,300 MWe. The current reactor output resulting from one thermal capacity increase and several electrical capacity increase measures is 1,410 MWe.

The exchange of the semi-gantry crane trolley UQ 11 was approved with licence of 22 October 2008.

Changes of the safety-related parameters for the core design and the exchange of the reactor protection have been applied for.

Grohnde NPP (KWG)

The Grohnde NPP is a PWR of the 3rd generation (pre-Convoy plant) and was commissioned in 1984 with a capacity of 1,365 MWe. The current reactor output of 1,430 MWe results from one thermal capacity increase and two electrical capacity increase measures.

For the Grohnde plant, applications were filed in the past years for the utilisation of uranium fuel elements with an initial enrichment of up to 4.4 weight percent uranium 235 and for increasing the thermal reactor capacity to 4,000 MWth. Furthermore, applications for the introduction of digital instrumentation and control systems in the area of neutron ex-core instrumentation are in the licensing procedure; the same applies to applications for the modification of safety-related parameters for the core design.

In 2008, no licences according to § 7 AtG were granted.

Emsland NPP (KKE)

The Emsland plant is a PWR of the 4th generation, one of three Convoy plants in the Federal Republic of Germany. It was commissioned in 1988 with a capacity of 1,316 MWe. The current reactor output of 1,400 MWe results from one thermal and several electrical capacity increase measures.

Application for an increase in thermal reactor capacity to 3,950 MWth has been filed and is currently in the licensing procedure.

No licences according to § 7 AtG were granted in the year under report.

Brokdorf NPP (KBR)

The Brokdorf NPP is a PWR of the 3rd generation (pre-Convoy). It was commissioned in 1986 with a capacity of 1,380 MWe. The current reactor output is 1,480 MWe, resulting from two thermal capacity increases and several electrical capacity increase measures. The last licence for increasing the thermal reactor power was granted on 23 May 2006. Thus, KBR is currently the plant with the largest electrical output in Germany.

On 30 April 2008, the 9th amended licence to the second partial operating licence for the Brokdorf NPP was granted. This licence comprises the detailed definition and extension of the primary (external) design criterion for the internal fuel rod pressure. The objective is to limit the internal excess pressure in the fuel rods which, thus, contributes to maintaining the fuel rods' integrity.

After the editorial deadline, the application for an increase in enrichment up to 4.45 weight-percent uranium 235 was decided on 19 February 2009 (10th amended licence).

Brunsbüttel NPP (KKB)

The Brunsbüttel NPP is the oldest BWR of design series 69 and was granted its first operation licence on 22 June 1976. The reactor output of 806 MWe has not been changed since it was commissioned.

In 2008, no licences according to § 7 AtG were granted for the Brunsbüttel NPP.

Krümmel NPP (KKK)

The Krümmel NPP is the BWR of the design series 69 with the largest electric capacity. It was commissioned in 1983 with a capacity of 1,316 MWe. The current reactor output of 1,402 MWe results from an improvement of the steam turbine's efficiency which was carried out in the major plant outage in 2005.

Running licensing procedures concern the use of mixed oxide fuel elements and the use of Svea 96 Optima (3) fuel elements.

In 2008, no nuclear licences according to § 7 AtG were granted for Krümmel.

2.2 NUCLEAR POWER PLANTS UNDER DECOMMISSIONING OR DECOMMISSIONING WAS DECIDED

In Germany there are currently 17 nuclear power plant units under decommissioning or decommissioning was decided (cf. Table I.3). Two of them are in the phase of safe enclosure, the others are being dismantled with the objective of entire dismantling ("greenfield").

Rheinsberg NPP (KKR)

The Rheinsberg NPP with a capacity of 70 MWe (WWER reactor type) was commissioned in 1966. It served to independently develop reactors in the GDR. The produced electric energy was fed into the state grid. After 24 years of operation, the plant was finally shut down in 1990. Since 9 May 2001, all nuclear fuel has been removed from the site, the fuel elements were delivered to the Interim Storage Facility North (ZLN). It is planned to entirely dismantle the plant. The first decommissioning licence was granted on 28 April 1995. Decommissioning work is carried out step by step with the relevant licences. With the licence granted on 23 July 2007 "Entire dismantling of the undissected reactor pressure vessel and transport provision" and the transport licence granted by BfS on 2 October 2007, the transport of the reactor pressure vessel to the Interim Storage Facility North could be successfully carried out on 30 October 2007.

Due to the activity inventory reduction resulting from the removal of the reactor pressure vessel, a licence for a modification of the security concept was granted on 15 December 2008. Among others, it comprises the "Security concept following the removal of the reactor pressure vessel" and the dismantling of security installations no longer required.

Karlsruhe Sodium-cooled Reactor (KNK II)

The Karlsruhe Sodium-cooled Reactor served to develop the breeder technology. The plant contained a 21-MWe sodium-cooled fast-breeder reactor and was commissioned in 1977. After the test programme was completed, the reactor was finally shut down on 23 August 1991.

The decommissioning concept provides for a dismantling of the plant in 10 steps eight of which have already been carried out. The 1st licence for the decommissioning of the plant was granted on 26 August 1993. Since 26 May 1994, the plant has been free of nuclear fuel, which was transported to Cadarache (F). In the 9th dismantling step the dismantling of the core tank and the biological shield was licenced. In 2008, the dissection of the core tank and its installations could be concluded. By remote-control, the dissected components were loaded into shielded transport casks and delivered to the Hauptabteilung Dekontaminationsbetriebe (HDB) of the Forschungszentrum Karlsruhe GmbH for further processing and storage. In the year under report, one also dealt with dissecting the sodium cold trap which was licensed in 2007.

After the plant has been released from the scope of the AtG, it is intended to conventionally dismantle the remaining buildings and to recultivate the premises. The objective is to conclude the work by 2013.

Karlsruhe Multipurpose Research Reactor (MZFR)

The Karlsruhe Multipurpose Reactor with a 57 MWe heavy-water cooled pressure vessel reactor was operated from 1965 until 1984. Due to the combined heat and power generation, it also served for the heat supply of the Forschungszentrum Karlsruhe, apart from electricity production. After it had been finally shut down, it was decided to immediately and entirely dismantle the plant. The spent fuel elements were reprocessed in the Karlsruhe Reprocessing Plant (WAK). Since then, dismantling has been carried out separately in several steps, each of them requiring nuclear licensing (partial decommissioning licences).

The works on the 7th decommissioning step – dismantling and dissection of the reactor pressure vessel and its installations as well as packaging of the dismantled components – were concluded in 2008. With the 8th decommissioning licence of 31 January 2007, all nuclear licences are available for the entire dismantling of the plant. Preparatory measures to dismantle the biological shield were started.

The measures will probably be concluded in 2013.

Obrigheim NPP (KWO)

The Obrigheim NPP, a PWR with a capacity of 357 MWe (gross) went critical for the first time on 22 September 1968, and started up its power operation in 1969. After 36 years of operation, the KWO was finally shut down on 11 May 2005, since the licence for power operation according to § 7 para. 1a AtG had expired.

Dismantling is to be carried out in altogether three independent licensing steps. The nuclear fuel was removed from the core. The fuel elements that were still in the internal fuel pool were brought into the external wet storage facility in the emergency building. Since March 2007, all fuel elements have been removed from the internal fuel pool. Dry storage in CASTOR casks is planned and was applied for at BfS according to § 6 AtG on 22 April 2005.

The first decommissioning licence (DL) on the final and permanent shut-down of operation was granted on 28 August 2008. Two steam generators that had already been dismantled in 1983 and stored on the premises of the Obrigheim NPP were transported by waterway to Lubmin with the objective of being decontaminated and dissected. On 1 December 2008, application was filed to amend the 1st DL. Among others, this application concerns the exchange of the material lock of the reactor building. On 15 December 2008, an application was filed to amend the 2nd DL, which, apart from an adjustment of the licensing procedure, also provides for the dismantling of components in the control area and of further components in the monitored area.

Gundremmingen NPP Unit A (KRB A)

The Gundremmingen Unit A plant (BWR) was commissioned in August 1966 with a capacity of 250 MWe. Characteristic of this plant was a water-steam separating and steam-drying plant in the reactor which was used for the first time in a BWR. After an incident in 1977, the operator decided in 1980 to not repair the plant but to shut it down finally for economic reasons. The last fuel elements were removed from the plant by 1989 and subsequently reprocessed. The licence according to § 7 para. 3 AtG for the decommissioning of the plant was granted on 26 May 1983, followed by an entire dismantling in individual phases on the basis of the existing nuclear licences.

In 2008, dismantling works continued to focus on decontaminating the reactor building.

After dismantling work has been completed, it is planned to use the remaining structures as a technology centre for the site. They are to serve for decontamination and waste treatment purposes for the two still running units KRB-II-B and KRB-II-C. The relevant nuclear licence was granted on 5 January 2006.

Kahl Experimental NPP (VAK)

The Kahl Experimental NPP with a 16 MWe BWR was the first nuclear power plant for electrical energy production in Germany. It was commissioned in 1960. In 1985, the plant was shut down since, according to statements made by the operator, all planned scientific and operational tests had been concluded.

The first partial decommissioning licence was granted with notification of 5 May 1988. The fuel elements were removed from the plant by 1989 and transported to the Karlsruhe Reprocessing Plant (WAK) for reprocessing. Spent MOX fuel elements that could not be reprocessed in the WAK were transported to the Central Storage Facility for Spent Fuel Elements (CLAB) in Sweden for storage and disposal. This was done in exchange of the reprocessing of Swedish uranium fuel elements in France (COGEMA) and it was based on an agreement between the utilities, COGEMA, and Sweden for the transport of Swedish fuel elements to COGEMA.

In the year under report, works to decontaminate the reactor building and to release the soil area around the plant from regulatory control were carried out. After the plant has entirely been released from regulatory control, the buildings are to be conventionally dismantled with the objective of the site being a “greenfield”.

Decommissioning works will probably be completed in 2010.

Greifswald NPP (KGR)

The construction of the Greifswald NPP (PWR) traces back to a decision made in 1955 by the GDR government to use nuclear energy for electrical energy production. Of the 8 PWR units of the Russian WWER type (Reactor W-230 and W-213) with 440 MWe each, Unit 1 was commissioned in 1973. Units 2 to 4 were commissioned in 1974, 1977, and 1979, respectively. Units 1 to 4 were shut down in 1990 on the basis of a safety assessment made by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and the Federal Office for Nuclear Safety and Radiation Protection (SAAS) of the GDR. It was furthermore decided to

decommission Unit 5, too, which went critical for the first time in 1989 and whose commissioning was stopped by SAAS, the regulatory authority at that time. Due to the dual-unit construction, Unit 5 is connected to Unit 6. All six units are to be dismantled without a longer period of prior safe enclosure. Units 6 to 8 were still under construction at that time (cf. Chapter 2.4).

Since 22 May 2006, there is no more nuclear fuel in the Greifswald NPP.

The first decommissioning licence according to § 7 para. 3 AtG for the decommissioning of the entire plant and for the dismantling of plant components was granted on 30 June 1995. Subject matter of the 35th modification licence granted on 16 August 2007 and of the 1st modification licence to the 4th partial licence to the aforementioned decommissioning licence is, among others, the modification of the waste management strategy for the dismantling of the reactor components of KGR Units 1 to 4. According to this concept, shielded large components can be intermediately stored in an undissected state in the Interim Storage Facility North (ZLN). The reactor pressure vessels of Units 1 and 2 were delivered to the ZLN in November 2007.

The 36th modification licence granted on 7 May 2008 relating to the licence of 30 June 1995 and the 20th licence relating to the dismantling of plant components include, among others, further dismantling of plants and components in the control and monitored area.

On 22 August 2008, EWN GmbH was given notice within the scope of a notice of assessment that the turbine house of Unit 3/4 and a part of the turbine house of Unit 5 were no longer subject to the provisions of the Atomic Energy Act. However, only the building area above the bottom of the new ground slab of the Unit 3/4 turbine house was released from the scope of the Atomic Energy Act.

The dismantling of the residual plant will probably be concluded in 2012.

Stade NPP (KKS)

The Stade NPP, a PWR with a capacity of 672 MWe, was in operation from 1972 to 2003. The plant was finally shut down on 14 November 2003. With letter of 23 July 2001, the operator E.ON filed an application for decommissioning and dismantling of the plant according to § 7 para. 3 AtG. Direct dismantling of the plant was applied for.

At the end of April 2005, the fuel elements were transported to France for reprocessing.

The first licence for decommissioning and dismantling of the KKS according to § 7 para. 3 AtG was granted on 7 September 2005. It provides for the necessary provisions concerning the treatment, conditioning and storage of the material arising in the process of dismantling (waste and residual materials concept), for release, dismantling phase 1 and for the construction of the storage facility for radioactive waste (LarA). The second licence granted on 15 February 2006 permits the dismantling of large components (steam generator) and the necessary modification of the lock. In September 2007, the dismounted steam generators were shipped to Studsvik Nuclear Dept. Radwaste AB, Sweden, for further treatment.

According to licence notice I/2008 dated 14 May 2008 dismantling of phase 3 part A was permitted. Among others, it includes the dismantling of the reactor pressure vessel lid, reactor internals, the biological shield as well as other systems and components.

Lingen NPP (KWL)

The Lingen plant, a BWR with a capacity of 252 MWe, was commissioned in 1968. After 9 years of power operation, the plant was shut down in January 1977 on account of steam-to-steam heat exchangers being damaged, so new ones could be installed. In the process of the major plant outage, further damage became apparent, so that the licensing authority required additional comprehensive improvement measures before approving the plant's new commissioning. However, those improvement measures were so expensive that the operator decided in March 1979 to decommission the nuclear part and to use the available steam turbine with a natural gas fired high-temperature gas turbine that had still to be installed. On the basis of the licence of 21 November 1985 the plant has been operated in safe enclosure since 1988. Prior to safe enclosure the fuel elements were transported to Sellafield (GB). The safe enclosure is monitored by the adjacent Emsland NPP (KKE).

In December 2007, Kernkraftwerk Lingen GmbH withdrew the application of 21 December 2004 for continuation of safe enclosure. On 15 December 2008, the operator filed an application according to § 7 para. 3 AtG for the dismantling of the plant. In the first licensing step initially applied for, all non-contaminated and contaminated plant components are to be dismantled. A second licensing step to be applied for later on

is to include the dismantling of the reactor pressure vessel with its installations, the biological shield, the residual dismantling, decontamination, and the plant's release from nuclear regulatory control.

Furthermore, on 26 September 2008, the licence was granted for dismantling the existing chimney which is in need of rehabilitation above a height of 10 m and for building a 60-m high exhaust air chimney.

Jülich Experimental NPP (AVR)

The Jülich Experimental NPP was an experimental reactor exclusively developed in Germany. It was commissioned in 1966 with a 15 MWE pebble bed high-temperature reactor (HTR) and served the development (which had started in Germany) of this reactor type with ball-shaped graphite fuel elements (in which there were uranium and thorium containing coated particles). It was finally shut down at the end of 1988 when, with the decommissioning of the prototype reactor THTR-300 (308 MWe) in Hamm-Uentrop, the further development of this technology was no longer pursued in Germany either. On 9 March 1994, the licence for the decommissioning, unloading of the reactor core, dismantling of plant components, and safe enclosure was granted. The unloading of the ball-shaped fuel elements into the central interim storage facility at the site of the Forschungszentrum Jülich GmbH was completed in June 1998.

For some years, the operator has dealt with a concept modification – direct dismantling instead of safe enclosure. With letter of 25 February 2005, updated through letter of 25 April 2006 and put into more concrete terms and supplemented by letter of 20 June 2008, AVR GmbH filed an application according to § 7 para. 3 AtG for entirely dismantling the reactor and releasing the premises from regulatory control. The licensing procedure has made good progress. On 4 November 2008, the reactor vessel was backfilled with pore lightweight concrete within the scope of a 5th modification licence of 9 November 2004. It is planned to lift the backfilled reactor vessel in two years and to bring it in an undissected state to a near-site interim storage facility on the premises of the Forschungszentrum Jülich GmbH.

Würgassen NPP (KWW)

The Würgassen NPP, a boiling water reactor with a capacity of 670 MWe, was in operation from 1971 to 1994. Since cracks were found at the core shroud of the reactor during a scheduled major plant outage in 1994, the former operator PreussenElektra decided to finally shut down the plant. Since October 1996, the plant has been free of nuclear fuel. The fuel elements were delivered to La Hague (F) for reprocessing.

The first decommissioning licence was granted on 14 April 1997. Three further decommissioning licences for the plant have been granted since that time.

In the period under report, dismantling within the scope of decommissioning the KWW was continued on the basis of the aforementioned decommissioning licences. It is planned to release the building from regulatory control by 2014. Within the scope of the site concept it is currently being considered to demolish the buildings. Two interim storage facility buildings for low-level and intermediate-level radioactive waste will remain until a repository can accept the waste.

Hamm-Uentrop Gas-cooled High-temperature Pebble Bed Reactor (THTR-300)

The Hamm-Uentrop THTR-300 with a helium-cooled 308 MWe pebble-bed high-temperature reactor was commissioned in 1983. In September 1989, the final decommissioning of the plant was decided after it had been shut down on 29 September 1988 for the scheduled annual outage. On 13 November 1989, the federal government, the Federal State of Northrhine-Westphalia, the HKG operating company and its partners signed a framework agreement concerning the completion of the THTR-300 project. The first partial licence for the decommissioning, reloading of the reactor core, and the dismantling of plant components was granted on 22 October 1993. Since then the ball-shaped fuel elements have been removed from the reactor core and delivered in CASTOR® casks to the Ahaus fuel element interim storage facility (BZA). The reactor core has been unloaded since 1995. On 21 May 1997, the licence for the operation of safe enclosure (maintenance operation) was granted. Since October 1997, the plant has been in safe enclosure which is to cover a period of approximately 30 years.

Mülheim-Kärlich NPP (KMK)

The Mülheim-Kärlich NPP, a PWR with a capacity of 1,302 MWe was commissioned in 1986. After the Federal Administrative Court had withdrawn the first partial licence it was shut down on 9 September 1988.

With letter dated 21 June 2001, RWE Power AG withdrew the applications according to § 7 AtG for granting the first partial licence for the construction and operation of the KMK – to the extent they had not been notified – and of the partial licence (continuous operation). All spent fuel elements were removed from the

NPP and delivered to La Hague (F) for reprocessing. New fuel elements intended for the reloading of the reactor were given back to the manufacturer in Belgium. The plant has, thus, been free of nuclear fuel since 29 July 2002.

It is intended to dismantle the KMK in three independent steps. Step 1 includes the final decommissioning of the plant. In the second step, among others, the reactor coolant system equipment is to be dismantled. Step 3 provides for, among others, the release of the buildings and the premises from regulatory control. The demolition of the released buildings is then to take place according to building law provisions.

On 16 July 2004, the licence for dismantling phase 1a was granted. Thus, the plant went into residual operation. For further dismantling, several auxiliary systems (among others exhaust air) can be adapted to the new requirements. The modification licence to licence 1a granted on 23 February 2006 permits the dismantling of all facilities shut down during phase 1a in the controlled area, if the record of proper waste management covers the waste arising in this process. With it all plant components no more required for residual operation can be dismantled. Exceptions to this are the primary coolant circuit, handling devices, and the biological shield. With letter of 8 May 2008, RWE Power applied for suspension of the licensing procedure for the on-site interim storage facility and the treatment centre until further notice. In 2008, dismantling works focussed on the decommissioning and dismantling of plant components in the reactor building annulus. Some buildings could be entirely cleared.

The total dismantling of the Mülheim-Kärlich plant will take approximately 10 years.

2.3 NUCLEAR POWER PLANTS ENTIRELY DISMANTLED AND RELEASED FROM REGULATORY CONTROL

Großwelzheim Superheated Steam Reactor (HDR)

As prototype and experimental plant, the Großwelzheim Superheated Steam Reactor with a capacity of 25 MWe served to develop this reactor design series and was commissioned in 1969. After only 1.5 years of operation, the plant was finally shut down in 1971 because of deformations at the cladding tubes of the novel superheat fuel elements. The spent fuel elements were reprocessed in the WAK. From 1974 to 1991, the reactor building and the installed systems were used for the performance of non-nuclear investigations of nuclear power plant behaviour in case of severe accidents (such as earthquakes). The decommissioning of the reactor was licensed on 16 February 1983. The plant was entirely dismantled.

In the middle of May 1998 the plant could be released from regulatory control. The residual conventional dismantling work was completed by mid October 1998.

Niederaichbach NPP (KKN)

The Niederaichbach NPP was a prototype NPP with a capacity of 106 MWe. It is characterised by the use of natural uranium and a heavy-water moderated pressure tube reactor with CO_2 gas cooling. By using the pressure tube system thick-walled pressure vessels normally required for LWR reactors should be avoided. The objective was to be able to use reactors of nearly any building size.

On 11 December 1972, the commissioning licence was granted. On 17 December 1972, the reactor went critical for the first time. Technical problems and the then already established light-water reactor design series contributed to the owner’s decision to finally shut down the reactor. The development of this reactor type was, thus, stopped. Decommissioning of the KKN was decided with the shut-down on 31 July 1974. Thus, the nuclear power plant was in operation for 18.3 full-load days. On 21 October 1975, the licence for establishing safe enclosure of the plant and, on 20 October 1981, the licence for “safe enclosure” was granted. The fuel elements were delivered to the CEA (Commissariat à l’Energie Atomique). The entire dismantling of the plant was licensed on 6 June 1986. On 17 August 1995, the decommissioning of the KKN was completed and the NPP was released from regulatory control. The KKN was the first nuclear power plant in the world with a capacity worth mentioning whose decommissioning was completed by handing over the site as "greenfield". Thus, for the first time in Germany, the feasibility of both the technical implementation of a complete removal and of the associated nuclear licensing procedure could be demonstrated.

2.4 STOPPED NUCLEAR POWER PLANT PROJECTS

Greifswald NPP (KGR) Units 6 to 8

Dismantling of the already constructed facilities has already made great progress.
Unit 6 is used as technical exhibition to demonstrate reactor technology at visiting tours. The engine house of Units 5 to 8 was entirely cleared and it is planned to use it industrially afterwards (cf. chapter 2.2). Non-contaminated equipment of Units 7 and 8 were transported to Unit 5 and dissected there, thus testing tools and equipment for the remote-controlled dissecting of reactor components. The tested tools and equipment are used for the dismantling of all reactor pressure vessels in Units 1 to 4.

Kalkar Sodium-cooled Fast Breeder Reactor (SNR 300)

The SNR 300 with a 327 MWe sodium-cooled fast-breeder reactor was constructed from 1973 to 1991, largely completed and commissioning was prepared. Before the already fabricated fuel elements were loaded, it was decided in 1991 to not commission the plant. The erected systems were then dismantled, scrapped or sold. On 1 April 1996, the ownership of the site was transferred to Kern-Wasser-Wunderland Freizeitpark GmbH and the site has since been used commercially. The fuel elements were at first kept in government custody by BfS and were later delivered to France for reprocessing (cf. Chapter 4.4.2).

Stendal NPP

In 1974, the Stendal construction site was opened with the objective of erecting four 440 MWe units of the Russian WWER type. In 1976, it was decided to construct Units A and B (PWR with 1,000 MWe each) in the Stendal NPP. Construction and installation work which had started in 1976 was finally stopped in 1990 after several years of delay. Part of the buildings and of the equipment was dismantled or has been used otherwise.

3. RESEARCH REACTORS WITH A CONTINUOUS THERMAL POWER ABOVE 50 KW

In Germany, altogether 17 research reactors with a continuous thermal power above 50 kW have to be considered of which currently (as at 31 December 2008).

4 research reactors are in operation

8 research reactors are under decommissioning or decommissioning was decided, and

5 research reactors have entirely been dismantled and released from regulatory control.

The operational and licensing state of these research reactors is described in chapters 3.1, 3.2 and 3.3, and in the relevant Tables II.1, II.2, and II.3 in Annex II – Research Reactors. A survey of still existing sites is given in Figure II.

3.1 RESEARCH REACTORS IN OPERATION

In Germany, altogether four research reactors with a continuous thermal power above 50 kW were still in operation at the end of 2008.

Berlin Experimental Reactor Unit II (BER II)

The BER II is a pool reactor with fuel elements of the MTR type. The thermal power is 10 MW and the thermal neutron flux is $1.5 \cdot 10^{14}$ 1/cm^2·s. The reactor was commissioned on 9 December 1973. Its main purpose is pure and applied basic research with beam pipe experiments and the generation of radioactive isotopes.

From 1985 to 1989, the plant was comprehensively expanded by doubling the thermal power from originally 5 MW to 10 MW and increasing the thermal neutron flux to $1.5 \cdot 10^{14}$ 1/cm^2·s, which is nearly the ten-fold. To reduce the proliferation risk, the operation of the BER II with fuel elements of low-enriched uranium (LEU) and mixed loadings with fuel elements of high-enriched uranium (HEU) and LEU was licensed on 14 June 1994. Following a number of mixed loadings a pure LEU core was built up for the first time and commissioned on 7 February 2000.

At the end of 2004, the entire operational instrumentation and control of the BER II was renewed and upgraded to digital technology after this had been permitted by the nuclear regulatory authority. After shortly four months of structural alteration works, the reactor was re-commissioned in January 2005.

Munich High-flux Neutron Source in Garching Unit II (FRM-II)

The FRM-II is the newest commissioned research reactor in Germany, a light-water cooled pool reactor with a compact core where high-enriched uranium (HEU) is used as fuel and heavy water as moderator. According to an obligation of the operating licence (3rd partial licence of 2 May 2003), the reactor core must be converted from HEU to fuel with a reduced enrichment level of 50 % uranium 235 (MEU) at maximum, which has to be done by 31 December 2010. With a thermal neutron flux of $8 \cdot 10^{14}$ 1/cm^2·s the plant – having a comparatively low thermal power of 20 MW – is the most intensive German neutron source for beam pipe experiments and irradiations for scientific, industrial, and medical purposes.

The first two partial licences for the construction of the plant were granted on 4 April 1996 and 9 October 1997 by the BStMLU as competent licensing authority. Nuclear commissioning and the operation of the plant are part of the 3rd partial licence granted on 2 May 2003.

The reactor went critical for the first time on 2 March 2004. Subsequent to a comprehensive programme to commission the plant and after the regulatory authority had given its permission; routine operation of the plant was taken up on 25 April 2005.

In 2008, the nuclear supervisory authority approved of an increase in the maximum uranium-235 burnup from originally 1,040 MWd to 1,200 MWd. Thus, an operation cycle can be extended from 52 full-load days up to 60 full-load days.

TRIGA Mark II Research Reactor of the Mainz University (FRMZ)

The Research Reactor of the Mainz University is an open pool reactor of the TRIGA Mark II type. It is a light-water cooled and moderated reactor with homogeneous fuel moderator elements of LEU and zirconium hydride. Nuclear commissioning was on 3 August 1965. In continuous operation the thermal power is 100 kW and the thermal neutron flux is $4 \cdot 10^{12}$ 1/cm^2·s. Additionally, the reactor can be operated in pulsed operation above 30 ms with a power peak of 250 MW and a thermal neutron flux of $8 \cdot 10^{15}$ 1/cm^2·s. The plant is operated for basic research in nuclear physics and, on account of the high neutron flux density which can be managed in pulsed operation for short periods of time, is especially suitable for examining short-lived radionuclides with fast pneumatic delivery systems.

On the basis of a licence of 28 July 1992, a comprehensive modification of the reactor systems was carried out.

Research Reactor Geesthacht Unit 1 (FRG-1)

The FRG-1 is an open pool reactor of the MTR type with a thermal power of 5 MW and a maximum thermal neutron flux of $1.4 \cdot 10^{14}$ 1/cm^2·s. It was commissioned with HEU on 23 October 1958 and is mainly used for material research with beam pipe experiments and isotope production and for carrying out neutron activation analyses.

From 1963, the FRG-1 was operated with the new FRG-2 reactor in a joint reactor hall but with different pools. Due to a joint operation licence of 6 September 1967, both reactors must be regarded as one reactor facility under licensing aspects. That also applies after the licence for taking the reactor out of operation and partial decommissioning of the FRG-2 was granted on 17 January 1995 (cf. chapter 3.2).

During the more than 40 years of operation the FRG-1 was continuously upgraded. February 1991 was the first time in Germany when a modification from HEU to LEU was carried out at a German research reactor on the basis of a modification licence dated 4 May 1988. Apart from reducing the proliferation risk, it was possible to increase the thermal neutron flux by using fuels of significantly higher density. With licence of 8 March 2000, the nuclear fuel was further densified and a 3x4 compact core with twelve fuel elements was set up. To prevent the core from falling dry in case of a leakage in the reactor coolant system, watertight partitions were built into the radioactive basement below the pools (licence of 21 May 2001). In 2003 and 2004, a new emergency power facility was installed with licence of 5 March 2002, and commissioned at the beginning of 2005.

On account of new structures in neutron research in Germany and even if it realizes state of a modern technology, it is intended to finally shut down the FRG-1 in 2010.

3.2 RESEARCH REACTORS UNDER DECOMMISSIONING OR DECOMMISSIONING WAS DECIDED

At the end of 2008, seven research reactors with a continuous thermal power above 50 kW were being decommissioned in Germany or it had been decided to decommission them.

Karlsruhe Research Reactor Unit 2 (FR 2)

The FR 2 was a closed tank reactor operated with low-enriched uranium (2 %) and moderated and cooled by heavy water. It was the first nuclear reactor facility which was developed and built according to a German concept. With 44 MW it was the German research reactor with the highest performance with respect to thermal power. With a thermal neutron flux of $1.0 \cdot 10^{14}$ 1/cm^2·s the FR 2 was used as neutron source for beam pipe experiments for basic research and for irradiation tests in fuel rod development and for isotope production for medical purposes.

Nuclear commissioning of the reactor with natural uranium was on 7 March 1961. To increase the original thermal neutron flux of $3.9 \cdot 10^{13}$ 1/cm^2·s to $1 \cdot 10^{14}$ 1/cm^2·s, the facility was retrofitted in 1966 to be operated with fuel elements with low-enriched uranium (2 %). The maximum thermal power of the reactor was thus increased from 12 MW to 44 MW (licence of 26 January 1966).

After 20 years of operation, the plant was finally shut down on 21 December 1981 for economic reasons. By 22 October 1982, the fuel elements were delivered to WAK for reprocessing. The first of several partial licences for decommissioning, partial dismantling, and safe enclosure for at least thirty years was granted on 3 July 1986. Since 20 November 1996, the reactor block as the remaining part of the facility has been in safe

enclosure. Since 1997, the reactor hall has been used for a permanent exhibition about the history of nuclear engineering.

Research Reactor Munich (FRM)

The FRM was a pool reactor of the American type with a thermal power of 4 MW and a thermal neutron flux of $7 \cdot 10^{13}$ 1/cm^2·s. As the first reactor in Germany the plant was commissioned on 31 October 1957. The purpose of the reactor was to provide neutrons for beam pipe experiments and irradiations, such as the generation of radioisotopes, the proof of trace elements, and tumour therapy.

In 1957, the plant was commissioned with LEU and a thermal power of 1 MW. However, already in 1960 it was changed over to using HEU. In the years of operation the thermal neutron flux was gradually increased from originally $1 \cdot 10^{13}$ 1/cm^2·s to $7 \cdot 10^{13}$ 1/cm^2·s by increasing the thermal power to 2.5 MW in 1966 and to 4 MW in 1968 (operation licences of 27 October 1966 and 10 May 1968). Furthermore, a beryllium reflector was installed in 1982. Since 1991, the core has been operated as mixed core and gradually changed over from HEU to MEU.

On 14 December 1998, the Technische Universität München (TUM) applied for the plant's decommissioning in order to use it later on – following another procedural step – as supporting system to the new Munich High-flux Neutron source in Garching (FRM-II, cf. Chapter 3.1). On 28 July 2000, the reactor was finally shut down, on 3 June 2002, the still existing 47 fuel elements were delivered to the USA. After the FRM-II has meanwhile taken up routine operation, the TUM submitted further documents relating to its application for being granted a decommissioning licence for the FRM, which are currently being examined by the competent licensing authority.

Research Reactor Neuherberg (FRN)

The FRN was a pool reactor of the TRIGA Mark III type with homogeneous fuel moderator elements of LEU and zirconium hydride. In continuous operation the thermal power was 1 MW and the thermal neutron flux was $3 \cdot 10^{13}$ 1/cm^2·s. In pulsed operation, the reactor could be operated for short periods of time above 10 ms with power peaks of up to 2000 MW. The facility was commissioned on 23 August 1972 and was used for isotope production in medico-biological research.

On 16 December 1982, the reactor was finally shut down. Within the scope of the operation licence the fuel elements were removed and disposed of in the USA. The decommissioning licence of 30 May 1983 comprised the decommissioning of the facility and the dismantling of plant components as well as effecting safe enclosure of the shielding block with the former reactor pool. With a separate licence notice dated 24 May 1984 it was permitted that the facility will continue to be in safe enclosure.

Research and Measuring Reactor Braunschweig (FMRB)

The FMRB was a light-water cooled and moderated pool reactor with two separate fission product zones of HEU which were neutronically coupled via a 400-l heavy-water tank. The reactor went critical for the first time on 3 October 1967. The thermal power was 1 MW and the thermal neutron flux was $6 \cdot 10^{12}$ 1/cm^2·s. The Federal Institute of Physics and Metrology (PTB) used the facility as neutron source for irradiations and beam pipe experiments, in particular in the area of neutron metrology and dosimetry and of condensed matter physics.

The reactor was taken out of operation on 19 December 1995, for economic reasons. On 28 August 1996, the residual fuel elements were delivered to the USA for disposal. On 2 March 2001, the decommissioning licence for the plant was granted. Dismantling of the facility was completed in mid 2004. The radioactive waste and residues accrued during the operation and dismantling of the facility were conditioned and, by May 2005, delivered to the interim storage facility that was erected in rooms of the FMRB for this particular purpose and which continues to be subject to nuclear supervision. The reactor building and other building areas and surfaces were gradually released from regulatory control by 28 July 2005 and can now be used by PTB for other purposes without restrictions.

Research Reactor Jülich Unit 2 (FRJ-2)

The FRJ-2 (DIDO, derived from D_2O) was a heavy-water cooled and moderated closed tank reactor of the English type and was operated with HEU. With a thermal power of 23 MW and a thermal neutron flux of $2 \cdot 10^{14}$/1/cm^2·s, the plant was used for beam pipe experiments and irradiations for isotope production and neutron activation analysis.

Nuclear commissioning of the plant was on 14 November 1962. In 1967, a first capacity increase from 10 MW to 15 MW (licence of 11 December 1967) was carried out by utilising available reserves, in 1972 a

second capacity increase was carried out to 23 MW by taking uprating and improvement measures (licence of 15 March 1972). Between November 1990 and April 1995, the reactor was taken out of operation to repair damage and to carry out backfitting measures. The regulatory authority permitted the plant's re-commissioning in February 1995.

On 2 May 2006, the FRJ-2 was finally shut down. It is currently in the post-operational phase. Within the scope of the operation licence the spent fuel elements were transported to the USA in 2008 for disposal. An application for decommissioning and dismantling the reactor facility was filed on 27 April 2007. On 15 December 2008 a revised application was filed. To continue scientific work the Forschungszentrum Jülich GmbH (FZJ) installed an outstation at the new FRM-II research reactor (cf. Chapter 3.1).

Research Reactor Geesthacht Unit 2 (FRG-2)

Just as the FRG-1 (Chapter 3.1) the FRG-2 was an open pool reactor of the MTR type, the thermal power was 15 MW and the maximum thermal neutron flux was $1.5 \cdot 10^{14}$ 1/cm^2·s. It was commissioned on 16 March 1963 as material test reactor and used for the further development of nuclear power plant components and reactor safety.

The FRG-2 was operated with the FRG-1 reactor in a joint reactor hall but with different pools. Since a new joint operation licence dated 6 September 1967 came into effect, both reactors must be regarded as one reactor facility under licensing aspects (cf. Chapter 3.1).

With the aforementioned notification of 6 September 1967, another licence was granted for the increase of the FRG-2's thermal power from 5 MW to 15 MW. During its thirty years of operation, the reactor was continuously operated with HEU; the application of the operator Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt mbH (GKSS) of 25 September 1986 for the conversion of the facility from HEU operation to LEU operation was not approved by the licensing authority.

Since orders for material testing through irradiation had decreased, GKSS, in consultation with BMFT and the industry, filed an application on 28 January 1993 for taking the FRG-2 out of operation and for a partial dismantling of the reactor. The licence was granted on 17 January 1995. Since on the basis of the operation licence of 6 September 1967 the FRG-2 and the FRG-1 are regarded as a joint reactor facility under the aspect of licensing and since the provisions of § 7 para. 3 AtG do not provide for a decommissioning of plant components, the shut-down and partial dismantling of the FRG-2 must legally be considered as a modification of the operation of the entire facility according to § 7 para. 1 AtG. The fuel elements were at first intermediately stored in the joint fuel pool and were disposed of in the USA by 20 September 2000. The formal decommissioning and final dismantling of the FRG-2 will later on be carried out together with the dismantling of the FRG-1 which will probably be shut down in 2010 within the scope of decommissioning the entire facility according to § 7 para. 3 AtG.

Research Reactor Rossendorf (RFR)

The RFR was a light-water moderated and cooled tank reactor of the Russian WWR-S(M) type. The thermal power was at last 10 MW and the thermal neutron flux was $1.2 \cdot 10^{14}$ 1/cm^2·s. Basically, the facility served as neutron source for isotope production, activation analyses, material research, and additionally for training purposes in the GDR nuclear energy programme.

The reactor was commissioned on 16 December 1957, with LEU and a thermal power of 2 MW, which was gradually increased to 10 MW by 1967, among others through a conversion from LEU operation to MEU operation. From 1987 to 1989, the RFR was extensively reconstructed, e. g. by exchanging the reactor vessel, improving the emergency cooling and the cooling circuits.

The operation of the reactor was permitted through temporary licences, the last licence was renewed on 8 October 1990 until 30 June 1991, by the then competent nuclear authority GEL (Gemeinsame Einrichtung der Länder Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt und Thüringen). The application of the operator of 5 March 1991 for a permanent operation licence was dismissed. On 27 June 1991, the reactor was finally shut down. After it had taken over competency as new nuclear authority, the Saxonian State Ministry for the Environment and Agriculture (SMUL) decreed according to § 19 para. 3 AtG on 28 June 1991 to discontinue the facility's operation, which was geared to nuclear fission.

From 30 January 1998, several partial licences for the decommissioning of the plant were granted. With the concluding 4th partial licence of 1 February 2005, the dismantling of the residual facility was granted. Related works were discontinued for two years for lack of budgetary funds and were only resumed in 2007. In 2008, works on the dismantling of the biological shield were carried out. It is intended to conclude dismantling by 2011 with the objective of "greenfield".

Between 30 May 2005 and 13 June 2005, the spent fuel elements were transported to the Ahaus Transport Cask Storage Facility in altogether 18 CASTOR® casks. On 18 December 2006, approximately 300 kg of unirradiated nuclear fuel of LEU and MEU were transported to Russia which had been the country of origin. This was done within the scope of a return programme agreed between the USA, Russia, and IAEA (RRRFR – Russian Research Reactor Fuel Return).

3.3 RESEARCH REACTORS ENTIRELY DISMANTLED AND RELEASED FROM REGULATORY CONTROL

In Germany, altogether six research reactors with a continuous thermal power above 50 kW have been entirely dismantled and released from regulatory control.

TRIGA HD I Research Reactor Heidelberg (TRIGA HD I)

The TRIGA HD I was a pool reactor of the TRIGA Mark I type with homogeneous fuel moderator elements of LEU and zirconium hydride. The thermal power of the reactor was 250 kW, the thermal neutron flux was 10^{13} 1/cm^2·s. The plant was commissioned on 26 August 1966 as irradiation source for nuclear-medical applications.

On account of a second research reactor (TRIGA HD II, see below) being built in the German Cancer Research Center in Heidelberg (DKFZ), the reactor was finally shut down on 31 March 1977. The fuel elements were transported to the new reactor facility for further use. The licence for decommissioning the facility was granted on 30 June 1980 and comprised the dismantling of the components and the safe enclosure of the reactor tank and the biological shield, which was effected on 11 December 1980. Since it is now intended to dismantle the building, the DKFZ filed an application for dismantling of the residual facility on 25 April 2003, which was approved on 16 January 2006. The dismantling of the facility and the clearance of the building structure were carried out in the first half of 2006. On 13 December 2006, the facility was released from regulatory control. It is intended to conventionally dismantle the building within the clearance procedure in 2009.

TRIGA HD II Research Reactor Heidelberg (TRIGA HD II)

Just as the TRIGA HD I (see above) the TRIGA HD II was a pool reactor of the TRIGA Mark I type with homogeneous fuel moderator elements of LEU and zirconium hydride. The thermal power of the reactor was also 250 kW, the thermal neutron flux was 10^{13} 1/cm^2·s. The reactor went critical for the first time on 28 February 1978 and was used for neutron activation analyses and for the production of short-lived radionuclides for medical purposes in cancer research.

Since isotope production had been taken over by an accelerator of the DKFZ and it had to be expected that there was no longer a need for the reactor to be working full capacity, the facility was shut down on 30 November 1999. On 1 June 2001, the fuel elements were delivered to the USA for disposal. On 13 September 2004, a licence according to § 7 para. 3 AtG for the decommissioning and entire dismantling of the research reactor was granted. The facility was entirely dismantled in 2005 and released from regulatory control on 13 December 2006.

Research Reactor Frankfurt Unit 2 (FR 2)

The FRF 2 was a light-water cooled and moderated reactor of the modified TRIGA type with homogeneous fuel moderator elements of LEU and zirconium hydride. The reactor was installed in the remaining buildings (reactor hall and reactor block) of the dismantled predecessor reactor FRF 1 on the basis of the construction licence of 10 January 1973. From 10 January 1958 to 19 March 1968, the FRF 1 was operated as a homogeneous fuel solution reactor of the L54 type with a thermal power of 50 kW. It was intended to use the new FRF 2 as neutron source for basic research in nuclear physics as well as in solid-state physics and for activation analyses and isotope production. The designed thermal power was 1 MW and the designed thermal neutron flux was $3 \cdot 10^{13}$ 1/cm^2·s. According to a decision of the Hessian Ministry of Culture of 11 July 1980, an operation licence was not granted and one abstained from the nuclear commissioning of the reactor, which was ready for use.

On 25 October 1982, the licence for the decommissioning of the FRF 2 and for the dismantling of plant components was granted. The reactor fuel elements that had not been used were delivered to a foreign research reactor facility (TRIGA MARK II in Ljubljana) in 1981. The residual activity in the facility resulted exclusively from the former operation of the FRF 1 and, after parts of the facility had been dismantled, was in

a state of safe enclosure. After the reactor building had meanwhile been used as interim storage facility for low-level radioactive waste produced by the Frankfurt University, the dismantling of the residual structures of the FRF – consisting of FRF 1 and FRF 2 – was licensed on 28 December 2004. On 31 October 2006, the facility was released from regulatory control after the activated concrete structures had been dismantled and the remaining building structures and the facility site had been cleared.

Research Reactor of the Hannover Medical School (FRH)

The FRH was a pool reactor of the TRIGA Mark I type with homogeneous fuel moderator elements of LEU and zirconium hydride. The thermal power of the reactor was 250 kW, the thermal neutron flux was $8.5 \cdot 10^{12}$ 1/cm^2·s. Nuclear commissioning of the reactor was on 31 January 1973. The use as neutron source mainly included neutron activation analysis and the production and activation of short-lived radionuclides for medico-biological applications.

Due to changed production processes for radiopharmaceuticals and a decreasing demand for using the reactor, it was finally shut down on 18 December 1996. On 9 July 1999, the fuel elements were delivered to the USA for disposal. On 22 February 2002, an application for the decommissioning and dismantling of plant components was filed and approved on 8 May 2006. The dismantling of the facility and the clearance measurements were completed by August 2007. The regulatory supervision of the facility as defined in § 19 AtG was terminated on 13 March 2008.

Research Reactor Jülich Unit 1 (FRJ-1)

The FRJ-1 (MERLIN, Medium Energy Research Light Water Moderated Industrial Nuclear Reactor) was a pool reactor of the English type operated with HEU with fuel elements of the MTR type. The thermal power was at last 10 MW and the thermal neutron flux was $1.1 \cdot 10^{14}$ 1/cm^2·s. The reactor was commissioned on 23 February 1962 and was used for irradiations and beam pipe experiments.

In 1971, the plant was comprehensively converted for an incease in neutron flux from $6 \bullet 10^{13}$ 1/cm^2·s to the last available level of $1.1 \cdot 10^{14}$ 1/cm^2·s. Among others, this concerned the use of new fuel elements with higher uranium 235 mass and modifications in the primary and secondary cycle for afterheat removal of the thermal power that had been doubled from 5 MW to 10 MW (licence notices of 3 June 1971 and 15 September 1971).

On 22 March 1985, the FRJ-1 was shut down. According to the operation licence, the fuel elements were removed from the facility and transported to the USA and Great Britain by October 1992. The licence for the decommissioning of the plant was granted on 8 June 1995. Dismantling of the plant was carried out gradually on the basis of further partial licences and supplementary notices. At last, the decontamination of the reactor hall and reactor hall fittings and the establishment of the prerequisites for clearance and release from regulatory control were approved with licence of 29 November 2004. These works were completed in 2007 and the plant was released from regulatory control on 23 November 2007. The reactor hall and reactor hall fittings were then dismantled conventionally, so that in the course of 2008 the state of “greenfield” could be achieved.

Nuclear Ship "Otto Hahn" (OH)

The „Otto Hahn“ was the only nuclear ship operated in Germany and was formally classified as research reactor. A “Progressive Pressurised Water Reactor (PWR)” with low-enriched uranium dioxide with a maximum enrichment of 5.42 % of uranium 235 and a thermal power of 38 MW was used as drive source.

The principal task of the “Otto Hahn” was to gain operational experience for nuclear-powered ships for civil use. The “Otto Hahn” was commissioned as nuclear ship on 11 October 1968, and was taken out of operation ten years later on 22 March 1979. By autumn 1979, the fuel elements were delivered to the WAK for reprocessing.

On 1 December 1980, a licence was granted for the decommissioning of the "Otto Hahn” according to § 7 AtG in connection §§ 3 and 4 of the Radiation Protection Ordinance (old version). After the reactor had been dismounted, the ship was decontaminated and cleared and, on 1 September 1982, released from regulatory control.

4. PLANTS OF NUCLEAR FUEL SUPPLY AND WASTE MANAGEMENT

Annex III includes essential data and information on nuclear fuel supply and waste management in the form of tables, figures, and enclosures. Figure 3 shows a survey map of the nuclear fuel supply and waste management sites.

4.1 URANIUM ENRICHMENT PLANTS

Gronau Uranium Enrichment Plant (UAG)

In the Gronau uranium enrichment plant (cf. Table III.1), natural uranium in the form of uranium hexafluoride (UF_6) is enriched in centrifuge cascades to the point of a maximum concentration of the fissile U-235 isotope of 6 percent by weight (w/o).

The plant was commissioned in mid August 1985 with 400 t of uranium separative work per year (SW/a). Capacity has gradually been increased to currently 1,800 t SW/a.

An application for extending the production capacity to 4,500 t SW/a was filed in September 1998. The licence was granted on 14 February 2005. It includes the construction and operation of a second uranium separating plant with a separation capacity of up to 2,700 t SW/a with a maximum enrichment of 6 w/o. The licence also includes the storage of 58,962 Mg of depleted uranium in oxidic form and 38,100 Mg as UF_6 of 10,000 Mg of natural uranium (feed) as UF_6 and 1,250 Mg of enriched uranium (product) with a maximum enrichment of 6 w/o U-235 as UF_6. The expanded plant has been constructed since mid 2008 and will be gradually commissioned.

4.2 FUEL ELEMENT FABRICATION PLANTS

In Germany, the following fuel element fabrication plants have been in operation, decommissioned, dismantled, and released from regulatory control (cf. Tables III.2; III.3):

ANF Fuel Element Fabrication Plant, Lingen

In the ANF Fuel Element Fabrication Plant, uranium fuel elements with a maximum fraction of 5 percent by weight (w/o) U-235 are produced for major use in light-water reactors. UO_2 powder, UF_6, or externally produced UO_2 pellets are used as basic materials.

Fuel element fabrication started in January 1979 with externally produced uranium pellets. In March 1987, the production of up to 400 Mg of UO_2 pellets annually was licensed with the 5th partial operation licence (start of production in 1988). The operation of dry conversion with up to 5 w/o U-235 of enriched uranium started in June 1994 (7^{th} partial operation licence). In June 1996, a second fuel rod production line and a storage and handling building for UO_2 pellets and powder were licensed. The licence for the processing of additional 250 Mg annually of externally produced uranium pellets to fuel elements was granted in March 1997. Also in March 2002, an increase of the annual uranium powder processing from 400 Mg to 500 Mg and in January 2005 to 650 Mg/y of uranium was licensed.

Siemens Fuel Element Fabrication Plant Hanau, Plant Section MOX-Processing

Since 1968, the plant has served to produce mixed-oxide fuel elements on the basis of UO_2 (PuO_2, PuO_2 or UO_2 fuel, mainly for light-water reactors.

Since the Hessian Environmental Ministry issued a decree according to § 19 AtG, the plant stopped operation in summer 1991 after an incident involving contamination had occurred. In April 1994, the operator decided to not re-commission the old plant, but to run a clean-out programme.

On 7 May 1996, Siemens AG filed an application for a licence to clean up the MOX facility. The project was discussed in a public hearing in October 1996. In September and November 1997 and on 28 January 1998, partial licences were granted to process the nuclear fuels in the MOX facility in such a way that they were storable and transportable.

The licensing procedure for the dismantling of the Siemens MOX facility was discussed in a public hearing in March 2000 in Hanau, the dismounting of the first production facilities was licensed in December 2007. The

first partial licence for the dismantling of the cleaned out facilities was granted in May 2001, the second partial licence in March 2003, and the third partial licence on 3 January 2005. According to the latter licence, some buildings and parts of the open-air ground can already be used conventionally. The fourth and concluding partial licence was granted on 16 March 2005.

In December 2005, the residual nuclear fuel was removed from the areas in the nuclear fuel storage facility used by the Federal Office for Radiation Protection for the execution of government custody according to § 5 AtG. At the end of December 2005, BfS committed the storage facility areas free of contamination to the nuclear responsibility of Siemens for further dismantling.

Dismantling work was concluded in July 2006 and the MOX processing plant section was released from regulatory control in September 2006.

The dismantling of the non-contaminated new facility which had to be carried out separately was licensed on 7 December 1998. The building which was designed against air crashes was emptied and is available for other use.

There are, thus, no restrictions to using the facility premises otherwise.

Siemens Fuel Element Fabrication Plant Hanau, Plant Section Uranium Processing

Since 1969, the plant served to produce uranium fuel elements with a maximum fraction of 5 percent by weight (w/o) of U-235 for major use in light-water reactors. UF_6 was used as base material.

On account of unfavourable overall boundary conditions at the Siemens site the production of uranium fuel elements was discontinued in October 1995. To prepare decommissioning, several single licences for the dismantling of plant components and for the removal of nuclear fuel were granted from 1996 to 1998. From 1998 to March 2001, three partial licences and several single licences for subsequent decommissioning were granted.

The finally approved decommissioning procedure included the dismantling of the production buildings and the remediation of the premises on the basis of the 10 µSv concept. (That means that it is justifiable to release the materials, the objects or the facility from radiation protection supervision if the release leads to radiation exposures that are in the order of 10 µSv per calendar year for individuals.) After the controlled areas had been closed and the buildings dismantled one started remediating the premises. Since uranium had entered the soil and the groundwater as a result of the facility operation, it had also become necessary to remediate the soil, the existing sewers, and the groundwater. After remediation work could be successfully concluded in January 2006, the facility was released from regulatory control in May 2006. Merely a groundwater remediation which had become necessary for chemico-toxic reasons and which is in the responsibility of the competent authority under water right is still continuing. The operation of the groundwater treatment plant was licensed according to § 7 StrlSchV.

Siemens Fuel Element Fabrication Plant, Plant Section Karlstein

Since 1966, the plant served to produce special fuel elements made of uranium oxide with a fraction of maximum 4 percent by weight (w/o) of U-235.

Within the scope of the decommissioning decision for the Siemens plant sections in Hanau the comparatively small plant in Karlstein was closed, too. The removal of all radioactive operational equipment was concluded. The Siemens Fuel Element Fabrication Plant, Plant Section Karlstein, was released from regulatory control in March 1999. The released buildings have been used for the conventional fabrication of structural parts.

NUKEM Fuel Element Fabrication Plant, Hanau

Since 1962, NUKEM produced special fuel elements for research reactors of uranium and thorium up to an enrichment degree of 94 percent by weight (w/o) for U-235.

On 23 December 1988, NUKEM filed an application for decommissioning the entire NUKEM plant. The licence for the decommissioning was granted on 10 March 1993. Further licences were granted for the dismantling of the non-safety relevant plant components.

The dismantling of the stationary production facility, soil remediation or decontamination and remediation of buildings which were to be used otherwise, was discussed in a public hearing in November 1997. The licence for the dismantling of the building and the remediation of the premises was granted on 19 October 2000.

It had turned out that the so-called “Monostahalle” located on the Degussa premises (outside the ring fence of the NUKEM-A premises), which was meanwhile used again by Degussa, had to be included in the decommissioning procedure. Therefore, two additional licences for the dismantling of this complex of buildings was applied for and granted on 9 November 1999 and on 26 June 2001.

All buildings inside the ring fence have meanwhile been dismantled. In May 2006, the remediation of the soil was concluded and the entire premises, with the exception of 1000 m^2 used for groundwater remediation, were released from regulatory control. Groundwater remediation will probably continue for some years.

Hochtemperatur-Brennelement Gesellschaft (HOBEG)

From 1972 to 1988, the facility of Hochtemperaturreaktor Brennelement GmbH (HOBEG) located on the Hanau premises was operated to produce ball-shaped fuel elements for high-temperature reactors. The capacity was up to 200,000 fuel elements per year. Altogether approximately 1 million fuel elements were fabricated. The facility which had been licensed according to § 9 AtG on 30 December 1974 was temporarily taken out of operation on 15 January 1988, and was decommissioned later on.

Between 30 January 1990 and 7 April 1995, altogether six licences for the decommissioning of the facility were granted. The components relating to process engineering were dismantled and their major part was sold. The buildings and the surrounding terrain were decontaminated. Following relevant measurements, the remaining buildings and the associated terrain were cleared and released from regulatory control on 18 December 1995. Today, the terrain and the buildings are used by Nuclear Cargo & Service GmbH.

4.3 STORAGE OF SPENT FUEL ELEMENTS IN CENTRAL AND DECENTRALISED INTERIM STORAGE FACILITIES

4.3.1 STORAGE OF SPENT FUEL ELEMENTS IN THE NUCLEAR POWER PLANTS

Spent fuel elements are at first stored in the nuclear power plants in the wet storage pools of the reactor facility and then in interim storage facilities near the site (cf. Table III.5).

In accordance with requirements imposed in the licences for the nuclear power plants, basically at least a capacity of one core load must be kept free in the wet storage pools to ensure that the reactor core can be entirely unloaded at any time. In general, the internal storage capacities cannot be used by several nuclear power plants. Exceptions were approved for the double unit facilities of Neckarwestheim and Philippsburg.

For the Obrigheim NPP the operation of an already constructed additional wet storage facility in the earthquake-protected emergency building outside the reactor building was licensed in 1998. The first fuel elements were stored here in 1999 (cf. Chapter 4.3.2).

4.3.2 DECENTRALISED ON-SITE INTERIM STORAGE FACILITIES

Table III.5 gives a survey of the decentralised on-site interim storage facilities in Germany.

AVR – Jülich Cask Storage Facility

The AVR cask storage facility is a dry storage facility for spent ball-shaped fuel elements originating from the AVR Jülich in transport and storage casks of the CASTOR®THTR/AVR type.

The cask storage facility is located in a partial area of waste storage hall II in the Department of Decontamination of the Forschungszentrum Jülich GmbH.

The nuclear licence for the storage of spent AVR ball-shaped fuel elements was granted on 17 June 1993 for a period of 20 years. It comprises the storage of maximum 300,000 fuel element balls in maximum 158 casks.

On 7 July 2005, the modification licence for the storage of the last 2,400 fuel element balls was granted.

Storage operations started on 23 August 1993. At the end of 2008, there were altogether 149 loaded casks of the CASTOR®THTR/AVR type in the AVR cask storage facility.

As possibly further interim storage in the AVR cask storage facility beyond 30 June 2013 will be required, a prolongation of the granted storage licence was applied for on 26 June 2007 by way of precaution.

Interim Storage Facility in the Obrigheim NPP

Based on licences dating from 1979 to 1983, Kernkraftwerk Obrigheim GmbH constructed an interim storage facility for spent fuel elements of the KWO. It is a wet storage facility for 980 fuel elements (approx. 286 t of HM) which was erected in the emergency building by 1984.

The operation licence of this storage facility comprises the storage of 980 fuel elements and of core components exclusively from the KWO. It was granted according to § 7 AtG on 26 October 1998.

Emplacement of fuel elements started mid 1999. On 31 December 2007, altogether 342 fuel elements were in the wet storage facility. On 22 April 2005, BfS was submitted an application by Kernkraftwerk Obrigheim GmbH for storage of the spent fuel elements in a dry storage facility (cf. the following section "On-site interim storage facilities").

On-site Interim Storage Facility

From 1998 to 2000, applications for the storage of nuclear fuel in the form of spent fuel elements in on-site interim storage facilities (SZL) were filed for altogether 13 sites by the NPP operators. The application for an on-site interim storage facility in Stade was withdrawn after one had decided to decommission the NPP.

The Federal Office for Radiation Protection (BfS) is the competent authority for granting licences according to § 6 AtG. Apart from the nuclear licence for the storage of nuclear fuel, the construction of the building especially requires a building licence according to the building regulations of the relevant federal state. On the basis of the European Directive 97/11/EC and the Law on the Environmental Impact Assessment, the licensing procedures relating to the applications of 1999 were accompanied by a joint Environmental Impact Assessment (EIA). Possible effects of the respective projects on man, animals, plants and their habitat, and on soil, water, air, and climate were examined.

After the terrorist attacks of 11 September 2001, the Federal Office for Radiation Protection also examined the effects of a targeted air crash on the on-site interim storage facilities applied for within the scope of the licensing procedures. For the licensed on-site interim storage facilities the examinations carried out by BfS came to the result that in case of a targeted air crash the lives and health of the population and the environment would not be jeopardised by the release of considerable amounts of radioactive substances and that it would not be necessary to take drastic disaster control measures.

The on-site interim storage facilities are dry storage facilities for spent fuel elements in transport and storage casks that are kept in storage halls or tunnel sections, respectively. In all already licensed storage facilities, CASTOR®V/19 or CASTOR®V/52 type casks are used initially. The granted licences for all on-site interim storage facilities applied for until 2000 permit the storage of spent fuel elements with a mass of heavy metal amounting to altogether 14,025 Mg on 1,435 storing positions for transport and storage casks of the CASTOR® type. Capacity has been dimensioned in such a way that all spent fuel elements accruing can be accepted until nuclear power plant operation has been discontinued and that they can remain there beyond

the time the nuclear power plant has been decommissioned and until a repository will be taken into operation.

By the end of 2003, storage of spent fuel elements was granted for 12 on-site interim storage facilities. BfS initially granted partial licences for those parts of the application whose examination had been concluded, so that work on the applications filed between 1998 and 2000 has not yet been concluded. In 2008, BfS continued the examinations within the scope of supplementary licences and amending licences for the on-site interim storage facilities. In the supplementary and amending licensing procedures it was examined if in individual cases supplementary examinations have to be carried out for the Environmental Impact Assessment.

With the exception of the Lingen on-site interim storage facility, the building permits for the on-site interim storage facilities were granted complementarily to the nuclear licences. The storage building in Lingen was licensed according to building law on 27 September 2000 and completed in April 2002. Thus, the Lingen interim storage facility was already operable when the nuclear licence was granted. The erection of the remaining on-site interim storage facilities could only be started in 2003/2004, after the Environmental Impact Assessment had come to an end and the building permits had been granted by the respective federal state building authorities. A survey of the respective first licences, the licensed masses of heavy metal (HM) and storing positions, start of erection and taking into operation (i. e. the first emplacement of a loaded cask) of the on-site interim storage facilities is given in Table 4.1. Further details on the on-site interim storage facilities can be found in Table III.5.

On 22 April 2005, BfS was submitted an application by Kernkraftwerk Obrigheim GmbH for storage of spent fuel elements in an on-site interim storage facility. On 1 January 2007, KWO GmbH was replaced by EnBW Kernkraft GmbH (EnKK) as applicant. Storage of altogether 342 spent fuel elements from the pressurised water reactor of the Obrigheim NPP was applied for, which had already been shut down in May 2005. The fuel elements are currently being stored in an already existing wet storage facility on the site (see above). As the external wet storage facility impedes the planned dismantling works for the Obrigheim NPP, the applicant intends to operate a separate on-site interim storage facility with dry interim storage of spent fuel elements on the premises of the Obrigheim NPP for 40 years at most. The EnKK concept provides for the storage of spent fuel elements in altogether 15 transport and storage casks of the CASTOR® 440/84 type. The storage of the nuclear fuel is applied for in a storage hall made of reinforced concrete with loading and storage area (approx. 35.3 m long, approx. 17.8 m broad, and approx. 16.7 m high). The thickness of the outer walls in this area is planned to be 85 cm and the thickness of the concrete roof approx. 55 cm. Thus, the wall thicknesses of the Obrigheim on-site interim storage facility corresponds to the wall thicknesses of the interim storage facilities in southern Germany, which were erected according to the so-called WTI concept. An operational building is attached to the east side of the storage hall. Furthermore, it is planned to erect a separate guardhouse (security centre) together with technical equipment for security services. The Obrigheim interim storage facility is to be designed for self-sustaining operation and is to be operated in a nearly self-sustained way as soon as it has been commissioned. By laying open the application documents to public inspection from 8 May to 7 July 2008, BfS has meanwhile initiated the public participation procedure. During this period, altogether 897 persons made objections against the project. From 8 October to 10 October 2008, these objections were discussed in depth between the applicant, experts, official delegates, and the objectors on the occasion of a public hearing. A verbatim transcript of the course of the public hearing and its results was made. In the further course of the procedure, the results of the public hearing will be taken into account in the examinations of the licensing requirements.

On-site interim storage facility (SZL)	Granting the 1st licence according to § 6 AtG	Mass HM [Mg]	Storing positions Total (Taken at the end of 2008)	Start of construc-tion	Taken into operation
SZL Biblis	22.09.2003	1400	135 (41)	01.03.2004	18.05.2006
SZL Brokdorf	28.11.2003	1000	100 (6)	05.04.2004	05.03.2007
SZL Brunsbüttel	28.11.2003	450	80 (6)	07.10.2003	05.02.2006
SZL Grafenrheinfeld	12.02.2003	800	88 (10)	22.09.2003	27.02.2006
SZL Grohnde	20.12.2002	1000	100 (12)	10.11.2003	27.04.2006
SZL Gundremmingen	19.12.2003	1850	192 (17)	23.08.2004	25.08.2006
SZL Isar	22.09.2003	1500	152 (12)	14.06.2004	12.03.2007
SZL Krümmel	19.12.2003	775	80 (14)	23.04.2004	14.11.2006
SZL Lingen	06.11.2002	1250	125 (24)	18.10.2000	10.12.2002
SZL Neckarwestheim	22.09.2003	1600	151 (27)	17.11.2003	06.12.2006
SZL Philippsburg	19.12.2003	1600	152 (26)	17.05.2004	19.03.2007
SZL Unterweser	22.09.2003	800	80 (3)	19.01.2004	18.06.2007

Table 4.1: On-site Interim Storage Facilities

4.3.3 CENTRAL INTERIM STORAGE FACILITIES OUTSIDE NUCLEAR POWER PLANT SITES

A survey of the central interim storage facilities outside nuclear power plant sites is given in Table III.4.

For the transport cask storage facilities of Ahaus (TBL-A), Gorleben (TBL-G), and the transport cask storage facility of the Interim Storage Facility North (ZLN), investigations into the possible impacts of a targeted air crash were carried out within the scope of investigations into a possible subsequent requirement according to § 7 AtG. Expert results have shown that in case of an assumed targeted air crash the lives and health of the population in the vicinity would not be jeopardised by the release of considerable amounts of radioactive substances and that no drastic disaster control measures need to be taken.

Ahaus Transport Cask Storage Facility

The Ahaus Transport Cask Storage Facility is a dry storage facility for spent fuel elements in transport and storage casks of the CASTOR® type.

The nuclear licence for the storage of fuel elements from light-water reactors according to § 6 AtG for a capacity of 1,500 Mg of heavy metal (HM) was granted on 10 April 1987, after a corresponding application had been filed on 2 August 1984. Storage operations started in June 1992.

The TBL-A was granted a nuclear licence for the storage of spent ball-shaped fuel elements from the THTR-300 in transport and storage casks of the CASTOR® THTR/AVR type; it was granted on 17 March 1992. By the end of April 1995, all 305 CASTOR® THTR/AVR casks containing the fuel elements from the THTR-300 were stored.

On the basis of a comprehensive new application a new licence was granted on 7 November 1997. It comprises the storage of maximum 3,960 Mg of HM in the previously licensed casks and in the new casks of the CASTOR® V/19, CASTOR® V/19 SN06, and CASTOR® V/52 types on 420 storing positions until 31 December 2036. In the licence the maximum storable activity is set out to be 2×10^{20} Bq and the heat output limit of all casks in the hall 17 MW.

In addition to the already stored 305 CASTOR® THTR/AVR casks, 2 CASTOR® V/19 casks, 1 CASTOR® V/19 SN06 cask, and 3 CASTOR® V/52 casks with LWR fuel elements were transported to the Ahaus Transport Cask Storage Facility on 20 March 1998.

In a first modification licence of 17 May 2000 for the TBL-A, the fuel inventory was adapted to the modified conditions. Among others, different fuel element types (mixed loading) may in future also be stored in casks of the CASTOR® V/19 SN06 type. The maximum heat output for this type and for the CASTOR® V/19 type is limited to 25 kW, compared to 39 kW before. It is no longer permitted to store the older CASTOR® types Ia, Ic, and IIa.

On 24 April 2001, a second modification licence was granted. It comprises the recovery of the maximum permissible heat output of 39 kW or 40 kW for the CASTOR® V/19 SN06 and CASTOR® V/52 cask types (which had been reduced with the first modification licence), the handling procedure when using a silver-coated large metal seal in the primary lid (wet compaction) as well as the modification of the technical acceptance requirements and the storage facility occupation (assembly of casks with enhanced heat output).

On 30 March 2004, the third modification licence was granted. It provides for the storage of nuclear fuel in the form of spent fuel elements from the Rossendorf Research Reactor in 18 transport and storage casks of the CASTOR® MTR2 type. In 2005, the 18 casks were transported from Rossendorf to Ahaus where they have been stored. Thus, altogether 329 loaded transport and storage casks have been stored in the TBL Ahaus since 2005.

On 4 July 2008, the fourth modification licence relating to the sealing of the ventilation openings and a modified storage facility occupation was granted.

On 22 December 2008, the fifth modification licence relating to the modification of security installations was granted.

After completion of the complaint and appeal proceedings the storage licence for the TBL Ahaus has meanwhile become definitive.

On 30 October 2006, Gesellschaft für Nuklear Service mbH (GNS) and Brennelement-Zwischenlager-Ahaus-GmbH (BZA) filed an application according to § 7 StrlSchV at the Münster regional government for the interim storage of radioactive waste from the operation and decommissioning of German nuclear power plants in the TBL Ahaus. The total activity of the stored radioactive waste is to be limited to maximum 10^{17} Bq. The duration of interim storage is to be limited to a period of maximum 10 years.

Furthermore, GNS and BZA filed an application according to § 6 AtG for the storage of high-pressure compacted radioactive waste from the reprocessing of spent fuels in transport and storage casks of the TGC36 type on 20 December 2006. From today's point of view one intends to store up to 150 casks.

Gorleben Transport Cask Storage Facility (TBL-G)

The Gorleben Transport Cask Storage Facility is a dry storage facility for spent fuel elements from nuclear power plants with light-water reactors and for HAW vitrified waste containers from reprocessing in transport and storage casks.

The nuclear licence according to § 6 AtG for the storage of fuel elements from light-water reactors for a capacity of 1,500 Mg of heavy metal (HM) was granted on 5 September 1983, after a corresponding application had been filed in September 1980. Storage operations started on 25 April 1995.

In a new licence of 2 June 1995, especially the storage of mixed oxide (MOX) containing fuel elements and the storage of nuclear fuels in the form of waste as well as of nuclear fuel containing waste and other radioactive substances was permitted, apart from the increase to altogether 3,800 Mg of HM and the storage of solidified high-level radioactive fission product solutions. The storable activity was limited to 2×10^{20} Bq. Prior to this decision a public participation procedure was carried out on the basis of the amendment to § 6 AtG.

On 1 December 2000, the TBL-G was granted a first modification licence to the licence of 2 June 1995. The licence concerned the modification of the Technical Acceptance Requirements for the casks. It also comprised the involvement of GNS as licencee as well as the use of other cask types for the fuel element types already licensed in 1995 and slight modifications of these fuel elements. On 18 January 2002, the second modification licence was granted. The approved modifications only concern the CASTOR® HAW 20/28 CG as from serial number 16.

On 23 May 2007, the use of the new cask type TN85 was permitted for the storage of high-level radioactive vitrified waste canisters from the reprocessing of spent fuel elements from German nuclear power plants. The TN85 cask of the French AREVA NC (formerly COGEMA) provides for a higher heat output of the vitrified waste containers to be stored of maximum 56 kW compared to the heat output of maximum 45 kW

previously permitted for the CASTOR casks. The return of the vitrified waste canisters to Germany has been set out in international contracts between the Federal Republic of Germany and the Republic of France.

With letter of 29 February 2000 and 2 March 2000, Brennelementlager Gorleben GmbH (BLG) or GNS, respectively, filed an application that HAW vitrified waste canisters from reprocessing be also stored in casks of the CASTOR® HAW/28M type with a thermal capacity of up to 56 kW per cask. With letter of 20 September 2006, this application was initially restricted to the storage of HAW vitrified waste canisters from reprocessing at AREVA NC. This application is currently being dealt with. The application for the storage of the HAW vitrified waste canisters from reprocessing in the British Sellafield Ltd. Plant is to be examined in another licensing step later on.

On 31 December 2008, 5 casks with spent fuel elements (1 CASTOR® Ic, 1 CASTOR® IIa, 3 CASTOR® V/19) and 86 casks with HAW vitrified waste canisters (1 TS 28 V and 74 CASTOR® HAW 20/28 CG and 11 TN85) were in the storage facility.

Transport Cask Storage Facility in the Interim Storage Facility North Rubenow (ZLN)

The Transport Cask Storage Facility in the Interim Storage Facility North is a dry storage facility for spent fuel elements in transport and storage casks. It is situated in hall no. 8 of the Interim Storage Facility North on the premises of EWN. The ZLN serves to store spent fuel elements, nuclar fuel, and other radioactive waste from the reactors of Rheinsberg and Greifswald.

On 5 November 1999, the licence according to § 6 AtG was granted, after a corresponding application had been filed in April 1993. The licence was granted for a capacity of maximum 585 t in maximum 80 casks of the CASTOR® 440/84 type. The maximum storable activity inventory is limited to 7.5×10^{18} Bq. The licence involved immediate enforcement. Claims were filed against it but it is now definitive. Emplacement operations of CASTOR® casks started on 11 December 1999.

Modifications applied for by the operator were licensed on 14 March 2001. Among others, the modifications comprise the storage of nuclear fuel in a cask of the CASTOR® 440/84 type with modified basket (among others, special fuel elements and plutonium containing sources) and in six casks of the CASTOR® 440/84 type that had already been loaded before the licence was granted.

Alternatively to dry compaction, the compaction of the primary lid metal sealing prior to drying (wet compaction) was also licensed in a second modification licence of 7 July 2003.

In a fourth modification licence for the ZLN dated 17 February 2006, the storage of casks of the CASTOR® 440/84 type with supplemented inventories, of 4 casks of the CASTOR® KRB-MOX type (among others with special fuel elements), and of maximum 10 empty casks with contaminated inner surfaces was permitted. Thus, the original extent of the licence has been achieved and the entire fuel from the facilities in Rheinsberg and Greifswald can be intermediately stored in the ZLN.

On 17 December 2008, the fifth modification licence relating to the modification and supplementation of security installations was granted.

No decision has been made so far on the application for the storage of four casks of the CASTOR® KNK type with spent and fresh fuel elements and for the storage of five containers of the CASTOR® HAW 20/28 CG type including inventory with HAW vitrified waste containers from the Karlsruhe reprocessing plant (VEK containers). The respective licence was filed in 2005 by EWN.[2]

On the appointed date of 31 December 2008, altogether 65 loaded CASTOR® casks were stored in the ZLN.

[2] After editorial deadline: The licence according to § 6 AtG fort he storage of five casks of the CASTOR HAW 20/28 CG including inventory with HAW vitrified waste block canisters (VEK canisters) was granted on 24 February 2009.

4.4 INTERIM STORAGE OF RADIOACTIVE WASTE AND NUCLEAR FUELS

4.4.1 INTERIM STORAGE OF RADIOACTIVE WASTE

A compilation of external waste interim storage facilities in Germany is given in Table III.6. Radioactive waste with negligible heat generation originating from NPP operation is currently intermediately stored on the premises of the nuclear power plants and in the external interim storage facilities in Gorleben, Mitterteich, Esenshamm, and Lubmin/Rubenow.

The major part of the radioactive waste produced by nuclear industry and research institutions is intermediately stored on the waste producers' premises. Radioactive waste produced in the medical field and by small waste producers is intermediately stored in Länder collecting depots.

In the Morsleben Repository for Radioactive Waste (ERAM) one drum with radium radiation sources and seven special containers with mainly Co-60 radiation sources are intermediately stored. BfS plans to dispose of these radiation sources in the ERAM within the scope of its closure. BfS filed the respective application for disposal of this waste on 12 September 2005.

4.4.2 GOVERNMENT CUSTODY OF NUCLEAR FUELS

According to § 5 AtG, nuclear fuels (such as fresh fuel elements, fuel rods, and UO_2-pellets) must be kept in government custody if the operator does not have a valid licence. The Federal Office for Radiation Protection is responsible for the enforcement of government custody. For this case the government has to take precautions.

Should, contrary to expectations, there be larger amounts of nuclear fuels to be kept in government custody, they are stored in situ. Maintaining an own installations for this purpose is disproportionate.

For smaller amounts of nuclear fuel accruing which have to be kept in government custody according to § 5 AtG in future, storage space a will be rented and containers and paraphernalia will be developed and purchased. The objective is to prepare container storage for emergencies which is to a great extent maintenance-free.

A plutonium-beryllium neutron source (Pu-Be source) is still in government custody in the BfS branch office in Berlin Karlshorst. A concept for the modified temporary storage of the Pu-Be source is being implemented.

4.5 REPROCESSING OF NUCLEAR FUELS

In the sixties of the 20th century, Germany started developing the technology of reprocessing spent fuel elements to complete the so-called nuclear fuel cycle. The Karlsruhe Reprocessing Pilot Plant (WAK) served to achieve this objective. There were plans for a national waste management centre (Gorleben Nuclear Waste Management Centre) where interim storage, industrial reprocessing, and disposal on one site were to be dealt with.

After this plan and domestic reprocessing had been given up, the management of spent fuel elements from German nuclear power plants through interim storage and reprocessing in other EC member countries was accepted as part of the integrated waste management concept and thus of the proof of precautionary measures to dispose of radioactive waste through the decision of the federal government of 6 June 1989. The construction of an industrial German reprocessing plant in Wackersdorf (WAW) that had been started was stopped in the same year and the spent fuel elements were transported to France (COGEMA, La Hague) or England (BNFL, Sellafield) for reprocessing.

As a result of an amendment to the Atomic Energy Act of 1994, direct disposal was put on a par with reprocessing as a waste management alternative, so that fuel elements were also intermediately stored in the Gorleben and Ahaus interim storage facilities for direct disposal later on.

To minimise the risk associated with reprocessing and transports for reprocessing, a ban was imposed on transports for reprocessing abroad after 30 June 2005 with the amendment to the Atomic Energy Act of 27 April 2002. Since then, the management of fuel elements has exclusively been restricted to direct disposal.

Karlsruhe Reprocessing Plant (WAK)

The WAK (cf. Table III.7) on the premises of the Forschungszentrum Karlsruhe GmbH (FZK) was a test facility for the reprocessing of spent fuels from research, prototype, and power reactors. Apart from the objective to gain operational experience, development projects for a German reprocessing plant were carried out on an industrial scale.

The WAK started operations in 1971 and ended operations in 1990, following a decision to do without a large-scale reprocessing plant.

The WAK is divided into three areas: Process building, High-Active Waste Storage Facility (HWL), and Plant for the Storage and Evaporation of High-Level Liquid Waste (LAVA) with containers and processing units for the storage of high-level active liquid waste concentrate (HAWC) and medium-level active liquid waste, and the Karlsruhe Vitrification Facility (VEK).

The plant's decommissioning concept provides for dismantling in 6 steps. The first two steps, shutting the plant down and deregulating the process installations and the dismounting of single systems in the process building have been concluded. Currently, decontamination work is being carried out and radiological inventories are being taken within the scope of the 3rd dismantling step.

A requirement for dismantling the LAVA is the vitrification of the stored high-level liquid waste in the VEK. On 20 December 1996, an application for granting a licence according to § 7 AtG was filed for the erection and operation of the VEK.The first partial construction licence for the VEK was granted on 30 December 1998. The construction of the VEK started at the beginning of 2000. Commissioning and non-nuclear vitrification operations of the plant have been completed. The second partial operation licence for hot (nuclear) operation was not yet granted in the period under report.[3]

The remote-controlled dismounting of the empty MAW storage containers in the HWL has been permitted with the 20th decommissioning licence dated 31 January 2006. In the year under report, preparation works for dismantling the containers were carried out.

The establishment of a transport preparation place for loaded CASTOR casks was permitted with the modification licence to the 3rd partial construction licence for the VEK dated 19 July 2005. Respective works have been completed.

Since the corporate shares of Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen (DWK) – which was one of the utilities – in the WAK was transferred to Energiewerke-Nord GmbH (EWN GmbH), the WAK became a federally owned company, 92 % of which is financed by the federal government and 8 % by the federal state of Baden-Wuerttemberg.

After EWN had taken over the WAK project, the overall technical concept for the decommissioning and dismantling of the WAK was been re-examined. The partial objectives „HAWC waste management" and „Deregulation following HAWC vitrification" were re-weighted. The dismantling of the decoupled building parts consisting of the process building, VEK, and HAWC storage area will be separately planned and carried out in future. With respect to the dissection of the HAWC casks – which are essential to the course of the project as regards time and costs – several technical variants were examined and an optimised procedure was established. The technical plans will be further specified on the basis of the revised concept. The overall planning was revised and corrected. Thus, the end of the project will probably be delayed to 2023.

Wackersdorf Reprocessing Plant (WAW)

In 1982, Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH (DWK) filed an application for the construction of a reprocessing plant at the Wackersdorf site (Oberpfalz/Bavaria) at the Bavarian State Ministry of Regional Development and the Environment.

This application resulted from the decision made by the heads of government of federal government and Länder in 1979, which considered the reprocessing including recirculation of the utilisable nuclear fuels and the disposal of radioactive waste from the reprocessing process to be realisable according to the state of the art of science and technology and demanded to rapidly construct a reprocessing plant. It was also a result from Lower Saxony Prime Minister Ernst Albrecht's (CDU) attitude: he considered the National Waste Management Centre in Gorleben not politically enforceable.

[3] After editorial deadline: The second partial operating licence for the VEK was granted on 24 February 2009.

The first partial building licence was granted in September 1985. The Bavarian Administrative Court considered the development plan contrary to law. Building started in December 1985. Modifications of the concept then made it necessary to develop a new safety report, to perform another public hearing, and to examine the safety of the facility as a whole.

Offers made by COGEMA and later on by BNFL to take over the reprocessing of spent fuel elements from German nuclear power plants for the long term and to do this at reasonable prices, persuaded the German utilities to reconsider the Wackersdorf project and to give it up. The procedure was formally completed by DWK withdrawing the building application in December 1989.

4.6 CONDITIONING OF FUEL ELEMENTS FOR DIRECT DISPOSAL

Gorleben Pilot Conditioning Plant (PKA)

(Cf. Table III.8)

In order to advance methods for direct disposal, a pilot conditioning plant for spent fuel elements and radioactive waste was erected at the Gorleben site (Lower Saxony). The plant is a multi-purpose facility, where, apart from fuel elements, all types of radioactive waste from nuclear facilities can be reloaded or conditioned in such a way that they are suitable for disposal. The plant was designed for a capacity of 35 Mg of HM per year.

In January 1990, the first nuclear partial licence was granted for the erection of the building shells and the fence and earth wall surrounding the plant and the preliminary positive overall judgement of the plant concept.

With notification of 21 July 1994, the Lower Saxony Environment Ministry granted the second partial licence for the erection of the PKA. It concerns the entire technical and electro-technical part as well as the PKA's instrumentation and control.

The third partial licence, which includes the operation licence, was granted in December 2000. Until the federal government will nominate a repository site, PKA operation is restricted to repairing defective transport and storage casks on the basis of a collateral clause to the granted licence.

On 18 December 2001, the Lower Saxony Environment Ministry issued a subsequent obligation to the second partial licence of 21 July 1994, that certain systems and plant components be operated in "cold operation". This serves to maintain the PKA in its tested state and ensures that a defective cask can be accepted at any time.

4.7 DISPOSAL

A survey of repositories for radioactive waste and repository projects in Germany is given in Table III.9. Competences in radioactive waste disposal are shown in Figure III.2 and the course of plan-approval (licensing) procedures and procedures according to Mining Law are presented in Figure III.3.

Mine for the Exploration of the GORLEBEN Salt Dome (Project)

The investigation of the Gorleben salt dome in the Lower Saxony administrative district of Lüchow-Dannenberg for its suitability to host a repository for all types of solid and solidified radioactive waste started in 1979.

Within the scope of the above-ground exploration, the above-ground measuring programme in the area of Dömitz-Lenzen north of the river Elbe was completed. Underground, the first exploration area (EB1) was driven in the north-eastern part of the Gorleben salt dome and investigated.

As a consequence of the agreement of 14 June 2000 between the federal government and the utilities concerning an energy consensus, the underground exploration of the Gorleben salt dome was discontinued for a period between 3 years (minimum) and 10 years (maximum) (Gorleben Moratorium), as the exploration can currently not contribute to clarifying conceptual and safety-related issues. The Gorleben Moratorium does not imply that the site will be given up. Not until the questions which the Moratorium is based on have been answered and it has become possible to compare it with other sites it can be decided if the exploration

of the Gorleben salt dome will be continued. Until then the geological findings gained so far will be saved and the exploration mine above ground and underground will be maintained in a state which will make it possible to resume operation. According to these boundary conditions, the relevant effective main operating plan regulates the phase of keeping the mine open and the measures required for maintaining the value.

In 2008, the competent mining authority was submitted the 5th amendment – updating and extension - to the main operating plan according to § 52 BBergG for the mine for the exploration of the Gorleben salt dome (main operating plan for keeping the mine open). The validity period of the authorisation of the 4th amendment was extended until 31 December 2008, the authorisation of the 5th amendment was granted in December 2008 (validity period 1 January 2009 – 30 September 2010).

The federal government's intention to legally support the Gorleben site and its position as applicant during the Moratorium and to protect the project against interventions of third parties, has led to an extension of the overall operating plan for the exploration mine until 30 September 2010. Furthermore, the project was ensured through the Ordinance on a Ban on Development Imposed by a Local Authority to Safeguard the Planned Development of the Gorleben Zone (Gorleben-Veränderungssperren-Verordnung, GorlebenVSpV). The GorlebenVSpV became effective one day after it had been announced on 26 July 2005.

With the beginning of the Moratorium, the underground exploration by heading, exploration drillings, and geotechnical measurements was stopped in October 2000. Geotechnical measurements are still only carried out to preserve evidence and/or to monitor the shape of drift near the contour in order to ensure mining safety.

Since 1 October 2000, only measures and works have been carried out that are necessary for reasons of mining safety and for operational reasons to maintain the exploration mine in a reliable state, even for a longer period of time, and to not invalidate the previous investments and work results.

KONRAD Repository

The Konrad mine in Salzgitter developed the iron ore deposit known since 1933 in depths between 800 m and 1,300 m. Sinking of shaft Konrad 1 started in 1957. Iron ore production already stopped in 1976 for economic reasons. On account of the mine being extraordinarily dry, it was initially investigated for its basic geoscientific suitability to host a repository for radioactive waste. After these investigations had been concluded with a positive result, the then competent Federal Institute of Science and Metrology (Physikalisch-Technische Bundesanstalt, PTB) filed the application for the initiation of a plan-approval (licensing) procedure according to § 9b AtG on 31 August 1982. The plan provided for the disposal of up to 650,000 m^3 of radioactive waste with negligible heat generation. Compared with these estimations, the waste volume expected today has clearly decreased. The volume licensed for disposal has been restricted to 303,000 m^3 of waste.

The radioactive waste to be disposed of mainly accrues in nuclear energy use for electricity generation, in the decommissioning and dismantling of nuclear facilities, in radioisotope application in craft, research, medicine, and at the Federal Armed forces as well as in research and development work. The volume of this waste is about 90 % but only 0.1 % of the activity of all radioactive waste. It is to be disposed of in deep geological formations.

The licensing procedure pending since 1982 was completed through the plan-approval decision of 22 May 2002. The application for a plan approval included application for immediate enforcement. According to the agreement between the federal government and the utilities on the termination of power generation from nuclear energy, BfS withdrew the application for immediate enforcement on 17 July 2000. Thus, the plan-approval decision could not be implemented. In March 2006, the pending actions against the plan-approval decision were rejected by the Lüneburg Higher Administrative Court; revision was not admitted. The complaints against the non-admission of the revision to the decisions of the Higher Administrative Court filed by the claimants were rejected by the Federal Administrative Court with decision of 26 March 2007. The plan-approval decision is, thus, legally binding.

With decision of 21 February 2008 of the 3rd Chamber of the First Senate of the Federal Constitutional Court, the city of Salzgitter's constitutional complaint was not accepted for a decision for lack of admissibility. A decision about a citizen's constitutional complaint has not been taken so far.

In addition to the (nuclear) plan-approval decision, works carried out in or at a mine also require a licence according to Mining Law issued by the competent mining authority. With approval of the main operating plan on 15 January 2008, this licence was granted for a term of six years.

In 2008, works for keeping the mine open and for maintaining the mine's safety were carried out above ground and underground. This included redevelopment works of buildings, shafts, and mine openings. Redevelopment works have always been carried out in such a way that they will not interfere with a later conversion of the mine.

MORSLEBEN Repository for Radioactive Waste (ERAM)

Based on the Unification Treaty of 1990, the Federal Republic of Germany has become responsible for the Morsleben Repository for Radioactive Waste (ERAM) installed by the GDR in the former potash and rock salt mines of Bartensleben and Marie. Except for the period from 1991 to 1994, when emplacement operations had discontinued, it was used until 1998 for the disposal of low-level and medium-level radioactive waste with short-lived radionuclides. Because of the legal transfer the Federal Office for Radiation Protection has been the holder of the permanent operation licence since 1990.

Between 1971 and 1998, altogether about 37,000 m^3 of low-level and medium-level radioactive waste was disposed of in the ERAM with a total activity of less than 6 x 10^{14} Bq (appointed date: 30 June 2005). On 21 May 1999, BfS announced that for safety reasons, emplacement operations in the ERAM would not be resumed. On the basis of the amendment to the Atomic Energy Act of 2002, the provisions of § 57 a AtG were modified to the extent that the permanent operation licence continues to be effective as plan-approval decision in the sense of § 9 b AtG for an indefinite period, except for the regulations relating to the acceptance and disposal of further radioactive waste. The acceptance of radioactive waste for disposal has been excluded. Since the emplacement of radioactive waste has been finally terminated, repository operation is to be converted into operation with the purpose of keeping the mine open. A corresponding plan for converting the ERAM and keeping it open was submitted to the competent licensing authority of the federal state of Saxony-Anhalt.

Since October 2003, selected mine openings of the central part where no radioactive waste is stored have been backfilled with a pumpable salt concrete. These measures are necessary to prevent mining hazards and to improve the geomechanic state of the ERAM's central part. Because of interaction with the salt rock, additional bearing arches and pillars have been erected to ensure that the mine is suitable for the implementation of the decommissioning measures in the future. The salt concrete, a mixture of salt grit, limestone meal, sand, concrete, and water, is a hydraulically hardening material which already sets after a few days and unfolds the planned supporting effect. By the end of 2008, about 662,000 m^3 of salt concrete were pumped into 21 out of 24 cavities on levels 1, 2a, 2, 3a, and 3.

On 9 May 1997, the application for further operation of the ERAM filed on 13 October 1992 at the MLU was restricted to the decommissioning of the ERAM. In the framework of the decommissioning the ERAM, also the radioactive waste intermediately stored until that time and the operational radioactive waste accruing in the process of decommissioning operation is to be diposed of in the process of decommissioning.

Works for the licensing procedure are focussed on the decommissing concept and on safety assessments. Decommissioning of the ERAM will be done in such a way that it is ensured that the radiation protection goals are complied with. Even if it cannot be entirely prevented in the long term that radionuclides are released from the sealed repository, only such amounts of these radionuclides may reach the biosphere that the protection goals are complied with in the long run. This is proved by long-term safety assessments. For this purpose, it is planned to backfill large parts of the underground facilities and the shafts with sealing and stabilising building materials. The emplacement areas will be sealed by sealing dams in the access galleries. Altogether, the concept provides for an amount of backfill of about four million cubic metres of salt concrete. The shafts are sealed with shaft sealings.

With letter of 2 September 2005, BfS submitted those documents to the MLU that are according to § 6 AtVfV required for the public participation procedure within the scope of the nuclear licensing procedure for the final decommissioning of the repository.

The plan for the decommissioning of the ERAM comprehensively and in detail presents the initial situation, the decommissioning concept with the planned backfilling and sealing measures up to the shaft sealings, the planned works relating to the conversion and dismantling of facilities and the radiological consequences for the environment. In the long-term safety assessment the possible impacts on future generations that are caused by the sealed repository have been calculated or assessed, respectively, considering different climatic, geological, and mining scenarios.

In addition to the plan, BfS also submitted an Environmental Impact Assessment study in which all results gained in the environment investigations have been presented and evaluated. Also an overview about

different variants of decommissioning has been presented. These documents will be laid open to public inspection within the scope of a public participation procedure.

The plan-approval decision (PFB) for the project "Decommissioning of the ERAM" will be granted after the public has been involved and the plan has been evaluated. Following a conversion phase, the implementation of the licensed decommissioning measures for the ERAM will start. The actual decommissioning of the repository, after the plan-approved decision will have been issued, will take about 15 years. Decommissioning costs will probably amount to at least 840 million euros (construction costs according to § 3 AtKostV). The total costs until completion of decommissioning works are estimated to amount to about two billion euros (including operating costs).

ASSE Repository for Radioactive Waste

From 1965 to 2008, Gesellschaft für Strahlen- und Umweltforschung (today: HMGU - Helmholtz Zentrum München – German Research Center for Environmental Health) operated the Asse II mine near Remlingen (rural district of Wolfenbüttel) on behalf of the Federal Ministry of Education and Research. In the former salt mine research and development work for the disposal of radioactive and chemico-toxic waste in salt formations was carried out.

From 1967 until 1978, about 125,000 drums of low-level radioactive waste were stored in 12 chambers at depths from 725 m to 750 m and 1,300 drums of medium-level radioactive waste in a chamber at a depth of 511 m. The total activity inventory amounts to 3.1×10^{15} Becqueral (1 January 2002), 40 % of the inventory being contained in the medium-level radioactive waste. When the licences had expired, no more waste has been stored in the Asse mine since the end of 1978. At no time was it intended to retrieve the considerable amounts of emplaced radioactive waste after the experimental investigations had been completed.

In 1997, it was decided that a further use of the mine was not intended and to prepare the final closure of the mine. Currently the licensing procedure for decommissioning the mine is in progress.

Between 1995 and 2003, the chambers in the southern flank of the research mine originating from the time of rock salt production were backfilled with a characteristic material (residual salts from the former Ronnenberg potash mine). Altogether 2.15 million Mg of salt grit were pumped into the mine. The purpose of this measure was to improve the stability of the mine and, thus, to prevent that the amount of influent saline solution from the overburden and adjoining rock (currently 11 m^3 per day) existing since 1988 will increase. As the salt grit is compactable, it does not have any stabilising effect.

Until 2003, the mine openings under the deepest emplacement chambers below the 800-m level had already been backfilled with salt grit and flooded with an $MgCl_2$ solution. This area consists of a cavern with a volume of 136,000 m^3 and a spiral drift with 93,000 m^3 volume.

The previous operator, Helmholtz Zentrum München, assumes that influent saline solutions occurring already now as a result of rock deformations cannot be excluded in future, either (long-term safety). Therefore, it was planned to backfill the residual pore space of the salt grit in the southern flank with a saline solution after all accessible chambers have been backfilled to the greatest possible extent. This solution should be in chemical balance with the existing potash salt (carnallitite) (protection fluid). The effect of the protection fluid should be a rapid increase in inner pressure, which reduces the rock movement (convergence). The purpose of this measure was to stabilise the total system.

On 21 November 2007, BMBF, BMU, and NMU agreed to evaluate supplementing and alternative measures to the HMGU decommissioning concept, takting into account the option of partially retrieving the MAW.

Among others, the agreement stated that an accompanying group of the rural district of Wolfenbüttel was to be established.

In February 2008, the "Asse II Accompanying Group" was constituted from local delegates of politics, administration, and citizens with headquarters on the premises of the rural district of Wolfenbüttel. Delegates of BfS, BMU, and NMU participate in the group's meetings in advisory capacity and without a vote.

A comparison of options for the closure of the Asse II mine is developed and financed by BMBF and BMU. Projektträger Karlsruhe (PTKA) and the Federal Office for Radiation Protection were assigned this task, taking over both its organisation and responsibility as regards content. Also experts of trust of the accompanying group will participate in the development of the comparison of options.

In the Comparison of Options working group (AGO) the HMGU decommissioning concept was revised and statements were made on the feasibility studies made by external experts on the stabilisation of the southern flank and on the retrieval of the MAW.

In the opinion of the AGO and in view of the given site and system specific boundary conditions, the decommissioning option "protection fluid" preferred by HMGU appears to be a possible option to create conditions in the Asse repository that allow for a prognosis of its future behaviour with sufficient safety, if all open points can be answered clearly and in sufficient depth. However, this decommissioning concept has the disadvantage that a contact of the radioactive waste with liquids would be accepted at an early stage. From the AGO point of view, not all alternatives have been sufficiently examined.

The AGO is affirmative to the backfilling of roof clefts as a first stabilisation measure. Further stabilisation measures through injections of backfill must still be examined. However, the AGO finally concludes that the risk will remain that the inflow of saline solution will still increase, despite of the measures proposed by CDM Consult GmbH. The AGO agrees with the statements of the CDM: "A clear correlation between the state of deformation of the rock and the inflow of saline solution can not be given … due to the complex rock conditions and the inflow of saline solution into the salt rock which cannot be clearly defined."

The study on the partial retrieval of the MAW developed by BfS has been available as draft since October. The retrievability study arrives at the conclusion that it is basically technically feasible to retrieve the waste. On account of various licensing and technical imponderabilia, estimations regarding time and effort are uncertain. As there is currently no comprehensive safety and incident assessment of the present state of the mine available, it is not possible to finally evaluate the justification. At the end of July 2008, the AGO received an incomplete draft of an incident assessment by HMGU which is not sufficient for serving as a basis for an evaluation. In a preliminary evaluation, the members of the AGO agree that no improvement of the situation as regards long-term safety is achieved by retrieving the MAW.

The elaboration of a comprehensive incident assessment is currently being advanced by BfS and will probably be available at the end of March 2009.

On 4 September 2008, the BMU, the BMBF, and the NMU agreed that the Asse II mine is to be procedurally treated as a repository in future. Accordingly, the aim was to transfer the operatorship of the Asse from Helmholtz Zentrum München (HMGU) to the Federal Office for Radiation Protection (BfS), with effect from 1 January 2009.

One day after the ministries had agreed on this change of operatorship, a first coordinating meeting of delegates from the ministries was carried out at BfS on 5 September 2008 to prepare the change of operatorship. Under the overall direction of BfS, three working groups (AG) were established to prepare the legal/organisational, operational/decommissioning-related, and financial aspects of taking over operatorship.

To adapt radiation protection of the mine to the general standards of nuclear engineering, a BfS-internal working group “Radiation Protection” was established on 17 September 2008.

Already since mid October 2008, monitoring through measurements and the implementation of operational radiation protection measures have been supported by two BfS technicians and one BfS radiation protection engineer.

The cabinet decision on the taking over of operatorship by BfS from 1 January 2009 was made on 5 November 2008. The Atomic Energy Act was amended to legally implement the transfer of Asse into nuclear law.

To keep contamination as low as possible, BfS developed a programme in November 2008 to manage the handling of influent saline solutions.

The first BfS measure to improve the safety situation of the mine will be the stabilisation of the southern flank by means of backfilling roof clefts. In the process of this measure, the cavities having occurred in the chambers of the southern flank on account of the backfill material having large pore spaces will be backfilled with Sorel concrete. Concrete plans on this issue were already made in October 2008, together with HMGU who had been the operator at that time. Following the preparatory planning work which started at the beginning of 2009, the works for the backfilling of roof clefts will probably start in July 2009.

ANNEXES - SURVEY

ANNEX I – NUCLEAR POWER PLANTS –

Status: as at 31.12.2008

Table I.1: Licensing and regulatory authorities of the federal government and the Länder for licences for the storage of nuclear fuel according to § 6 AtG and facilities according to § 7 AtG

	Authority for licences for the storage of nuclear fuel according to § 6 AtG	**Supervisory authority according to § 19 in conjunction with § 6 AtG**
Federal Republic of Germany	Federal Office for Radiation Protection	Länder supervisory authorities
Land	**Licensing authority for facilities according to § 7 AtG**	**Supervisory authority according to § 19 in conjunction with §§ 6 and 7 AtG**
Baden-Württemberg	Environment Ministry in consultation with Ministry of Economics and Ministry of the Interior	Environment Ministry Baden-Württemberg
Bavaria	Bavarian State Ministry of the Environment, Public Health and Consumer Protection; for power systems in consultation with the State Ministry of Economic Affairs, Infrastructure, Transport and Technology	Bavarian State Ministry of the Environment, Public Health and Consumer Protection
Berlin	Berlin Senate Department for Urban Development	
Brandenburg	Brandenburg Ministry for Rural Development, Environment and Consumer Protection	
Bremen	Senator for the Environment, Building, Transport and Europe, in consultation with the Senator for Labour, Women, Public Health, Adolescents and Social Affairs	
Hamburg	Authority for Urban Development and Environment	
Hesse	Ministry for Environment, Rural Space and Consumer Protection	
Mecklenburg-Vorpommern	Ministry of the Interior in consultation with Ministry of Economics, Labour and Tourism	Ministry of the Interior
Lower Saxony	Ministry for the Environment and Climate Protection	
North Rhine-Westphalia	Ministry of Economic Affairs and Energy	
Rhineland-Palatinate	Ministry for the Environment, Forests and Consumer Protection	
Saarland	Ministry for the Environment	
Saxony	State Ministry for the Environment and Agriculture	
Saxony-Anhalt	Ministry for Agriculture and Environment	
Schleswig-Holstein	Ministry for Social Affairs, Health, the Family, Youths and Senior Citizens	
Thuringia	Ministry for Agriculture, Nature Conservation and the Environment	

Table I.2a: Nuclear power plants in operation
Status: as at 31.12.2008

Nuclear Power Plant	Site	Land	Operator	Type	Capacity gross [MWe]	Capacity net [MWe]	1st partial licence	Start of con-struction	Initial criticality
Neckarwestheim Unit 1	Neckar-westheim	BW	EnBW Kernkraft GmbH (EnKK)	PWR	840	785	24.01.1972	02/1972	26.05.1976
Neckarwestheim Unit 2	Neckar-westheim	BW	EnBW Kernkraft GmbH (EnKK)	PWR	1,400	1,310	09.11.1982	11/1982	29.12.1988
Philippsburg Unit 1	Philippsburg	BW	EnBW Kernkraft GmbH (EnKK)	BWR	926	890	09.10.1970	10/1970	09.03.1979
Philippsburg Unit 2	Philippsburg	BW	EnBW Kernkraft GmbH (EnKK)	PWR	1,458	1,392	06.07.1977	07/1977	13.12.1984
Isar Unit 1	Essenbach	BY	E.ON Kernkraft GmbH	BWR	912	878	16.05.1972	05/1972	20.11.1977
Isar Unit 2	Essenbach	BY	E.ON Kernkraft GmbH	PWR	1,475	1,400	12.07.1982	09/1982	15.01.1988
Grafenrheinfeld	Grafenrheinfeld	BY	E.ON Kernkraft GmbH	PWR	1,345	1,275	21.06.1974	01/1975	09.12.1981
Gundremmingen Unit B	Gund-remmingen	BY	Kernkraftwerk Gundremmingen GmbH	BWR	1,344	1,284	16.07.1976	07/1976	09.03.1984
Gundremmingen Unit C	Gund-remmingen	BY	Kernkraftwerk Gundremmingen GmbH	BWR	1,344	1,288	16.07.1976	07/1976	26.10.1984
Biblis Unit A	Biblis	HE	RWE Power AG	PWR	1,225	1,167	31.07.1970	01/1970	16.07.1974
Biblis Unit B	Biblis	HE	RWE Power AG	PWR	1,300	1,240	06.04.1972	02/1972	25.03.1976
Unterweser	Esenshamm	NI	E.ON Kernkraft GmbH	PWR	1,410	1,345	28.06.1972	07/1972	16.09.1978
Grohnde	Grohnde	NI	E.ON Kernkraft GmbH	PWR	1,430	1,360	08.06.1976	06/1976	01.09.1984
Emsland	Lingen	NI	Kernkraftwerke Lippe-Ems GmbH	PWR	1,400	1,329	04.08.1982	08/1982	14.04.1988
Brokdorf	Brokdorf	SH	E.ON Kernkraft GmbH	PWR	1,480	1,410	25.10.1976	01/1976	08.10.1986
Brunsbüttel	Brunsbüttel	SH	Kernkraftwerk Brunsbüttel GmbH & Co. oHG	BWR	806	771	02.04.1970	04/1970	23.06.1976
Krümmel	Krümmel	SH	Kernkraftwerk Krümmel GmbH & Co. oHG	BWR	1,402	1,346	18.12.1973	04/1974	14.09.1983

Table I.2b: Survey of thermal and electrical capacity increases in German nuclear power plants
Status: as at 31.12.2008

Nuclear Power Plant	Licensed thermal power at initial criticality in MWth (licence)	Thermal power increase in MWth (licence, application)	Electricity output in MWe gross (in the year of criticality)	Modification of electricity output (year)	Current electrical gross output in MWe	Capacity increase in MWth applied for (application)
Neckarwestheim Unit 1	2,362 (1. partial building licence of 24.01.1972)	2,497 (2. partial building licence of 26.05.1976, application of 02.04.1971) [1)]	855 (1976)	840 (1990)	840	2,597 (25.04.2000)
Neckarwestheim Unit 2	3,765 (4. partial operation licence of 28.12.1988)	3,850 (3. modification licence of 13.05.1991, application of 24.10.1990)	1,316 (1988)	1,314 [1989] 1,316 (1990) 1,365 (1992) 1,395 (08/2004) 1,400 (01/2007)	1,400	3,965 (25.04.2000)
Philippsburg Unit 1	2,575 (1. partial building licence of 09.10.1970)	-	900 (1979)	912 (1994) 926 (1996)	926	-
Philippsburg Unit 2	3,765 (1. partial building licence of 06.07.1977)	3,803 (5. modification licence of 26.11.1991, application of 05.09.1991) 3,850 (8. modification licence of 08.05.1992, application of 07.03.1991) 3,950 Modification licence of 29.03.2000, application of 30.04.1998)	1,349 (1984)	1,357 (1991) 1,390 (1992) 1,402 (1993) 1,424 (1996) 1,458 (11/2000)	1,458	-
Isar Unit 1	2,575 (4. partial building licence of 18.11.1977)		907 (1977)	912 (06/2000)	912	2,755 (04.04.2000) Application suspended

Nuclear Power Plant	Licensed thermal power at initial criticality in MWth (licence)	Thermal power increase in MWth (licence, application)	Electricity output in MWe gross (in the year of criticality)	Modification of electricity output (year)	Current electrical gross output in MWe	Capacity increase in MWth applied for (application)
Isar Unit 2	3,765 (4. partial building licence of 12.07.1982)	3,850 (1. modification licence of 25.02.1991, application of 16.10.1990) 3,950 (5. modification licence of 20.11.1998, application of 07.04.1998)	1,370 (1988)	1,390 (1989) 1,400 (1991) 1,410 (1993) 1,420 (1995) 1,440 (1996) 1,455 (1998) 1,475 (2000)	1,475	-
Grafenrheinfeld	3,765 (5. partial building licence of 10.11.1981)	-	1,299 (1981)	1,300 (1984) 1,345 (1993)	1,345	3,950 (16.05.2000)
Gundremmingen Unit B	3,840 (11. partial building licence of 18.10.1984)	-	1,310 (1984)	1,300 (1987) 1,344 (1994)	1,344	4,100 (Application of 14.09.1999 for units B and C, withdrawn on 21.12.2001) 4,000 (New application of 19.12.2001 for units B and C)
Gundremmingen Unit C	cf. KRB-B	-	1,310 (1984)	1,308 (1987) 1,344 (1995)	1,344	Cf. KRB-B
Biblis Unit A	3,540 (6. partial building licence of 14.12.1973)	-	1,204 (1974)	1,147 (1978) 1,204 (1980) 1,225 (1995)	1,225	-
Biblis Unit B	3,733 (1. partial building licence of 06.04.1972)	-	1,300 (1976)	1,238 (1978) 1,300 (1980)	1,300	-
Unterweser	3,733 (3. modification licence of 15.03.1982)	3,900 Modification licence of 16.08.2000, application of 19.9.1997)	1,300 (1978)	1,320 (1991) 1,350 (1996) 1,410 (11/2000)	1,410	-

Nuclear Power Plant	Licensed thermal power at initial criticality in MWth (licence)	Thermal power increase in MWth (licence, application)	Electricity output in MWe gross (in the year of criticality)	Modification of electricity output (year)	Current electrical gross output in MWe	Capacity increase in MWth applied for (application)
Grohnde	3,765 (1. partial building licence of 08.06.1976)	3,850 Modification licence of 09.02.1990, application of 27.06.1989) 3,900 Modification licence of 29.06.1999, application of 13.06.1997)	1,365 (1984)	1,394 (1990) 1,430 (1995)	1,430	4,000 (24.09.2007)
Emsland	3,765 (4. partial licence of 30.03.1988)	3,850 (1. modification and supplement licence of 09.02.1990, application of 06.06.1989)	1,316 (1988)	1,314 (1988) 1,341 (1990) 1,363 (1992) 1,400 (08/2000)	1,400	3,950 (16.12.2002)
Brokdorf	3,765 (1. partial operation licence of 30.12.1985)	3,850 (Modification licence of 15.02.1994 to 2. partial operation licence of 03.10.1986) 3,900 (7. amending licence to 2. operation licence of 23.05.2006, application of 16.12.2002)	1,380 (1986)	1,400 (1987) 1,395 (1988) 1,440 (1997) 1,480 (2008)	1,480	-
Brunsbüttel	2,292 (1. operation licence of 22.06.1976)	-	806 (1976)	-	806	-
Krümmel	3,690 (1. operation licence of 14.09.1983)	-	1,316 (1983)	1,376 (2005) 1,402 (2007)	1,402	-

[1)] As to GKN 1: The second partial operation licence of 26.05.1976 comprises, among others, zero power and power tests up to 30 % of the thermal reactor output.
Supplements: 1. Amendment to the 2. partial operation licence of 02.08.1976: zero power and power tests up to 80 % of the thermal reactor output
2. Amendment to the 2. partial operation licence of 05.10.1976: zero power and power tests up to 100 % of the thermal reactor output
3. Amendment to the 2. partial operation licence of 15.06.1977: test operation up to 100 % of the thermal reactor output

Table I.3: Nuclear power plants under decommissioning or decommissioning was decided

Nuclear Power Plant	Site	Land	Operator	Type	Gross capacity [MWe]	Start of con-struction	Initial criticality	Final shut-down	Status
Rheinsberg	Rheinsberg	BB	Energiewerke Nord GmbH	PWR	70	01/1960	11.03.1966	01.06.1990	Dismantling licence of 28.04.1995 et seqq.
Compact sodium-cooled reactor	Eggenstein-Leopoldshafen	BW	Forschungszentrum Karlsruhe GmbH	SNR	21	09/1974	10.10.1977	23.08.1991	Dismantling licence of 26.08.1993 et seqq.
Multi-purpose research reactor	Eggenstein-Leopoldshafen	BW	Forschungszentrum Karlsruhe GmbH	PWR	57	12/1961	29.09.1965	03.05.1984	Dismantling licence of 17.11.1987 et seqq.
Obrigheim	Obrigheim	BW	EnBW Kernkraft GmbH (EnKK)	PWR	357	03/1965	22.09.1968	11.05.2005	1. decomm. licence of 28.08.2008
Gundrem-mingen Unit A	Gundremmingen	BY	Kernkraftwerk Gundremmingen GmbH	BWR	250	12/1962	14.08.1966	13.01.1977	Dismantling licence of 26.05.1983 et seqq.
Kahl Test Nuclear Power Plant	Kahl, Main	BY	Versuchsatomkraftwerk Kahl GmbH	BWR	16	07/1958	13.11.1960	25.11.1985	Dismantling licence of 05.05.1988 et seqq.
Greifswald Unit 1	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	03/1970	03.12.1973	18.12.1990	Licence of 30.06.1995 et seqq. for decomm./ dismantl. entire facility
Greifswald Unit 2	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	03/1970	03.12.1974	14.02.1990	Licence of 30.06.1995 et seqq. for decomm./ dismantl. entire facility

Nuclear Power Plant	Site	Land	Operator	Type	Gross capacity [MWe]	Start of con-struction	Initial criticality	Final shut-down	Status
Greifswald Unit 3	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	04/1972	06.10.1977	28.02.1990	Licence of 30.06.1995 et seqq. for decomm./ dismantl. entire facility
Greifswald Unit 4	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	04/1972	22.07.1979	02.06.1990	Licence of 30.06.1995 et seqq. for decomm./ dismantl. entire facility
Greifswald Unit 5	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	12/1976	26.03.1989	30.11.1989	Licence of 30.06.1995 et seqq. for decomm./ dismantl. entire facility
Stade	Stade	NI	Kernkraftwerk Stade GmbH & Co. oHG	PWR	672	12/1967	08.01.1972	14.11.2003	Decomm./dismantl. phase 1 of 07.09.2005, phase 2 of 15.02.2006 Phase 3 of 14.05.2008
Lingen	Lingen, Ems	NI	Kernkraftwerk Lingen GmbH	BWR	252	10/1964	31.01.1968	05.01.1977	Licence for Safe Enclosure on 21.11.1985; application for dismantling of facility of 15.12.2008

Nuclear Power Plant	Site	Land	Operator	Type	Gross capacity [MWe]	Start of con-struction	Initial criticality	Final shut-down	Status
Jülich Experi-mental Nuclear Power Plant	Jülich	NRW	Arbeitsgemeinschaft Versuchsreaktor GmbH	HTR	15	08/1961	26.08.1966	31.12.1988	1. Decomm. Licence for Safe Enclosure on 09.03.1994 Application for entire dismantl. of 25.02.2005
Würgassen	Würgassen	NRW	E.ON Kernkraft GmbH	BWR	670	01/1968	22.10.1971	26.08.1994	1. Decomm. licence of 14.04.1997
Hamm-Uentrop Gas-cooled High-temperature Pebble Bed Reactor	Hamm-Uentrop	NRW	Hochtemperatur-Kernkraftwerk GmbH	HTR	308	05/1971	13.09.1983	29.09.1988	Licence for operation of Safe Enclosure of 21.05.1997
Mülheim-Kärlich	Mülheim-Kärlich	RP	RWE Power AG	PWR	1,302	01/1975	01.03.1986	09.09.1988	Licence for decomm./ dismantl. phase 1a of 16.07.2004

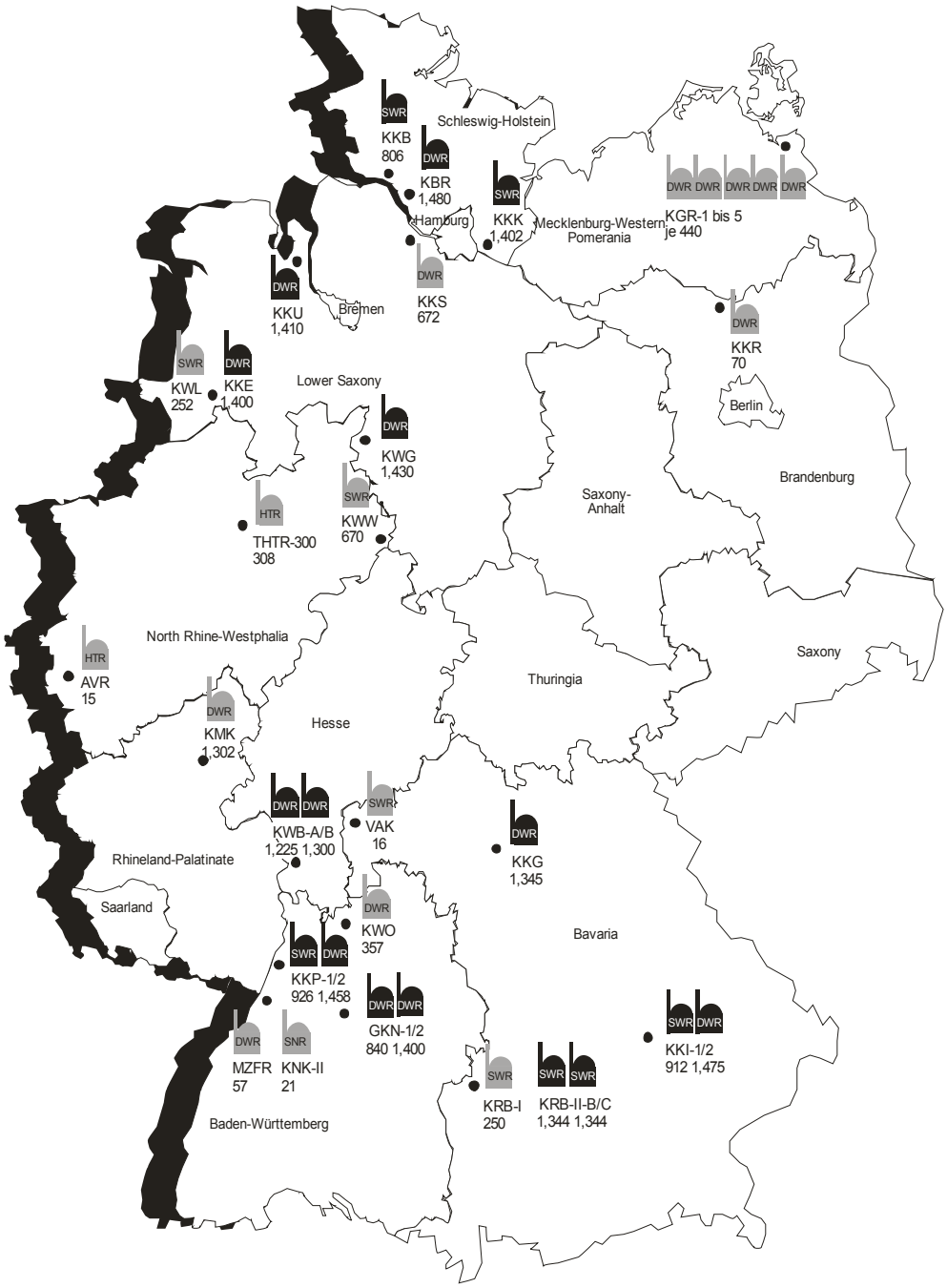
Table I.4: Nuclear power plants entirely dismantled and released from regulatory control

NPP	Site	Land	Operator	Type	Gross capacity [MWe]	Start of con-struction	Initial criticality	Final shut-down	Status
Super-heated Steam Reactor	Großwelzheim	BY	Forschungszentrum Karlsruhe GmbH	SSR	25	01/1965	14.10.1969	20.04.1971	Entirely dismantled
Nieder-aichbach	Niederaichbach	BY	Forschungszentrum Karlsruhe GmbH	PTR	106	06/1966	17.12.1972	31.07.1974	Entirely dismantled

.

Table I.5: Stopped nuclear power plant projects

NPP	Site	Land	Operator	Type	Gross capacity [MWe]	Start of construction	Final shut-down	Status
Greifswald Unit 6	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	1976	30.11.1989	Licence of 30.06.1995 et seqq. for decomm./dismantl. entire facility
Greifswald Unit 7	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	1976		Project stopped
Greifswald Unit 8	Lubmin	MV	Energiewerke Nord GmbH	PWR	440	1976		Project stopped
Sodium-cooled Fast Breeder Reactor 300	Kalkar	NRW	Schnell-Brüter-Kernkraftwerksgesellschaft mbH	FBR	327	1973		Project stopped 20.03.1991
Stendal A	Stendal	ST	Altmark Industrie GmbH	PWR	1,000	1976		Project stopped
Stendal B	Stendal	ST	Altmark Industrie GmbH	PWR	1,000	1976		Project stopped



Legend

In operation

Under decommissioning or decommissioning was decided

Figures: Gross capacity MWe

Status: As at 31.12.2008

Figure 1: Nuclear power plants in Germany

ANNEX II – RESEARCH REACTORS –

Status: as at 31.12.2008

Table II.1: Research reactors in operation

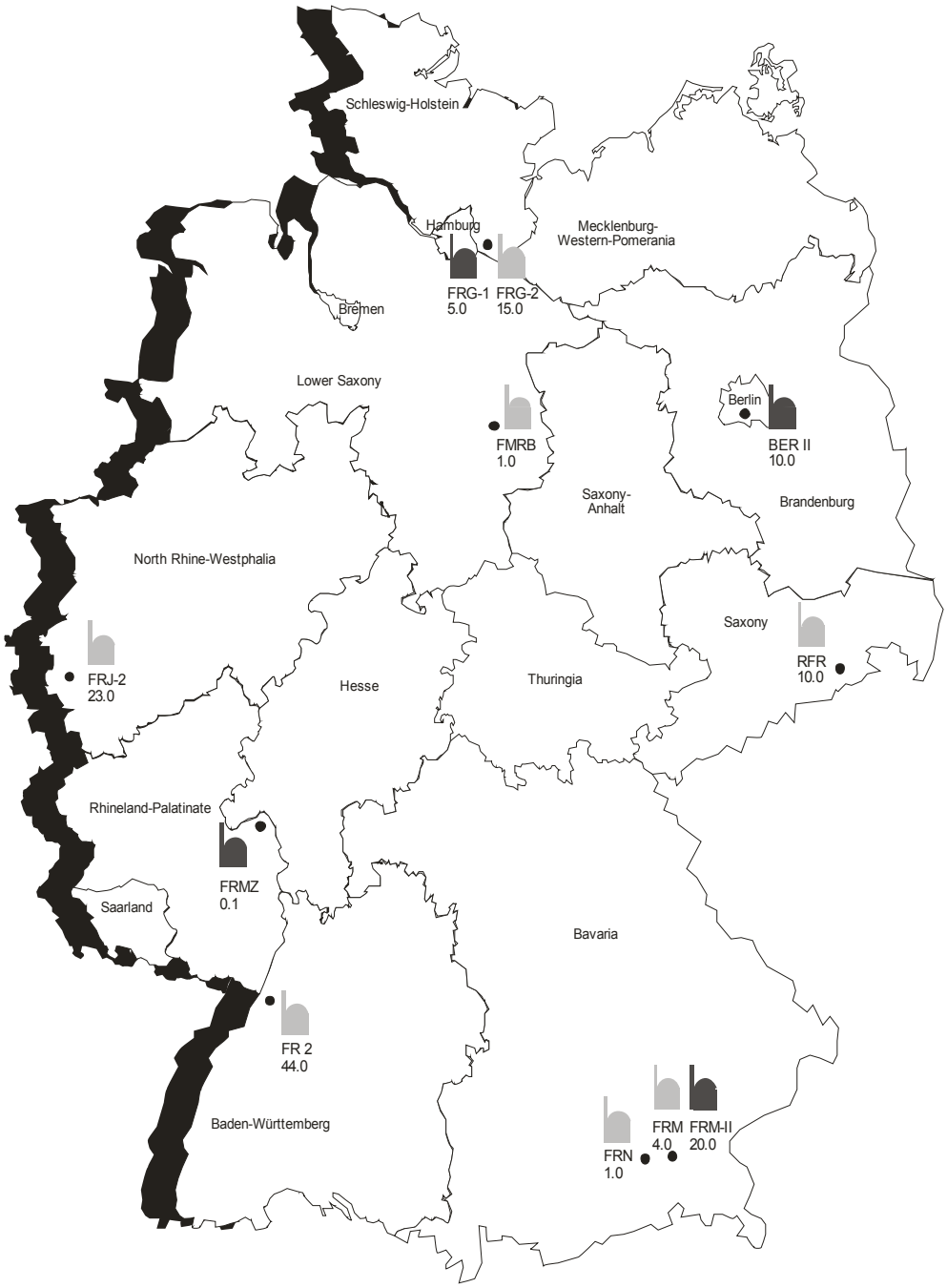
RR	Site	Land	Operator	Type	Thermal power [MWth]	Thermal neutron flux [$cm^{-2} \cdot s^{-1}$]	Initial criticality	Status
Berlin Experimental Reactor Unit II	Berlin	BE	Helmholtz-Zentrum Berlin (HMI)	Pool, MTR	10	$1.5 \cdot 10^{14}$	09.12.1973	In operation
Munich High-flux Neutron Source II	Garching	BY	Technische Universität München (TUM)	Pool, Compact core	20	$8 \cdot 10^{14}$	02.03.2004	In operation
Research Reactor Mainz	Mainz	RP	Universität Mainz Institut für Kernchemie	Pool, Triga Mark II	0.1	$4 \cdot 10^{12}$	03.08.1965	In operation
RR Geesthacht Unit 1	Geesthacht	SH	GKSS-Forschungszentrum Geesthacht GmbH (GKSS)	Pool, MTR	5	$1.4 \cdot 10^{14}$	23.10.1958	In operation

Table II.2: Research reactors under decommissioning or decommissioning was decided

RR	Site	Land	Operator	Type	Th. power [MWth]	Thermal neutron flux [$cm^{-2} \cdot s^{-1}$]	Initial criticality	Out of operation	Status
Karlsruhe RR Unit 2	Egg.-Leo-poldshafen	BW	Forschungszentrum Karlsruhe GmbH	Tank type D_2O reactor	44	$1 \cdot 10^{14}$	07.03.1961	21.12.1981	Decommissioning licence (DL) of 03.07.1986 et seqq., Safe Enclosure since 20.11.1996
RR Munich	Garching	BY	Technische Universität München (TUM)	Pool, MTR	4	$7 \cdot 10^{13}$	31.10.1957	28.07.2000	Application for decommissioning of 14.12.1998
RR Neuherberg	Ober-schleißheim	BY	Helmholtz Zentrum München, Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH	Pool, Triga Mark III	1	$3 \cdot 10^{13}$	23.08.1972	16.12.1982	DL of 30.05.1983, Safe Enclosure since 24.05.1984
Research and Measuring Reactor Braun-schweig	Braun-schweig	NI	Physikalisch Technische Bundesanstalt Braunschweig (PTB)	Pool, MTR	1	$6 \cdot 10^{12}$	03.10.1967	19.12.1995	DL of 02.03.2001, facility released from regulatory control by 28.07.2005, except for interim storage facility
RR Jülich Unit 2 (DIDO)	Jülich	NRW	Forschungszentrum Jülich GmbH (FZJ)	Tank type D_2O reactor	23	$2 \cdot 10^{14}$	14.11.1962	02.05.2006	Application for decommissioning of 27.04.2007
RR Geesthacht Unit 2	Geesthacht	SH	GKSS-Forschungs-zentrum Geesthacht GmbH (GKSS)	Pool, MTR	15	$1.5 \cdot 10^{14}$	16.03.1963	28.01.1993	Licence for taking out of operation and partial dismantling of 17.01.1995, decommissioning later on with FRG-1
RR Rossendorf (RFR)	Rossendorf	SN	Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V. (VKTA)	Tank type WWR-S(M)	10	$1.2 \cdot 10^{14}$	16.12.1957	27.06.1991	DL of 30.01.1998 et seqq., final partial licence for residual dismantling of 01.02.2005

Table II.3: Research reactors entirely dismantled and released from regulatory control

RR	Site	Land	Operator	Type	Thermal power [MWth]	Thermal neutron flux [$cm^{-2} \cdot s^{-1}$]	Initial criticality	Out of operation	Status
TRIGA HD I RR Heidelberg	Heidelberg	BW	Deutsches Krebsforschungszentrum (DKFZ)	Pool, Triga Mark I	0.25	$1 \cdot 10^{13}$	26.08.1966	31.03.1977	Released from regulatory control on 13.12.2006, within the scope of the clearance procedure, probable conventional dismantling of the building in 2009
TRIGA HD II RR Heidelberg	Heidelberg	BW	Deutsches Krebsforschungszentrum (DKFZ)	Pool, TRIGA Mark I	0.25	$1 \cdot 10^{13}$	28.02.1978	30.11.1999	Released from regulatory control on 13.12.2006
RR Frankfurt Unit 2	Frankfurt	HE	Johann Wolfgang Goethe Universität Frankfurt	Modified TRIGA	1	$3 \cdot 10^{13}$ (designed)	No criticality	Not operated	Released from regulatory control on 31.10.2006
RR of the Hannover Medical School	Hannover	NI	Hannover Medical School	Pool, TRIGA Mark I	0.25	$8.5 \cdot 10^{12}$	31.01.1973	18.12.1996	Released from regulatory control on 13.03.2008
RR Jülich Unit 1 (MERLIN)	Jülich	NRW	Forschungszentrum Jülich GmbH (FZJ)	Pool, MTR	10	$1.1 \cdot 10^{14}$	24.02.1962	22.03.1985	Released from regulatory control on 23.11.2007
"Otto Hahn" Nuclear Ship	Geesthacht	SH	GKSS-Forschungszentrum Geesthacht GmbH (GKSS)	FDR, Ship reactor	38	$2.8 \cdot 10^{13}$	26.08.1968	22.03.1979	Released from regulatory control on 01.09.1982, storage of reactor pressure vessel according to StrlSchV



Legend

In operation

Under decommissioning or decommissioning was decided

Figures: Thermal power MW

Status: As at 31.12.2008

Figure II: Research reactors with a continuous thermal power above 50 kW

ANNEX III – PLANTS OF NUCLEAR FUEL SUPPLY AND WASTE MANAGEMENT

Status: as at 31.12.2008

Table III.1: Uranium enrichment plants

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
GRONAU URANIUM ENRICHMENT PLANT (UAG) **NRW**	Uranium enrichment up to a fraction of max. 6 % U-235	4,500 Mg of uranium separative work per year (SW/a) according to notification of 14.02.2005	3. partial licence: 04.06.1985 (operation licence) 9. partial licence: 31.10.1997; capacity increase to 1800 Mg SW/a 7. partial/modification licence: 27.11.1998, modification licence for 2 further separation halls Notification no. 7/6 of 14.02.2005 on increase of production capacity to 4500 Mg of SW/a	The licence of 14.02.2005 also comprises the handling of depleted and enriched uranium (up to max. 6 percent by weight U-235). The expanded plant has been constructed since mid 2008 and will be gradually commissioned.

Table III.2: Fuel element fabrication plants

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
ANF FUEL ELEMENT FABRICATION PLANT **Lingen** **NI**	Fabrication of mainly LWR fuel elements of low-enriched uranium dioxide	Handling and processing of annually altogether 650 Mg of uranium in the form of uranium powder or uranium pellets with up to 5 % U-235-fraction	Operation licence of 18.01.1979, 7. partial operation licence of 08.06.1994 (operation of conversion plant with enriched uranium) 07.03.1997: Capacity increase of fuel element fabrication by 250 Mg of externally produced uranium pellets per year 11.01.2005: Increase of uranium powder throughput rate to 650 Mg per year	According to § 6 AtG ANF stores on their premises certain types of radioactive waste from their own fuel element fabrication determined for disposal and UF_6 for third parties

Table III.3: Fuel element fabrication plants under decommissioning or released from regulatory control

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
SIEMENS FUEL ELEMENT FABRICATION PLANT, PLANT SECTION KARLSTEIN **BY**	Fabrication of special fuel elements of low-enriched uranium dioxide	Annual throughput of 400 Mg of UO_2 up to max. 4.0 % U-235 fraction	Operation licence according to § 9 AtG: 02.09.1966 Operation licence according to § 7 AtG: 30.12.1977 Licence according to § 7 AtG for dismantling of plant components: 16.08.1994 and 18.03.1996 Released from regulatory control March 1999	Fuel element fabrication has been discontinued; conventional fabrication of ends
SIEMENS FUEL ELEMENT FABRICATION PLANT HANAU **PLANT SECTION: MOX-PROCESSING** **HE**	Fabrication of MOX fuel elements of plutonium and uranium mainly for use in LWR	Throughput of about 35 Mg HM/a, expansion to 120 Mg of HM/a was planned	15.08.1968: Operation licence according to § 9 AtG: Last comprehensive licence according to § 9 AtG 30.12.1974 Operation licence according to § 7 AtG: 11.03.1991 Several partial licences for removing the fuel from the production line and dismantling of the plant for MOX fuel from 1997 to 2005 Released from regulatory control Sept. 2006	In April 1994, the operator decided to not re-commission the old plant. The fabrication facilities have been dismantled. Government custody has been terminated. Dismantling work completed in July 2006.
SIEMENS FUEL ELEMENT FABRICATION PLANT, HANAU **PLANT SECTION: URANIUM-PROCESSING** **HE**	Fabrication of LWR fuel elements of low-enriched uranium	Throughput 1,350 Mg U/a	Operation licence according to § 9 AtG: 22.07.1969 Operation licence according to § 7 AtG: 31.08.1990 Several individual and partial licences for removing the fuel of the production line and for dismantling the facility from 1996 to 2001 Released from regulatory control May 2006	Fabrication of uranium fuel elements stopped in October 1995. Dismantling work incl. remediation of the premises was completed in January 2006. Groundwater decontamination is still continuing (licence according to § 7 StrlSchV).

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
NUKEM FUEL ELEMENT FABRICATION PLANT **Hanau-Wolfgang** **HE**	Fabrication of special fuel elements of enriched uranium and thorium for research reactors	100 kg U-235 enrichment up to 20 %; 1,700 kg U-235 enrichment between 20 % and 94 %; 100 Mg natural uranium; 100 Mg depleted uranium; 200 Mg thorium	Operation licence according to § 9 AtG: 30.07.1962 Several licences for decommissioning, dismantling and remediation of premises between 1993 and 2001 In May 2006 released from regulatory control, except for a partial area of 1000 m^2 for further groundwater decontamination	Operation licence discontinued on 15.01.1988; by 31.12.1988 the fuel was removed from the production line Dismantling works and soil remediation have been completed. Groundwater remediation is still continuing.
Hochtemperatur-Brennelement-Gesellschaft (HOBEG) **Hanau** **HE**	Fabrication of ball-shaped fuel elements for high-temperature reactors (HTR) on the basis of uranium (up to 94 % of uranium 235) and thorium	200,000 fuel elements per year 11.7 Mg HM (during operation time)	Operation licence according to § 9 AtG: 30.12.1974 6 licences for decommissioning between 30.01.1990 and 07.04.1995 On 18.12.1995 released from regulatory control	The facility was temporarily taken out of operation on 15 January 1988, and was decommissioned later on. The components relating to process engineering were dismantled. Decontamination of premises and building has been completed. Premises and buildings are used by Nuclear Cargo & Service GmbH.

Table III.4: Central fuel element interim storage facilities

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
TRANSPORT CASK STORAGE FACILITY IN THE INTERIM STORAGE FACILITY NORTH (ZLN) **Rubenow (near Greifswald)** **MV**	Storage of spent fuel elements from the Rheinsberg and Greifswald reactors in transport and storage casks (dry storage).	585 Mg HM in max. 80 storage casks Max. storable activity: 7.5×10^{18} Bq	According to § 6 AtG of 05.11.1999 1. modification licence of 14.03.2001. modification licence of 07.07.2003 3. modification licence of 19.12.2005 4. modification licence of 17.02.2006 5. modification licence of 17.12.2008	On 31.12.2008 65 casks of the CASTOR® 440/84 type were stored in the ZLN.
TRANSPORT CASK STORAGE FACILITY GORLEBEN (TBL-G) **Gorleben** **NI**	Storage of spent fuel elements in transport and storage casks and of solidified HAW fission product solutions and other radioactive waste (dry storage).	3,800 Mg HM or 420 cask storing positions Max. storable activity: 2×10^{20} Bq	05.09.1983 according to § 6 AtG; order for immediate enforcement of 06.09.1988 New licence of 02.06.1995 for spent fuel elements and vitrified fission product solutions 1. modification licence of 01.12.2000. 2. modification licence of 18.01.2002 3. modification licence of 23.05.2007	On 31.12.2008, altogether 91 casks were stored in the TBL-G 5 casks of which contained spent fuel elements, 86 casks HAW vitrified waste block canisters

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
TRANSPORT CASK STORAGE FACILITY AHAUS (TBL-A) **Ahaus** **NRW**	Storage of spent fuel elements in transport and storage casks of the CASTOR® type (dry storage).	420 cask storing positions (LWR) Capacity up to altogether max. 3,960 Mg HM Max. storable activity: 2 x 10^{20} Bq	10.04.1987 acc. to § 6 AtG Amended version of the storage licence of 07.11.1997 (increase of the mass of HM and licence for further cask types) 1. modification licence of 17.05.2000. 2. modification licence of 24.04.2001 3. modification licence of 30.03.2004 4. modification licence of 04.07.2008 5. modification licence of 22.12.2008	In April 1995 the emplacement of 305 CASTOR® THTR/AVR casks with fuel elements of the THTR-300 was terminated. In 1998, 3 CASTOR® V/19 and 3 CASTOR® V/52 were additionally transported to the TBL-A. In 2005, 18 CASTOR® MTR 2 casks were stored that had been transported from Rossendorf to Ahaus

Table III.5: DECENTRALISED INTERIM STORAGE FACILITIES

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
ON-SITE INTERIM STORAGE FACILITY NECKARWESTHEIM **Gemmrigheim** **BW**	Storage of spent fuel elements from units GKN 1 and GKN 2 of the Neckar Joint NPP	1,600 Mg of heavy metal in up to 151 transport and storage casks with up to 8.3 x 10^{19} Bq activity and 3.5 MW heat release.	According to § 6 AtG of 22.09.2003 1. modification licence of 22.03.2006 2. modification licence of 28.09.2006 1. amendment to the licence of 03.09.2007	Start of construction 17.11.2003 First emplacement 06.12.2006 At the end of 2008, altogether 27 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY PHILIPPSBURG **Philippsburg** **BW**	Storage of spent fuel elements from units 1 and 2 of the Philippsburg NPP	1,600 Mg of heavy metal in up to 152 transport and storage casks with up to 1.5 x 10^{20} Bq activity and 6.0 MW heat release.	According to § 6 AtG of 19.12.2003 1. modification licence of 05.10.2006 2. modification licence of 21.12.2006	Start of construction 17.05.2004 First emplacement 19.03.2007 At the end of 2008, altogether 26 casks were stored in the interim storage facility
INTERIM STORAGE FACILITY OBRIGHEIM NPP **Obrigheim** **BW**	Storage of spent fuel elements and core components from the Obrigheim NPP (wet storage)	980 fuel elements (ca. 286 Mg HM)	26.10.1998 acc. to § 7 AtG	On 31.12.2008, altogether 342 fuel elements were in the wet storage facility
ON-SITE INTERIM STORAGE FACILITY GRAFENRHEINFELD **Grafenrheinfeld** **BY**	Storage of spent fuel elements from the Grafenrheinfeld NPP	800 Mg of heavy metal in up to 88 transport and storage casks with up to 5 x 10^{19} Bq activity and 3.5 MW heat release.	According to § 6 AtG of 12.02.2003 Order for immediate enforcement of 10.09.2003 1. modification licence of 31.07.2007	Start of construction 22.09.2003 First emplacement 27.02.2006 At the end of 2008, altogether 10 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY GUNDREMMINGEN **Gundremmingen** **BY**	Storage of spent fuel elements from units B and C of the Gundremmingen NPP	1,850 Mg of heavy metal in up to 192 transport and storage casks with up to 2.4 x 10^{20} Bq activity and 6.0 MW heat release.	According to § 6 AtG of 19.12.2003 Order for immediate enforcement of 28.07.2004 1. modification licence of 02.06.2006	Start of construction 23.08.2004 First emplacement 25.08.2006 At the end of 2008, altogether 17 casks were stored in the interim storage facility

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
ON-SITE INTERIM STORAGE FACILITY ISAR **Niederaichbach** **BY**	Storage of spent fuel elements from Isar 1 and Isar 2 NPPs	1,500 Mg of heavy metal in up to 152 transport and storage casks with up to 1.5 x 10^{20} Bq activity and 6.0 MW heat release.	According to § 6 AtG of 22.09.2003 Order for immediate enforcement of 28.05.2004 1. modification licence of 11.01.2007 2. modification licence of 29.02.2008	Start of construction 14.06.2004 First emplacement 12.03.2007 At the end of 2008, altogether 12 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY BIBLIS **Biblis** **HE**	Storage of spent fuel elements from units A and B of the Biblis NPP	1,400 Mg of heavy metal in up to 135 transport and storage casks with up to 8.5 x 10^{19} Bq activity and 5.3 MW heat release.	According to § 6 AtG of 22.09.2003 1. modification licence of 20.10.2005 1. amendment to the licence of 20.03.2006 2. modification licence of 27.03.2006	Start of construction 01.03.2004 First emplacement 18.05.2006 At the end of 2008, altogether 41 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY GROHNDE **Grohnde** **NI**	Storage of spent fuel elements from the Grohnde NPP	1,000 Mg of heavy metal in up to 100 transport and storage casks with up to 5.5 x 10^{19} Bq activity and 3.75 MW heat release.	According to § 6 AtG of 20.12.2002 Order for immediate enforcement of 19.09.2005 1. modification licence of 17.04.2007	Start of construction 10.11.2003 First emplacement 27.04.2006 At the end of 2008, altogether 12 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY LINGEN (EMSLAND) **Bramsche (near Lingen)** **NI**	Storage of spent fuel elements from the Emsland NPP	1,250 Mg of heavy metal in up to 125 transport and storage casks with up to 6.9 x 10^{19} Bq activity and 4.7 MW heat release.	According to § 6 AtG of 06.11.2002 with order for immediate enforcement 1. amendment to the licence of 31.07.2007 1. modification licence of 01.02.2008	Start of construction 18.10.2000 First emplacement 10.12.2002 At the end of 2008, altogether 24 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY UNTERWESER **Rodenkirchen** **NI**	Storage of spent fuel elements from the Unterweser NPP	800 Mg of heavy metal in up to 80 transport and storage casks with up to 4.4 x 10^{19} Bq activity and 3.0 MW heat release.	According to § 6 AtG of 22.09.2003 Order for immediate enforcement of 05.02.2007 1. modification licence of 27.05.2008	Start of construction 19.01.2004 First emplacement 18.06.2007 At the end of 2008, altogether 3 casks were stored in the interim storage facility

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
AVR CASK STORAGE FACILITY IN THE FZJ **Jülich** **NRW**	Storage of spent AVR fuel elements in transport and storage casks of the CASTOR® type	Up to 300,000 AVR fuel elements in max. 158 CASTOR® THTR/AVR casks	Notification according to § 6 AtG of 17.06.1993 1. modification licence of 27.04.1995 2. modification licence of 07.07.2005	On 31.12.2008, 149 casks of the CASTOR® THTR/AVR type were stored in the interim storage facility.
ON-SITE INTERIM STORAGE FACILITY KRÜMMEL **Krümmel (near Geesthacht)** **SH**	Storage of spent fuel elements from the Krümmel NPP	775 Mg of heavy metal in up to 80 transport and storage casks with up to 9.6 x 10^{19} Bq activity and 3.0 MW heat release.	According to § 6 AtG of 19.12.2003 1. modification licence of 16.11.2005 Order for immediate enforcement of 28.04.2006 2. modification licence of 17.10.2007	Start of construction 23.04.2004 First emplacement 14.11.2006 At the end of 2008, altogether 14 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY BROKDORF **Brokdorf** **SH**	Storage of spent fuel elements from the Brokdorf NPP	1,000 Mg of heavy metal in up to 100 transport and storage casks with up to 5.5 x 10^{19} Bq activity and 3.75 MW heat release.	According to § 6 AtG of 28.11.2003 1. modification licence of 24.05.2007	Start of construction 05.04.2004 First emplacement 05.03.2007 At the end of 2008, altogether 6 casks were stored in the interim storage facility
ON-SITE INTERIM STORAGE FACILITY BRUNSBÜTTEL **Brunsbüttel** **SH**	Storage of spent fuel elements from the Brunsbüttel NPP	450 Mg of heavy metal in up to 80 transport and storage casks with up to 6.0 x 10^{19} Bq activity and 2.0 MW heat release.	According to § 6 AtG of 28.11.2003 Order for immediate enforcement of 28.10.2005 1. modification licence of 14.03.2008	Start of construction 07.10.2003 First emplacement 05.02.2006 At the end of 2008, altogether 6 casks were stored in the interim storage facility

Table III.6: External waste interim storage facilities

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
COLLECTING DEPOT OF THE UTILITIES MITTERTEICH **BY**	Interim storage of waste with negligible heat generation from Bavarian nuclear facilities	40,000 waste packages (200-l, 400-l, or cast-iron casks)	Licences for use and manipulation according to § 3 StrlSchV of 07.07.1982	In operation since July 1987.
INTERIM STORAGE FACILITY NORTH (ZLN) **Rubenow** **MV**	Interim storage of operational and decommissioning waste of the Greifswald and Rheinsberg NPPs with interim storage of the dismantled large components	200,000 m^3	Licence for use and manipulation according to § 3 StrlSchV of 20.02.1998	In operation since March 1998. Since 11.12.2007 the ZLN is licencee of storage of radioactive substances from other nuclear facilities with LWR with five years prior to and after a treatment/ conditioning each.
WASTE STORAGE FACILITY ESENSHAMM **NI**	Storage of waste with negligible heat generation from the Unterweser and Stade NPPs	200-l and 400-l drums, concrete casks, steel-plate casks, concrete containers, cast-iron casks with a total activity of up to 1.85 x 10^{15} Bq	Licences for use and manipulation according to § 3 StrlSchV of 24.06.1981, 29.11.1991, and 06.11.1998	In operation since autumn of 1981.
WASTE STORAGE FACILITY GORLEBEN (DRUM STORAGE FACILITY) **NI**	Storage of waste with negligible heat generation from NPPs, medicine, research, and crafts	200-l, 400-l-drums, possibly with lost concrete shielding, type-III concrete casks, type-I-II cast-iron casks, type-I-IV casks with a total activity of up to 5 x 10^{18} Bq	Licences for use and manipulation according to § 3 StrlSchV of 27.10.1983, 13.10.1987, and 13.09.1995	In operation since October 1984.

Table III.7: Reprocessing plants (under decommissioning)

Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
KARLSRUHE REPROCESSING PLANT (WAK) Eggenstein-Leopoldshafen **BW**	Experimental plant for reprocessing and technology development	0.175 Mg HM/day; ca. 40 Mg UO_2/a	Operation WAK: 1. partial operation licence according to § 7 AtG of 02.01.1967 Decommissioning WAK: 1. decommissioning licence, March 1993 20. decommissioning licence according to § 7 AtG: 31.01.2006 Construction VEK 1. partial licence according to § 7 AtG for modification work at the WAK in the process of constructing the vitrification plant (VEK): 30.12.1998 3. partial building licence according to § 7 AtG (complete finishing of the VEK): 15.11.2001 Modification licence to 3. partial building licence, 19.07.2005 (construction of a transport provision area for loaded CASTOR® casks) Operation VEK: 1. partial building licence for the VEK 20.12.2005 (non-nuclear commissioning)	The plant was commissioned in 1971. At the end of 1990 reprocessing operations were stopped. Decommissioning has been initiated. The installations of the process building have been largely dismantled. The storage facility for high-level radioactive waste (HWL) is now being dismantled, too. A vitrification plant for HAWC was constructed and gradually inactive commissioning started in November 2006. In 2007, the facility was tested for three months in non-nuclear combined operation.

Table III.8: Conditioning plants for fuel elements

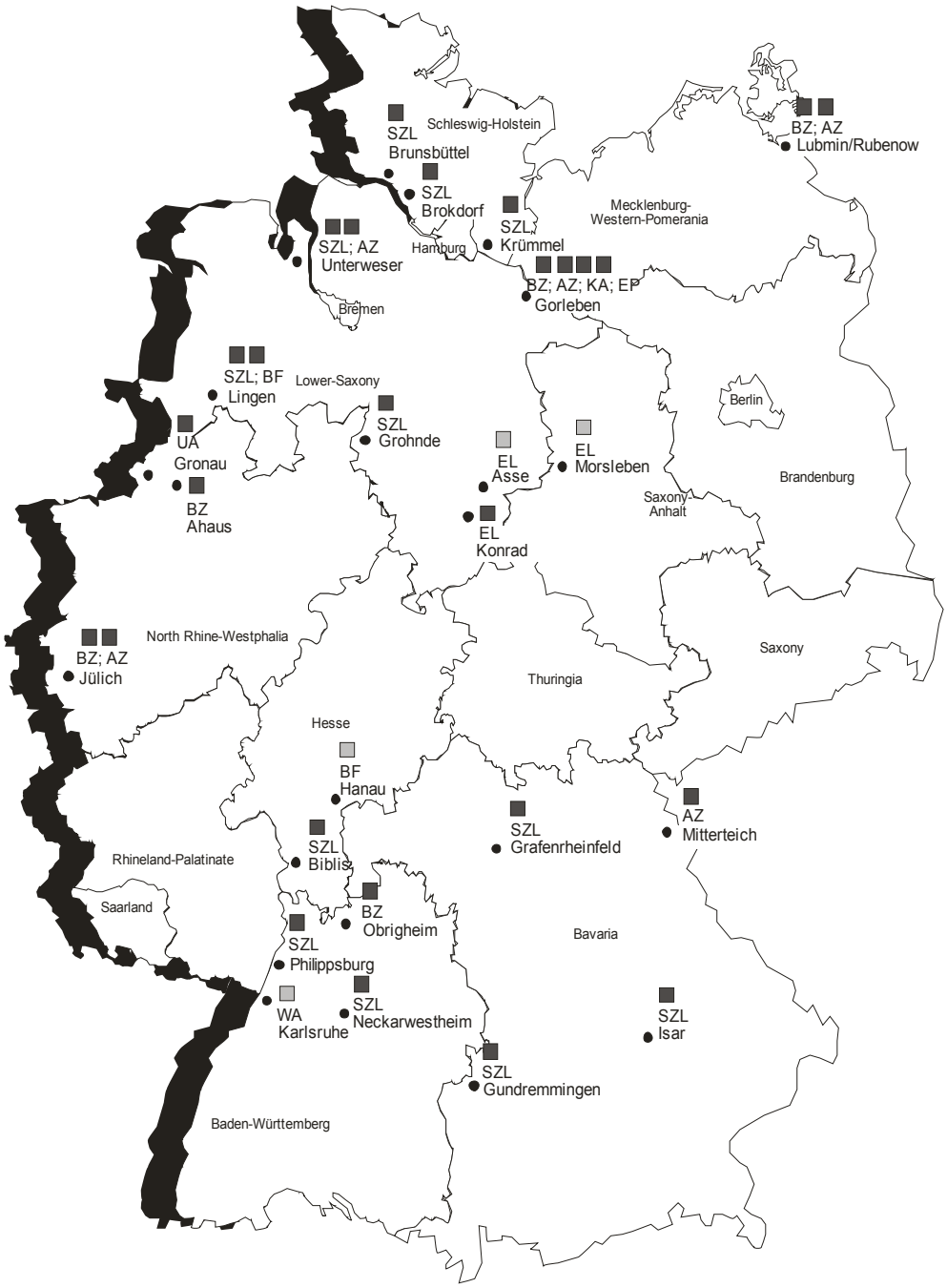
Name of plant and site	Purpose of the plant	Capacity according to licence	Licence	Notes
PILOT CONDITIONING PLANT (PKA) Gorleben **NI**	Repair of defective casks, conditioning of radioactive residues and waste (among others, spent fuel elements, fuel rods and fuel element components) for interim storage and disposal	Heavy metal throughput applied for: 35 Mg/a Capacity of operational buffer storage facility: 12 Mg HM	According to § 7 AtG 1. partial licence: 30.01.1990) 2. partial licence: 21.07.1994) (Subsequently imposed obligation of 18.12.2001) 3. partial licence: 19.12.2000 (includes operation licence)	According to the 3rd partial licence the use of the plant is at first restricted to the repair of defective storage casks. An additional requirement to the 2nd partial licence ensures that one is ready to accept defective casks at any time.

Table III.9: Disposal

Name of facility and site	Purpose of the facility	Amounts disposed of / activity	Licence	Notes
MINE FOR THE EXPLORATION OF THE GORLEBEN SALT DOME **Gorleben** **NI**	Proof that the site is suitable for hosting a repository for all types of radioactive waste		Application according to § 9b AtG in 1977 (plan-approval application)	The geological host rock formation is rock salt. To clarify conceptual and safety-related questions the exploration of the Gorleben salt dome was discontinued for a period between 3 years (minimum) and 10 years (maximum) (Gorleben Moratorium).
KONRAD REPOSITORY **Salzgitter** **NI**	Disposal of radioactive waste with negligible heat generation		Application according to § 9b AtG in 1982 (plan-approval application) Withdrawal of application for immediate enforcement with BfS letter of 17.07.2000. The plan-approval decision (licence) was granted on 22.05.2002. After legal remedies have been exhausted (claims against the plan-approval decision), it is legally binding and can be implemented. One citizen's constitutional complaint is still pending. With approval of the main operating plan on 15 January 2008, this licence was granted for a term of six years. Thus, also the second licence needed for construction is available.	The geological host rock formation is coral oolite (iron ore). Undeneath an impermeable barrier of the Cretaceous.

Name of facility and site	Purpose of the facility	Amounts disposed of / activity	Licence	Notes
ASSE REPOSITORY FOR RADIOACTIVE WASTE **Remlingen** **NI**	Research and development work for the disposal of radioactive and chemico-toxic waste	Between 1967 and 1978 ca. 24,500 LAW and ca. 1,300 MAW waste packages were emplaced. Total activity 4.1 x 10^{15} Bq (01.01.2002), 40 % of which are contained in the MAW	Licence according to § 3 StrlSchV as amended on 15.10.1965	The geological host rock formation is rock salt. Decision of BMBF, BMU, and NMU of 4 September 2008, that the Asse II mine is to be procedurally operated as a repository.[4]
MORSLEBEN REPOSITORY FOR RADIOACTIVE WASTE (ERAM) **Morsleben** **ST**	Disposal of low-level and medium-level radioactive waste with mainly short-lived radionuclides	Disposal of altogether 36,753 m^3 of low-level and medium-level radioactive waste, total activity of all radioactive waste stored is in the order of magnitude of less than 6 x 10^{14} Bq, the activity of the alpha-emitters is in the order of magnitude of 10^{11} Bq.	22.04.1986: Continuous operating licence (DBG) granted. According to § 57a AtG it continued to be effective until 30.06.2005; through amendment to the AtG in 2002, the DBG is effective for an unlimited period of time as plan-approval decision, except for the regulations relating to the acceptance of further radioactive waste or its emplacement for the purpose of disposal. 12.04.2001: Declaration of renunciation of accepting further radioactive waste for disposal	The geological host rock formation is rock salt. Emplacement operations stopped on 25.09.1998. Conversion of the mine and keeping it open were applied for on 10.07.2003. Decommissioning was applied for on 09.05.1997. The documents to be laid open to public inspection which are required for the public participation procedure were submitted to the licensing authority (MLU) with letter of 12.09.2005. The documents were revised in 2008, in order to submit them again to the licensing authority MLU in February 2009.

[4] After editorial deadline: On 1 January 2009, BfS took over the operatorship of the Asse from HMGU.



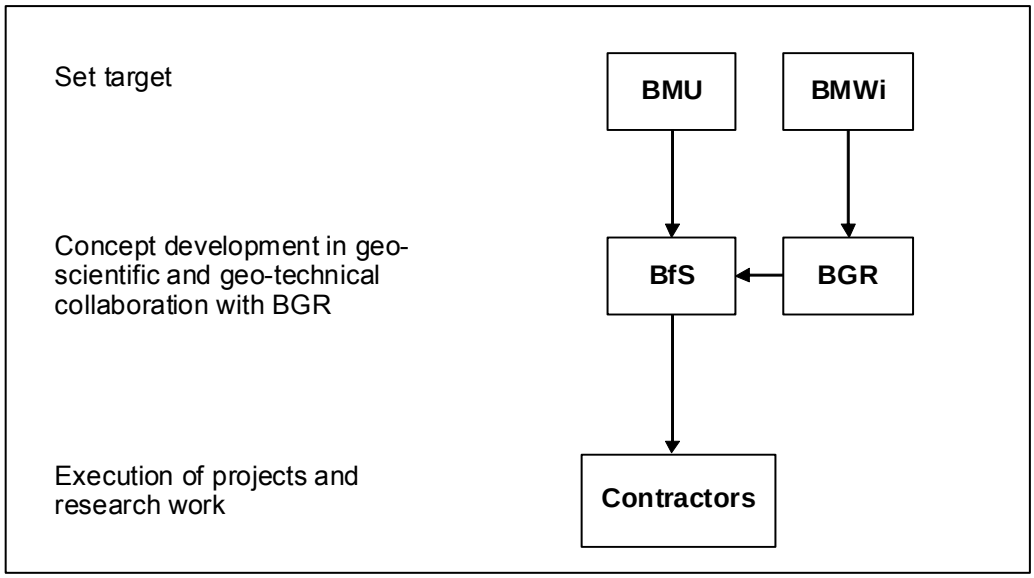
Legend

AZ	Interim storage facility for rad. Waste	KA	Pilot conditioning plant
BF	Fuel element fabrication plant	SZL	On-site interim storage facility
BZ	Fuel element interim storage facility	UA	Uranium enrichment plant
EL	Repository for radioactive waste	WA	Reprocessing plant
EP	Planned Repository project		

In operation/ planned
under decommissioning

Status: As at 31.12.2008

Figure III.1: Sites of nuclear fuel supply and waste management



BMU

According to the Atomic Energy Act (AtG), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) is the federal ministry competent for nuclear safety and radiation protection. It supervises BfS.

BMWi

The Federal Ministry of Economics and Technology (BMWi) is responsible for the staff number and quality of BGR as Superior Federal Authority in its portfolio.

BfS

The Federal Office for Radiation Protection (BfS) is responsible for the construction and operation of federal facilities for the long-term storage and disposal of radioactive waste.
It initiates and coordinates facility-related research and development work. For implementing its tasks BfS can avail itself of third parties (§ 9a para. 3 AtG). It imposes prepayments/contributions and costs on the parties liable to pay.

BGR

The Federal Institute for Geosciences and Natural Resources (BGR) has the task to support BfS in geoscientific and geotechnical questions associated with the planning, construction, operation, and decommissioning of repositories.

Contractors

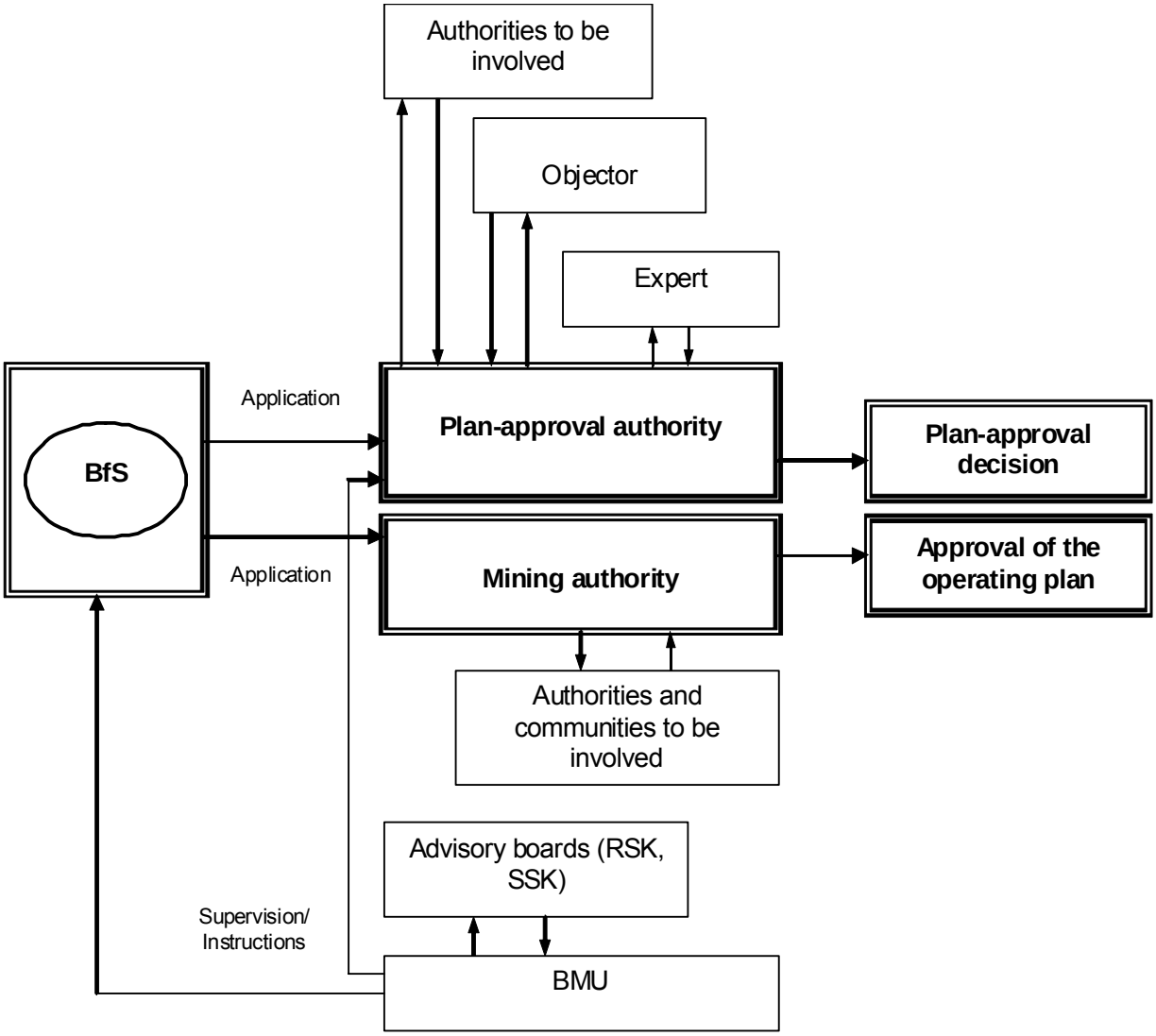
a) Large research institutions

On behalf of BMBF they perform basic research and, on behalf of BfS, facility-related research and development work. Contractors of BfS are, among others, the Helmholtz Zentrum München – Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH (former GSF), Gesellschaft für Reaktorsicherheit (GRS), the Forschungszentrum Karlsruhe GmbH (FZK), and the Forschungszentrum Jülich GmbH (FZJ).

b) DBE mbH

On behalf of BfS, the German Company for the Construction and Operation of Waste Repositories (DBE) performs tasks on the planning, construction, and operation of federal facilities for the long-term storage and clearance of radioactive waste. DBE is third party in the sense of the provisions set out in § 9a para. 3 AtG.

Figure III.2: Competencies in radioactive waste disposal



The diagram shows the links between the parties in the nuclear plan-approval procedure and in mining law procedures.

Legend:

BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BfS	Bundesamt für Strahlenschutz (Federal Office for Radiation Protection)
RSK	Reaktorsicherheitskommission (Reactor Safety Commission)
SSK	Strahlenschutzkommission (Commission on Radiological Safety)

Figure III.3: Course of the nuclear plan-approval (licensing) procedure and the procedures according to Mining Law

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