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Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

Report of the Federal Republic of Germany for the Third Review Meeting
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List of Abbreviations

AkEnd	<i>Arbeitskreis Auswahlverfahren Endlagerstandorte</i> (Committee on a Selection Procedure for Repository Sites)
ALG	<i>Abfalllager Gorleben</i> (Gorleben Interim Storage Facility/Waste Store)
AREVA NC	AREVA Nuclear Cycle (formerly COGEMA)
AtG	<i>Atomgesetz</i> (Atomic Energy Act)
AtSMV	<i>Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung</i> (Nuclear Safety Officer and Reporting Ordinance)
AtVfV	<i>Atomrechtliche Verfahrensverordnung</i> (Nuclear Licensing Procedures Ordinance)
AVK	<i>Abfallfluss-, Verfolgungs- und Produkt-Kontrollsystem</i> (Waste flow tracking and product control system)
AVR	<i>Arbeitsgemeinschaft Versuchsreaktor GmbH</i> (Experimental nuclear power plant in Jülich)
BAFA	<i>Bundesamt für Wirtschaft und Ausfuhrkontrolle</i> (Federal Office of Economics and Export Control)
BAM	<i>Bundesanstalt für Materialforschung und -prüfung</i> (Federal Institute for Materials Research and Testing)
BfS	<i>Bundesamt für Strahlenschutz</i> (Federal Office for Radiation Protection)
BGBI.	<i>Bundesgesetzblatt</i> (Federal Law Gazette)
BLG	<i>Brennelement-Lager Gorleben</i> (Fuel element storage facility at Gorleben)
BMBF	<i>Bundesministerium für Bildung und Forschung</i> (Federal Ministry of Education and Research)
BMU	<i>Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit</i> (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BNFL	British Nuclear Fuels Ltd.
BVerwG	<i>Bundesverwaltungsgericht</i> (Federal Administrative Court)
BWR	Boiling Water Reactor
CEA	Commissariat à l'Énergie Atomique (Paris)
COGEMA	Compagnie Générale des Matières Nucléaires
CSD-C	<i>Colis Standard des Déchets Compactés</i> (Radioactive waste compacted under high pressure)
DBE	<i>Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH</i> (German Service Company for the Construction and Operation of Waste Repositories)
GDR	German Democratic Republic
DESY	<i>Deutsches Elektronen-Synchrotron</i>
DIN	<i>Deutsches Institut für Normung e. V.</i> (German Institute for Standardisation)
EAN	European Article Numbering
EBA	<i>Eisenbahn-Bundesamt</i> (Federal Office for Railways)
EIA	Environmental Impact Assessment

ERAM	<i>Endlager für radioaktive Abfälle Morsleben</i> (Repository for Radioactive Waste Morsleben)
EURATOM	European Atomic Energy Community
EUROCHEMIC	European Company for the Chemical Processing of Irradiated Fuels
EU	European Union
EVU	<i>Energieversorgungsunternehmen</i> (Electric Power Utility)
EW	Exempt waste
FRJ	<i>Forschungsreaktor Jülich</i> (Research reactor Jülich)
FRM	<i>Forschungsreaktor München, Garching</i> (Research reactor Munich, Garching)
FZD	<i>Forschungszentrum Dresden-Rossendorf e.V</i> (Research Centre Dresden-Rossendorf)
FZJ	<i>Forschungszentrum Jülich GmbH</i> (Research Centre Jülich GmbH)
FZK	<i>Forschungszentrum Karlsruhe GmbH</i> (Research Centre Karlsruhe GmbH)
GKSS	<i>Forschungszentrum Geesthacht GmbH (formerly: Gesellschaft für Kernenergie- verwertung in Schiffbau und Schifffahrt mbH)</i> (Research Centre Geesthacht GmbH)
GNS	<i>Gesellschaft für Nuklear-Service mbH</i>
GorlebenVSpV	<i>Gorleben-Veränderungssperren-Verordnung</i> (Gorleben Development Freeze Ordinance)
GRB	<i>GRB - Sammelstelle Bayern für radioaktive Stoffe GmbH</i> (Bavarian collecting facility for radioactive substances)
GSI	<i>Gesellschaft für Schwerionenforschung mbH</i>
GSF	<i>Helmholtz Zentrum München - Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH (ehemals: Gesellschaft für Strahlenforschung)</i> (Helmholtz Zentrum München – German Research Centre for Environmental Health GmbH)
HAW	High Active Waste
HAWC	High Active Waste Concentrate
HDB	<i>Hauptabteilung Dekontaminationsbetriebe des Forschungszentrums Karlsruhe</i> (Central Decontamination Department of the Karlsruhe Research Centre)
HDR	<i>Heißdampfreaktor, Großwelzheim</i> Superheated Steam Reactor, Großwelzheim
HEU	Highly Enriched Uranium
HGF	<i>Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren</i>
HGK	<i>Hochtemperatur-Kernkraftwerk GmbH</i>
HLW	High-level waste
HMI	<i>Hahn-Meitner-Institut für Kernforschung</i>
HRQ	<i>Hochradioaktive Quellen</i> (High Active Sources)
HTR	<i>Hochtemperaturreaktor</i> (High Temperature Reactor)
IAEA/IAEO	International Atomic Energy Agency/ <i>Internationale Atomenergie Organisation</i>
ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
ILW	Intermediate-level waste

IMIS	<i>Integriertes Mess- und Informationssystem zur Überwachung der Umweltradioaktivität</i> (Integrated Measurement and Information System for Monitoring Environmental Radioactivity)
INES	International Nuclear Event Scale
ISO	International Organisation for Standardisation
ITU	<i>Europäisches Institut für Transurane</i> (European Institute for Transuranic Elements)
KFA	<i>Kernforschungsanlage Jülich</i> (now FZJ)
KfK	<i>Kernforschungszentrum Karlsruhe</i> (now FZK)
KKN	<i>Kernkraftwerk Niederaichbach</i> (Niederaichbach Nuclear Power Plant)
KKS	<i>Kernkraftwerk Stade</i> (Stade Nuclear Power Plant)
KNK II	<i>Kompakte Natriumgekühlte Kernreaktoranlage, Karlsruhe</i> (Compact sodium-cooled nuclear reactor plant, Karlsruhe)
KRB-A	<i>Kernkraftwerk Gundremmingen Block A</i> (Gundremmingen Nuclear Power Plant, Unit A)
KTA	<i>Kerntechnischer Ausschuss</i> (Nuclear Safety Standards Commission)
KWU	<i>Kraftwerk Union AG</i>
LAA	<i>Länderausschuß für Atomkernenergie</i> (Länder (Federal States) Committee on Nuclear Power)
LBA	<i>Luftfahrtbundesamt</i> (Federal Civil Aviation Authority)
LAW	Low Active Waste
LLW	Low-level waste
LWR	Light Water Reactor
MAW	Medium Active Waste
Mg SM	10 ⁶ g (1 metric ton) heavy metal
MOX	Mixed oxide
MTR	<i>Materialtestreaktor</i> (Material testing reactor)
MZFR	<i>Mehrzweckforschungsreaktor, Karlsruhe</i> (Multi-purpose research reactor, Karlsruhe)
NCS	Nuclear Cargo + Service GmbH
NEA	Nuclear Energy Agency
NORM	Naturally Occurring Radioactive Material
NPP	Nuclear Power Plant
OECD	Organisation for Economic Co-operation and Development
OJ EC	Official Journal of the European Communities
PAE	<i>Projektgruppe Andere Entsorgungstechniken des Forschungszentrum Karlsruhe</i> (Project Group for Alternative Waste Management Techniques, Karlsruhe Research Centre)
PKA	<i>Pilot-Konditionierungsanlage, Gorleben</i> (Pilot Conditioning Plant, Gorleben)
PSR	Periodic safety review
PUREX	Plutonium-Uranium Recovery by Extraction
PWR	Pressurised water reactor
RPV	Reactor pressure vessel
REI	<i>Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen</i> (Directive concerning emission and immission monitoring of nuclear power plants)

ReVK	<i>Reststofffluss-Verfolgungs- und Kontrollsystem</i> (Software system for the documentation, methodical tracking and management of radioactive materials and waste)
RFR	Rosendorfer Forschungsreaktor (Rossendorf research reactor)
RSK	<i>Reaktorsicherheitskommission</i> (Reactor Safety Commission)
SKB	Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Co)
SSK	<i>Strahlenschutzkommission</i> (Commission on Radiological Protection)
STEAG	<i>Steinkohlen-Elektrizitäts AG</i>
StrISchV	<i>Strahlenschutzverordnung</i> (Radiation Protection Ordinance)
SUR	<i>Siemens Unterrichtsreaktor</i> (Siemens research reactor designed for training purposes)
SZL	<i>Standortzwischenlager</i> (On-site interim storage facility)
TBL	<i>Transportbehälterlager</i> (Transport Cask Storage Facility)
TBL-A	<i>Transportbehälterlager Ahaus</i> (Transport Cask Store Ahaus)
TBL-G	<i>Transportbehälterlager Gorleben</i> (Transport Cask Store Gorleben)
THTR	<i>Thorium-Hochtemperaturreaktor, Hamm-Uentrop</i> (Thorium High-Temperature Reactor, Hamm-Uentrop)
TRIGA	Training, Research and Isotope Production Facility of General Atomic (Reactor)
TU	<i>Technische Universität</i> (Technical University)
UKAEA	United Kingdom Atomic Energy Agency
VAK	<i>Versuchsatomkraftwerk Kahl</i> (Experimental nuclear power plant, Kahl)
VEK	<i>Verglasungseinrichtung Karlsruhe</i> (Karlsruhe vitrification plant)
VKTA	<i>Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V.</i>
VLLW	Very-low-level waste
VSLW	Very-short-lived waste
WAK	<i>Wiederaufbereitungsanlage Karlsruhe</i> (Karlsruhe reprocessing plant)
WTI	<i>Wissenschaftlich-Technische Ingenieurberatung GmbH</i>
WWER	Water-cooled and water-moderated energy reactor (Soviet design)
ZAB	<i>Zwischenlager für abgebrannten Brennstoff, Greifswald</i> (Interim storage facility for spent fuel, Greifswald)
ZAW	<i>Zentrale Aktive Werkstatt, Greifswald</i> (Central active workshop, Greifswald)
ZfK	<i>Zentralinstitut für Kernforschung, Rossendorf</i> (Central Institute for Nuclear Research, Rossendorf)
ZLN	<i>Zwischenlager Nord, Greifswald</i> (Interim Storage Facility "Nord", Greifswald)
ZLO	<i>Zwischenlager Obrigheim</i> (Interim Storage Obrigheim)

A. Introduction

A.1. Structure and Content of the Report

The Federal Government will continue to meet Germany's existing international obligations, particularly with regard to fulfilment of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. In submitting this report, Germany is demonstrating its compliance with the Joint Convention and how it ensures the safe operation of facilities for the management of spent fuel and radioactive waste, including the decommissioning of nuclear installations. At the same time, there is also still a need for future action in order to continue maintaining the required high standards of safety and ensure disposal.

The report to the Joint Convention follows the guidelines regarding the form and structure of national reports. As such, it is divided into sections which address the individual articles of the Convention as prescribed in the guidelines. An introduction considering the historical and political development of nuclear power use is followed by a comment on each individual obligation. Statements made in the report tend to be of a generic nature, although plant-specific details are given wherever necessary in order to illustrate compliance with the requirements of the Convention.

In order to demonstrate compliance with the obligations, explanatory comments are given on the pertinent national laws, ordinances and standards, and descriptions are provided of the manner in which essential safety requirements are met. In the current national report, special emphasis is placed on describing the licensing procedure and state supervision, as well as the measures applied by the operators at their own responsibility for maintaining an appropriate standard of safety.

The report contains a list of nuclear facilities currently in operation as defined by this Convention, including an overview of the safety-relevant design characteristics of those installations, classified according to their management of spent fuel or radioactive waste, together with a list of decommissioned and dismantled installations, plus a comprehensive list of the legal and administrative provisions, statutory regulations and guidelines in the field of nuclear power which are relevant to the safety of the facilities as defined by this Convention and which are referred to in this report.

The third German national report does not merely include modifications of the second report but provides an integrated overall description. Any major amendments since the report for the Second Review Meeting in May 2006 are summarised at the end of respective sections in a special chapter (Progress made or major changes since the last Review Meeting).

The information provided by the report applied as at the deadline of 31 March 2008 unless expressly specified otherwise.

The third German report under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was jointly revised and updated by organisations dealing with the safe disposal of spent fuel assemblies and radioactive waste in Germany. These are the nuclear regulatory authorities of the Federation and different Federal States (*Länder*), supported by expert organisations, as well as representatives of energy utilities and their most important service provider, Gesellschaft für Nuklear-Service mbH, who is an important waste originator. The report was approved by the Federal Cabinet at its meeting on 24 September 2008.

According to the national regulations of the Federal Republic of Germany, which are in line with the international requirements, the residual materials arising from former uranium ore mining are not counted among the radioactive waste, which is why these activities are - as in the National Report for the second Review Meeting 2006 - presented in a separately annexed report describing the status of the ecological restoration as at the end of the year 2007.

To justify this procedure, reference is made to the fact that according to § 118 of the Radiation protection Ordinance (StrlSchV) [1A-8] pursuant to Art. 9 para. 2 in combination with Ann. II, Chapter XII, Section III nos. 2 and 3 of the Unification Treaty of 31 August 1990 (BGBl. II 1990, p. 885) [1A-4] individual regulations of the former GDR shall continue to apply in the New Federal States to the ecological restoration of the legacies of former workings as well as to the decommissioning and ecological restoration of the operational installations and sites of uranium ore mining if any radioactive materials, especially the decay products of radon, are present. These regulations are:

- the Ordinance on the Guarantee of Atomic Safety and Radiation Protection (VOAS) of 11 October 1984 together with the implementing regulation regarding the Ordinance on the Guarantee of Atomic Safety and Radiation Protection and
- The Regulation for Guaranteeing Radiation Protection in Connection with Heaps and Industrial Tailings Ponds and the Use of Materials Deposited there (HaldenAO).

Compared with other regulations on radioactive waste, both Ordinances ensure a different treatment, taking into account the slight radioactivity and the special characteristics of the former Wismut workings and the current Wismut ecological restoration actions. Materially, radiation protection is fully taken into consideration.

Such an approach is necessary as the StrlSchV can only be applied with restrictions or not at all to ecological restoration in the area of former mining activities. The VOAS is based in its radiation protection principles on the recommendations of the International Commission on Radiological protection (ICRP 26 of 1977 and ICRP 32 of 1981). Regarding the classification of the materials arising at the uranium ore mining locations and other legacies (contaminated sites), it is necessary that the terminology and exemption limits of the above-mentioned regulations of the former GDR be used due to their continued application. In the case of heap materials and tailings as well as other waste materials at the Wismut sites and the contaminated sites of uranium ore mining, the waste arising is generally not radioactive waste according to the VOAS or the implementing regulation regarding the VOAS. More detailed technical explanations regarding these regulations were already provided in the report and the answers for the second Review Meeting in 2006.

A national legal consideration of the residues from uranium ore mining and processing according to the regulations of the VOAS and the HaldenAO does not contradict the requirements nor the purpose of the Joint Convention. What is essential for reaching the objectives of the Convention (Chapter 1, Art. 1 i to iii) and their review is a transparent structure of the measures. This transparency is to be ensured by the respective National Reports. In its previous two reports, Germany provided comprehensive information at the Review Meetings on the ecological restoration activities and the progress made; the intention is to keep doing so. The only difference to other views which hold that information in this respect is mandatory is that the accounts are given not as part of the National Report but rather in a separately annexed report. This approach does not, however, mean that those Contracting Parties which interpret the purpose of the Joint Convention differently from Germany are denied any information that they need for the mutual verification of whether the safety objectives formulated in the Joint Convention have been reached.

A.2. Historical Development

In the Federal Republic of Germany, research and development into the civil use of nuclear energy began in 1955 after the Federal Republic of Germany had officially renounced the development and possession of nuclear weapons. The research and development programme was based on intensive international co-operation and included the construction of several prototype reactors, as well as the elaboration of concepts for a closed nuclear fuel cycle and for the final storage of radioactive waste in deep geological formations.

In 1955, the Federal Government established the Federal Ministry for Nuclear Affairs and Germany became a founder member of the European Atomic Energy Community (EURATOM) and the Nu-

clear Energy Agency (NEA) of the OECD. With the aid of US manufacturers, German power plant manufacturers began to develop commercial nuclear power plants (Siemens/Westinghouse for PWR, AEG/General Electric for BWR).

In subsequent years, the following nuclear research centres were founded in West Germany:

- 1956 in Karlsruhe (Kernforschungszentrum Karlsruhe, KfK, now Forschungszentrum Karlsruhe, FZK),
in Jülich (Kernforschungsanlage Jülich, KFA, now Forschungszentrum Jülich, FZJ)
in Geesthacht (Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt, GKSS, now Forschungszentrum GKSS),
- 1959 in Berlin (Hahn-Meitner-Institut für Kernforschung, HMI, now Hahn-Meitner-Institut, HMI),
in Hamburg (Deutsches Elektronen-Synchrotron, DESY),
- 1969 in Darmstadt (Gesellschaft für Schwerionenforschung, GSI).

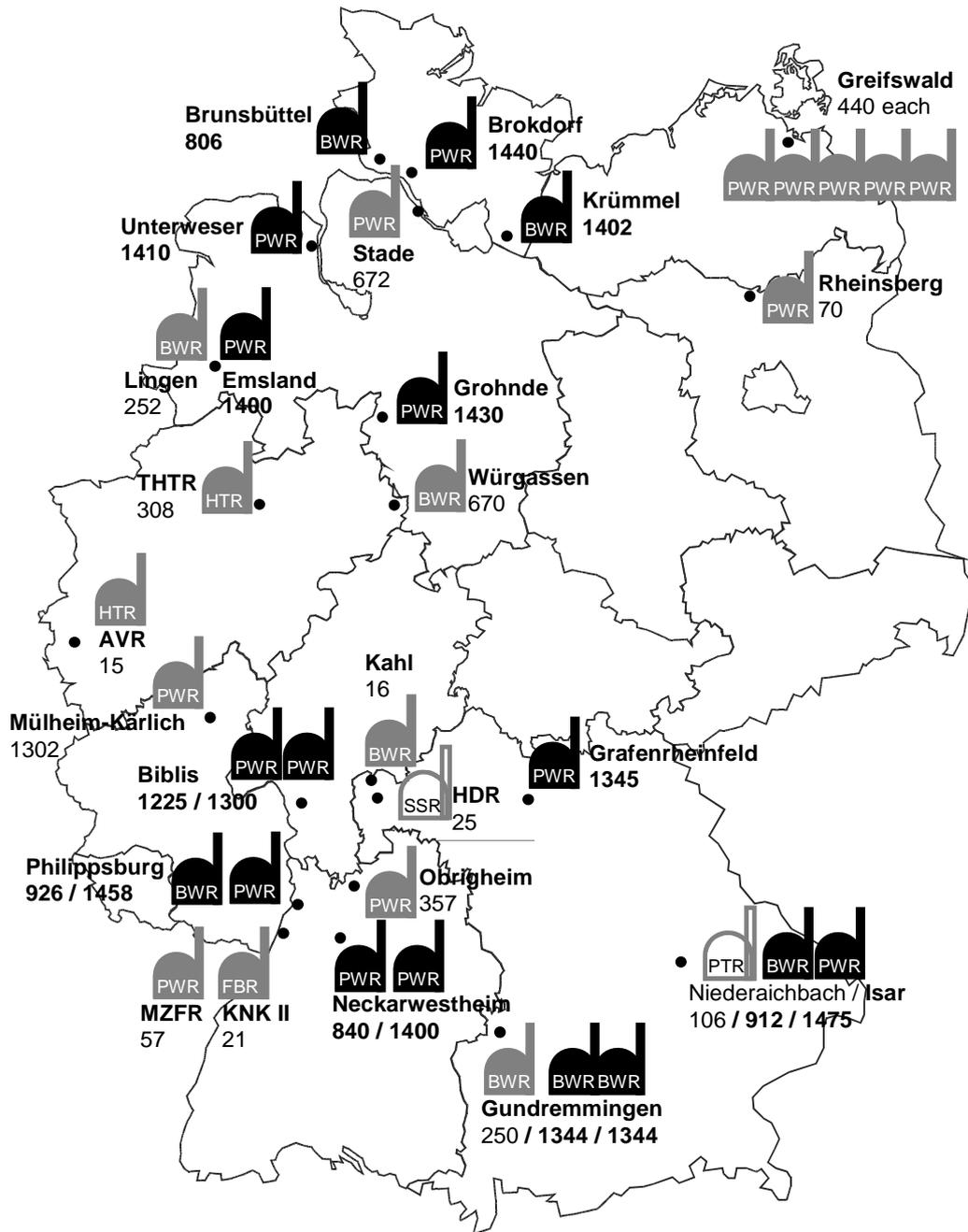
Many universities were equipped with research reactors. The FRM research reactor in Garching was the first to go critical on 31 October 1957, and the most recent licence was granted on 2 May 2003 (3rd partial licence for the operation) for the FRM II research reactor at the same site. The operation was started in the year 2004.

In 1958, the first German nuclear power plant, the 16 MWe experimental nuclear power plant (VAK) in Kahl, was ordered from General Electric and AEG, and became operational in 1960. Between 1965 and 1970, this was followed by further orders for power reactors with 250-350 MWe and 600-700 MWe respectively.

In the years that followed, larger power reactors (PWR and BWR) were built by the company Kraftwerk Union (KWU) with a capacity of 1 300 MWe, the last of which commenced operation in 1988. Since then, nuclear energy has accounted for just about 26 % of electricity production in Germany. The power reactors are operated with enriched uranium (up to 4.7 % U-235) and MOX fuel assemblies containing recycled plutonium originating from the reprocessing of German fuel assemblies in France and the United Kingdom.

Reactors with a lower output from the early years of nuclear power use have since been taken out of operation, and are in varying stages of decommissioning. Two of them have been dismantled and the land recultivated. Three larger power reactors have likewise been deactivated. Dismantling at Würgassen is far advanced, whilst in the case of Mülheim-Kärlich it has been started; as to Stade, two decommissioning licences have been granted in the years 2005 and 2006 (for details cf. Table L-14). The Obrigheim nuclear power plant was closed down on 11 May 2005; an application for decommissioning had been made on 21 December 2004. The nuclear power plant is currently in its post-operational phase. The geographical situation of the operating and decommissioned German nuclear power plants is shown in Figure A-1.

Figure A-1: Nuclear Power Plants in Germany



05/2007

Legend	
PWR	Pressurized Water Reactor
BWR	Boiling Water Reactor
FBR	Fast Breeder Reactor
HTR	High Temperature Reactor
PTR	Pressure Tube Reactor
SSR	Superheated Steam-Cooled Reactor
	in operation
	shut down
	completely dismantled

Numbers indicate gross capacity [MWe]

In the 1950s, West Germany likewise began to independently develop reactors, with close collaboration between the nuclear research centres and industry. This led to the construction of a number of experimental reactors. Worth mentioning in this connection are the order placed in 1958 with BBK/BBC for the experimental 15 MWe *Arbeitsgemeinschaft Versuchsreaktor* (AVR) high-temperature pebble-bed reactor at the former Jülich Nuclear Research Facility, and the order placed in 1961 with Siemens for the 57 MWe multi-purpose research reactor (MZFR), a heavy water PWR. In the early Sixties, development work began on a fast breeder at the former Karlsruhe Nuclear Research Centre. This was later followed by the construction of two prototypes, a high-temperature pebble-bed reactor on the basis of thorium (Thorium High Temperature Reactor – THTR-300) and a fast breeder (SNR-300), each with a capacity of 300 MWe. The THTR was shut down after six years of operation (1983 until 1989) and is currently in safe enclosure; the fuel assemblies used are stored in the Ahaus Transport Cask Store. Although the SNR was completed, it was never loaded with fuel assemblies. The SNR fuel assemblies that had been produced already are being processed in France into mixed-oxide (MOX) fuel assemblies for light water reactors.

In 1955, the GDR began developing its nuclear programme for the peaceful use of nuclear energy, and was supported by the Soviet Union. In 1956, the Central Institute for Nuclear Research (ZfK) was founded in Rossendorf near Dresden, where a research reactor supplied by the Soviet Union started operation in 1957. At the turn of 1991/1992, the facilities went into the ownership of the FZR Rossendorf Research Centre (now Forschungszentrum Dresden-Rossendorf e. V. (FZD)) (research tasks) and Nuclear Engineering and Analytics Rossendorf Inc. (Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V. VKTA) (operation of nuclear installations).

The first commercial reactor – a 70-MWe pressurised water reactor of Soviet design – was built in Rheinsberg and reached criticality in 1966. It was decommissioned on 1 June 1990. Between 1973 and 1989, five pressurised water reactors, four of the WWER-440/230 type and one of the WWER-440/W-213 type, started operation in Greifswald. During the course of German reunification, all five of these reactors were shut down and are now being dismantled. At the same time, the construction of five further WWER reactors at Greifswald and Stendal was discontinued.

In total, 19 nuclear power plants in Germany are currently in the process of decommissioning or have been dismantled, or else decommissioning has been applied for (cf. Table L-14 in the Annex). The 17 power units still in operation are due to be decommissioned gradually over the next fifteen years as stipulated in the agreement between the federal government and the utilities of 11 June 2001 (initialled on 14 June 2001) [BUN 00].

As early as in the 1950s, nuclear waste management was included in all planning activities. A Memorandum of the German Atomic Commission, an advisory committee to the former Ministry for Atomic Issues, of 9 December 1957 already pointed out the need for comprehensive development in the field of waste management. The importance of safe radioactive waste management was emphasised by the legislator in an amendment of the Atomic Energy Act (AtG) [1A-3] in 1976 which included the new § 9a that demanded the proper disposal of radioactive waste. Furthermore, the Principles Relating to the Provision to be Made for the Handling and Disposal of Spent Fuel of Nuclear Power Plants, which were amended by decision of the heads of government of the Federation and the *Länder* on 28 September 1979 (Deutscher Bundestag, Drucksache 11/1632) to include the disposal of the German nuclear power plants, stipulated as a prerequisite for licences to commission and operate the nuclear power plants that the guaranteed safekeeping of the spent fuel assemblies had to be demonstrated six years in advance.

Regarding the commercial use of nuclear power in Germany, in addition to power reactors, other nuclear fuel cycle facilities and especially facilities for the orderly disposal of all radioactive waste arising also began to emerge.

In the 1970s, the German utilities (EVU) planned to build a centre where all activities connected with the fuel cycle and waste management would be concentrated on one site, the so-called “integrated disposal centre”. This nuclear disposal centre (*Nukleares Entsorgungszentrum*, NEZ), con-

sisting of a reprocessing plant, fuel fabrication plants for uranium and MOX fuel assemblies, waste management facilities for all types of waste and a repository for all this waste, was to be constructed at the site of Gorleben in Lower Saxony (cf. Chapter H.3.3). Plans for the centre, with the exception of the repository project, were later shelved in 1979, whereupon the utilities turned instead to plans for a scaled-down project which would be confined to the reprocessing, the fabrication of MOX fuel assemblies and the treatment of radioactive waste at the site of Wackersdorf in Bavaria. In 1989, the utilities subsequently resolved to abandon this project, and the on-going licensing procedure was cancelled. From then onwards, the utilities exclusively turned their attention instead to reprocessing in foreign European countries.

Various nuclear facilities dedicated to the fuel cycle and waste management have nevertheless been built in Germany. In the past, facilities for the fabrication of U, HTR and MOX fuel assemblies were operated at the Hanau site. However, these have since all been closed and dismantled; only facilities for groundwater remediation remain in operation there. A new MOX facility was built to replace the old one at this site but was never commissioned. One uranium-enrichment plant at Gronau and one fuel fabrication plant at Lingen remain operational.

The reprocessing plant at Karlsruhe (WAK) was decommissioned in 1990 and is currently in the process of being dismantled. There are plans to vitrify the highly radioactive solutions of fission products still remaining at this plant in order to prepare them for disposal. A corresponding plant for this purpose, the Karlsruhe Vitrification Plant (VEK) has been built and cold-tested. The final partial licence for hot operation of the VEK has not yet been granted.

A number of facilities are currently operational for the interim storage of spent fuels as well as the treatment, conditioning and interim storage of radioactive waste.

The amendment of the Atomic Energy Act in 2002 banned the nuclear power plants as from 1 July 2005 to ship any spent nuclear fuel to reprocessing plants (Section 9a AtG). The operators of the nuclear power plants have to demonstrate that provisions for the handling and disposal of the fuel assemblies and the radioactive waste to be taken back from reprocessing abroad have been made by the provision of adequate interim storage possibilities for the spent fuel assemblies with the objective of direct final disposal. In particular, they have to take care that near-site interim storage facilities for the storage of the fuel assemblies until their dispatch to a federal repository are built and operated.

In the meantime, on-site interim storage facilities (SZL) for spent fuel assemblies in transport and storage casks have been erected and commissioned at the sites of all operating nuclear power plants (cf. Table L-4).

The licensing procedure for the Gorleben pilot conditioning plant (PKA), which has been designed for the conditioning of spent fuel assemblies for direct disposal, was concluded in December 2000 with the granting of the 3rd partial construction licence. According to a collateral clause in the licensing decision, its operation is limited at present to the repair of defective transport and storage casks for spent fuel assemblies and HAW glass canisters. Only after the Federal Office for Radiation protection (BfS) has named a repository site and the conditioning procedure has been qualified with regard to the suitability of the generated waste products for emplacement in a repository may the PKA be operated for the conditioning of fuel assemblies at an annual throughput of up to 35 Mg HM.

Development work in the field of repositories began with the installation of the Asse mine in a disused salt mine, where low- and medium-active waste was disposed of until the end of 1978.

In the former GDR, the Morsleben repository (ERAM) located in a disused salt mine was available for the disposal of low and medium-active waste; following reunification, this repository was used for the emplacement of further low- and medium-active waste from the whole reunified Germany up until September 1998. At present, the documents for the plan approval procedure for the back-filling and closure of the Morsleben repository are being prepared.

For the Konrad mine, a former iron ore mine, plan approval was applied for in 1982 regarding the erection and operation of a repository for radioactive waste with negligible heat generation. The corresponding plan approval decision was served in May 2002. The complaints raised against the decision have been rejected by several courts up to the Federal Administrative Court. The decision has thereby become definitive. The competent authority, the Federal Office for Radiation Protection (BfS), was ordered in a letter by the BMU of 30 May 2007 to begin with the conversion of the Konrad mine into a repository for radioactive waste with negligible heat generation. Work has since then been going on with the aim of commissioning the repository in 2013.

At the Gorleben site, following above-ground exploration activities that had begun in 1979, underground exploration of the salt dome started in 1986. The exploration was to establish whether the salt dome was suitable for a repository especially for high-active waste (HAW). On the basis of the Agreement between the Federal Government and the Energy Utilities of 11 June 2001, the exploration activities carried out in the mine to explore the Gorleben salt dome have been suspended since 1 October 2000 for at least three and no longer than ten years to clarify conceptual and safety-related questions. The geological findings obtained until the start of the moratorium do not contradict a potential suitability of the Gorleben salt dome. The moratorium does not mean that Gorleben has been abandoned as a repository site. What it is rather more about is that no further investments are made during the examination of the conceptual and safety-related questions that cannot contribute to the clarification of these issues.

The *Bundesrat* (Upper House of the Federal Parliament) passed a decision on 14 May 2004 calling upon the Federal Government among other things to lift the moratorium on the exploration of the Gorleben salt dome and to bring to an end the exploration activities rapidly and without bias, but with the aim to come to a definitive statement on the suitability of Gorleben as a possible repository for heat-generating radioactive waste.

At the end of 2005, the Federal Office for Radiation Protection (BfS) presented the results of the investigations to clarify the individual safety-related issues concerning final disposal in salt rock as compared to other host rock formations. These issues included i.a. the control of gas formation that occurs due to the corrosion of the containers and the decomposition of the waste, and the suitability of salt as host rock as compared to other types of rock, such as clay and granite. The possibilities and limitations of a generic (i.e. abstract) comparison of host rock types were shown up, and the individual safety-related issues were answered. According to these findings, there is no type of host rock that would in principle always guarantee maximum repository safety. Future activities regarding the disposal of radioactive waste should therefore concentrate on site-specific safety analyses that should accompany site exploration, the comparison of different sites, and the planning of a repository in an iterative parallel process [BfS 05].

The energy utilities are of the opinion that the issues of doubt raised to justify the moratorium have been resolved in the meantime, so that there is no longer any reason not to continue the unbiased exploration of the salt dome.

The coalition partners in the Federal Government specified in their Coalition Agreement of 11 November 2005 that the solution to the repository question should be addressed in a speedy and results-oriented manner so that a solution is reached in this legislative period. At the present time, there are different views among the Federal Government on how to proceed further in the realisation of a repository for heat-generating radioactive waste. In essence, it is about the question whether the exploration of the Gorleben site – in whose principal suitability so far there are no doubts – shall be continued or whether previously a selection procedure shall be conducted in order to search for possibly better alternatives before a site is finally selected and further explored.

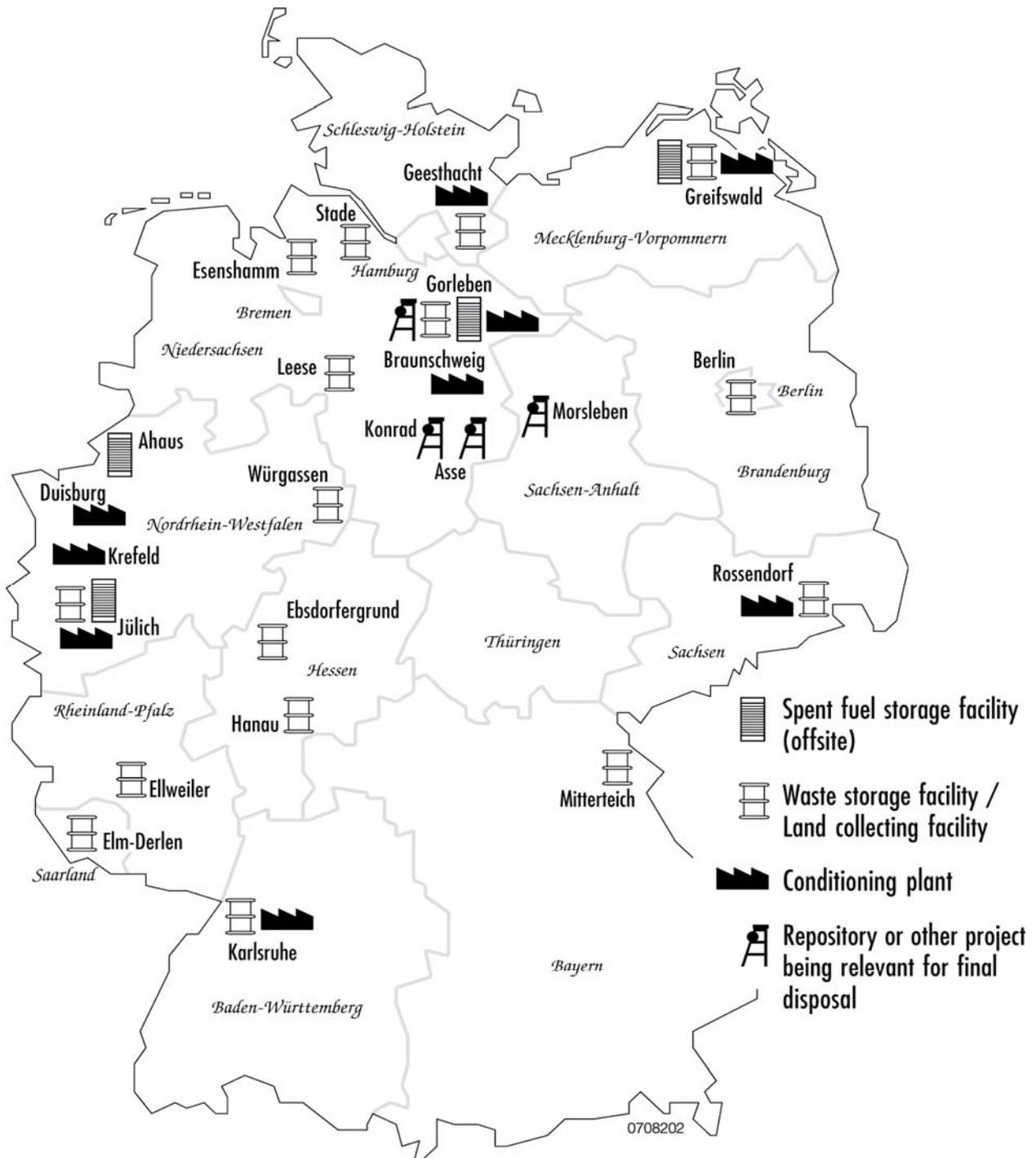
So far, the Federal Government has not made a decision on the further procedure.

In 1946, a Soviet owned stock company began mining uranium ore on the territory of what was later to become the German Democratic Republic (GDR), as from 1954 these operations were continued by the Soviet-German Wismut joint-stock company. The mining of uranium ore was terminated at

the end of 1990 following German reunification. Uranium ore mining has caused considerable environmental damage which since then has been remediated by the federally-owned company Wismut GmbH. However, the residues left over from the former uranium ore mining do not count as radioactive waste, which is why these activities are described in a report attached separately in the Annex.

The sites of the facilities for the interim storage, conditioning and disposal of spent fuel assemblies and radioactive waste - as far as they have not been erected at the locations of operating nuclear power plants - are shown in Figure A-2.

Figure A-2: Interim storage, conditioning and disposal sites



A.3. Political Development

In the past, a technical and scientific environment was established with state funds in Germany which created the foundations through corresponding research and development not only for electricity production by means of nuclear power but also for the associated fuel cycle, waste treatment and the preparations necessary for the final disposal of radioactive waste. In this context, a safety concept was developed for all the above-mentioned nuclear facilities. In 1998, the former Federal Government agreed to phase out the use of nuclear power for the commercial generation of electricity.

The Act on the Phase-out of the Use of Nuclear Energy for the Commercial Production of Electricity in a Carefully Coordinated Process of 22 April 2002 [1A-2], which is based on the Agreement between the Federal Government and the electricity utilities of 11 June 2001, created new framework conditions for the use of nuclear power in Germany. The phase-out in a carefully coordinated process is only one of the purposes of the Atomic Energy Act (AtG). The starting point for a step-by-step termination of the operation of the nuclear power plants is an average total operating life of 32 years.

Following the federal elections in 2005 and the formation of the government, it was laid down in the coalition agreement that different views persist regarding the use of nuclear power. The Agreement struck between the Federal Government and the electricity utilities on 11 June 2001 and the procedures contained therein as well as the associated regulations provided in the Atomic Energy Act remain in place unaltered.

Germany continues to be involved in international research into nuclear safety; here, the focus is on forward-looking concepts of passive safety and waste minimisation.

It was furthermore specified in the Coalition Agreement that the fractions forming the Federal Government recognise that the safe disposal of radioactive waste is a national responsibility and that they will strive for a solution of this issues speedily and in a results-oriented manner. The intention is documented to come to a solution by the year 2009.

Further aspects of the Atomic Energy Act with relevance for the Joint Convention are the following:

- The reprocessing of spent fuel assemblies from power reactors is abandoned and replaced instead by the direct disposal of the spent fuel assemblies. The shipment of spent fuel assemblies for reprocessing abroad has been banned since 1 July 2005, and the spent fuel assemblies are placed in interim storage within the grounds of the nuclear power plants until the conditions for their disposal have been created.
- Suitable precautionary measures have to be taken for the nuclear fuels returned from reprocessing. It has to be demonstrated in particular that the separated plutonium can be recycled in the German nuclear power plants. This demonstration is provided by presenting corresponding plans for the use of plutonium.
- The whereabouts of the waste resulting from reprocessing have to be documented with evidence.
- The requirements for the kind and contents of the verifications have been put in concrete terms by corresponding provisions in the Atomic Energy Act.

Further items of this agreement of 11 June 2001 that were not turned into law but which apply to the scope of the agreement have been realised:

- The licensing procedure for the pilot conditioning plant at the Gorleben site has been completed. The licence was granted in December 2000. As long as no repository site for heat-generating waste has been named, it is restricted to the repair of defective transport and storage casks for spent fuel assemblies and HAW glass canisters.

- The moratorium period for the Gorleben salt dome commenced on 1 October 2000. The mine will be kept open for the period of the moratorium, with a legal provision, the so-called Gorleben Development Freeze Ordinance (Gorleben-Veränderungssperren-Verordnung - GorlebenVspV) [1A-22], ensuring that the site is preserved and made safe in its current state. This Ordinance entered into force with its publication in the Federal Bulletin on 16 August 2005.
- The plan approval procedure for the Konrad repository was completed and a plan approval decision adopted on 22 May 2002. The decision became legally valid by the ruling of the Federal Administrative Court of 26 March 2007. The aim is to commission the repository in 2013.

It is essential to ensure the safe operation of the nuclear power plants during the remainder of their operating lives, as well as the safety of the facilities for the treatment of spent fuel assemblies and radioactive waste. To this end, an efficient and comprehensively informed supervisory system of nuclear installations is essential. In order to ensure that this remains the case, the competent government agencies in Germany will guarantee the necessary financial resources, the technical expertise of their personnel, the required level of human resources as well as an expedient and effective organisation. The regulatory authorities will take measures to ensure that this applies analogously to the operators of the facilities.

In Germany, the Basic Law (GG) [GG 49] sets forth the principles of a democratic social order, namely the government's responsibility to protect life and health and natural resources needed to sustain life, the separation of powers, the independence of licensing and supervisory authorities, and the supervision of administrative actions by independent courts. The legislation, administrative authorities and jurisdiction created specifically for the peaceful use of nuclear energy provide the framework of a system which safeguards the protection of life, health and property of those directly employed by the industry, and the general public, from the hazards of nuclear energy and the damaging effects of ionising radiation, as well as ensuring the regulation and supervision of safety during the construction and operation of nuclear installations. In accordance with the statutory requirements in the field of nuclear technology, ensuring safety is the highest priority. By applying the best available technology as a key guiding principle, measures are taken to ensure that internationally accepted safety standards as specified, for example, in the "Fundamental Safety Principles" of the IAEA [IAEA 06] are taken into account. One principal objective of the German Federal Government's safety policy in the field of nuclear energy was, and still is, that the operators of nuclear facilities should maintain and further develop a high safety culture within their own field of responsibility.

A.4. Overview

Table A-1 below has been added according to a decision of the second Review Meeting and provides an overview of the situation regarding the treatment of radioactive waste and spent fuel assemblies in Germany.

Table A-1: Treatment of radioactive waste and spent fuel elements in Germany

Waste management task	Long-term strategy	Financing	Current practice / installations	Planned installations
Spent fuel assemblies	Interim storage in casks; subsequently conditioning and direct disposal in deep geological formations	Annual refunding, as adequate for the originator, of the costs incurred by the Federation for the planning and construction of repositories according to fixed distribution key (polluter-pays principle)	4 central dry storage facilities, 12 dry storage facilities at the nuclear power plant sites, 1 wet storage facility (Obrigheim)	1 on-site interim storage facility (Obrigheim), 1 repository (site yet undecided)
Radioactive waste from the nuclear fuel cycle	Interim storage at the site of origin or centrally with the aim of disposal in deep geological formations	See "Spent fuel assemblies" (polluter-pays principle)	Conditioning and interim storage (at the site of origin or centrally)	1 repository licensed; refitting under preparation; commissioning approx. 2013
Other radioactive waste	Interim storage at central sites with the aim of disposal in deep geological formations	Waste originators pay fees to the <i>Land</i> collecting facilities (polluter-pays principle); <i>Land</i> collecting facilities pay repository cost portion to the Federation	Conditioning and interim storage (<i>Land</i> collecting facilities)	1 repository licensed; refitting under preparation; commissioning approx. 2013
Decommissioning of nuclear installations	Green field (with unrestricted release of the largest part of the radioactive waste materials)	Setting aside provisions for nuclear asset retirement by installations owned by the utilities and in the case of nuclear fuel cycle installations and financing from public funds in the case of state-owned installations (polluter-pays principle)	Direct dismantling or safe enclosure	Not relevant
Disused radiation sources	Interim storage at central sites with the aim of disposal in deep geological formations	Waste originators pay fees to the <i>Land</i> collecting facilities (polluter-pays principle)	Interim storage (<i>Land</i> collecting facilities)	1 repository licensed; refitting under preparation; commissioning approx. 2013

B. Policies and Practices

This section deals with the obligations according to Article 32 1. of the Convention.

Article 32. Reporting

1. *In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:*
 - (i) *spent fuel management policy;*
 - (ii) *spent fuel management practices;*
 - (iii) *radioactive waste management policy;*
 - (iv) *radioactive waste management practices;*
 - (v) *criteria used to define and categorise radioactive waste.*

B.1. Preliminary Note

The report explains the situation regarding the safe management of spent fuel assemblies in Germany. In Germany, the reprocessing of spent fuel assemblies would be classified under “management” within the meaning of this Convention. However, as Germany has delivered spent fuel assemblies to France and the United Kingdom for reprocessing, it will not be reported here on the reprocessing of German fuel assemblies. There are no fuel assemblies used by the military sector in Germany, and hence there is also no need to report on this aspect.

The report also explains the situation regarding the safe management of radioactive waste in Germany in the scope of this Convention. Waste with increased proportions of natural radioactivity (NORM) (cf. comments on Article 3 2.) is included in the scope of application. Waste assigned to the military sector is excluded from reporting, since management of the latter does not fall within the scope of civil supervision.

Article 26 deals exclusively with general issues of decommissioning. A report on the facilities currently in the process of decommissioning can be found in the remarks on Article 32 2. (v).

B.1.1. Spent Fuel Management Policy

Germany’s objective regarding the management of spent fuel has changed. Until 1994, the Atomic Energy Act (AtG) [1A-3] included the requirement of reusing the fissile material in the spent fuel assemblies. This requirement changed in 1994, and the operators of nuclear power stations then had the option of either re-use by means of reprocessing, or else direct disposal.

Since 1 July 2005, delivery of spent fuel assemblies from power reactors for the purposes of reprocessing has been prohibited in accordance with an amendment to the Atomic Energy Act to this effect of 22 April 2002 [1A-2]. The last fuel assemblies to be delivered for reprocessing were dispatched from the Stade nuclear power plant in May 2005. Now only the direct disposal of the spent fuel assemblies existing and arising in future in Germany is possible.

For the spent fuel assemblies which had been delivered for reprocessing until 30 June 2005, the proof of re-use must be kept of the recycled plutonium separated during reprocessing. This is designed to ensure that throughout the remaining residual operating lives of the nuclear power plants, all separated plutonium is processed in the fabrication of MOX fuel assemblies and thus re-used.

As there is as yet no repository available for the spent fuel assemblies, they will be stored intermediately at the sites where they were created until such time as the repository is commissioned, in order to avoid the transportation of spent fuel; corresponding storage facilities exist as needed.

Usually, the spent fuel assemblies from research reactors will be returned to their country of origin for disposal. If this is not possible, these too will be intermediately stored until their final transportation to the repository.

As stated in the justification of the amendment of the AtG in 2002, the aim is to construct a repository in deep geological formations for the disposal of heat-generating radioactive waste (spent fuel assemblies and high-level waste from the reprocessing of spent fuel assemblies) around the year 2030.

B.1.2. Spent Fuel Management Practices

The spent nuclear fuel delivered to France and the United Kingdom until 30 June 2005 will be reprocessed. During the period since the last report, the operators of the nuclear power plants have provided evidence of the safe re-use of all plutonium generated, generally by means of its re-use as MOX fuel assemblies in reactors, and the safe storage of all uranium.

All other types of fuel assemblies remaining in Germany, and those which will continue to be generated, will be stored in an interim storage facility until their final transportation into a repository. For this purpose, interim storage facilities have been constructed at the sites of the nuclear power plants. The spent fuel is stored dry in casks licensed for transport and storage. Spent fuel assemblies from decommissioned power reactors of Soviet design in Greifswald and Rheinsberg are likewise stored dry in casks at a central storage facility in Greifswald (Interim Storage Facility "Nord" - ZLN). An application to erect an interim storage facility for the dry storage of fuel assemblies has been submitted for the decommissioned Obrigheim nuclear power plant, where a wet storage facility is presently in operation.

B.1.3. Radioactive Waste Management Policy

From the outset, Germany's policy in the field of radioactive waste management has been directed at depositing all kinds of radioactive waste in deep geological formations.

To demonstrate the safety of a repository, the German concept of the disposal of all radioactive waste in deep geological formations provides for the backfilling of cavities and the sealing of drifts and shafts. Measures for retrieval are not part of this concept.

The legal requirement is that prior to disposal, all steps of treatment of the radioactive waste are subjected to the polluter-pays principle. Disposal itself is the responsibility of the Federal Government.

In accordance with this principle, the state obligates the producers of waste by law to ensure the controlled and safe management of radioactive waste arising during the operation and decommissioning of nuclear facilities (such as nuclear power plants and research centres). As such, they operate or order facilities in which the radioactive waste incurred may be treated and stored until its disposal; this may take place either in decentralised or centralised facilities.

Furthermore, they are also responsible for the safe management of the radioactive waste resulting from the reprocessing of German spent fuel in France and the United Kingdom following its return, which Germany is under obligation to accept.

Where not stored by the producer, radioactive waste from research, industry and medicine must be deposited in *Land* collecting facilities provided by the *Länder*. The Federal Government is obliged to accept the waste from these storage facilities for final disposal if it cannot be released once the radioactivity has decayed.

B.1.4. Radioactive Waste Management Practices

Only stable (or fixed) radioactive waste will be accepted for disposal in deep geological formations; liquid and gaseous waste is excluded from acceptance. The controlled, safe disposal of radioactive waste therefore requires its conditioning.

Conditioning comprises several stages, depending on the quality and nature of the raw waste. After targeted collection or grading (where necessary), the raw waste may first be pre-treated and then either processed into interim products or directly into packages suitable for storage or disposal.

Proven methods and reliable mobile or stationary installations already exist for the pre-treatment and conditioning of radioactive waste. Mobile conditioning installations are the preferred choice for the treatment and packaging of operational waste from nuclear power plants. Stationary installations which are capable of conditioning various different types of raw waste tend to be used primarily in the major research centres; there are also a number of other stationary conditioning installations which are operated on site by the respective polluters.

Apart from waste management at German facilities, facilities in other European foreign countries are also utilised. Radioactive waste arising from the operation of nuclear installations is delivered to Sweden for conditioning; the waste products are subsequently returned to Germany. Waste from the reprocessing of spent fuel from German power reactors is conditioned in France and the United Kingdom and are then also returned to Germany.

Both centralised and decentralised storage facilities are available for the interim storage of radioactive waste with negligible heat generation from nuclear power plants and the nuclear industry. For waste arising from the use and handling of radioisotopes in research, industry and medicine (cf. the explanatory comments on Article 32 1. (iii)), State collection facilities operated by the *Länder* (Federal States) are available for interim storage.

On the basis of the current licensing situation, heat-generating radioactive waste may be put in interim storage in the local and central interim storage facilities. Central storage facilities are available for the waste returned from reprocessing. The licences for the interim storage facilities are generally valid for a period of 40 years, starting with the emplacement of the first cask. In addition, heat-generating radioactive waste is also stored in research institutions and, to a low extent, also in *Land* collecting facilities.

Within the scope of product control, the compliance of the packages with the requirements set out in the acceptance criteria of the repository will be reviewed. The acceptance criteria of the Konrad repository [BfS 95] are relevant in this context. The product control measures concern both existing conditioned radioactive waste, as well as waste due to be conditioned in the future. They are designed in such a way as to ensure reliable detection of any packages which fail to meet the specifications.

The application of qualified conditioning methods for radioactive waste has been mandatory since 1989 [3-59]. Accompanying controls verify compliance with the waste acceptance requirements for final disposal. In the case of old waste, qualification is possible by checking samples. The measures to be carried out reach from non-destructive measurements, such as gamma spectroscopic testing, to sampling and alpha analyses.

Between 1971 and 1998, low- and medium-level radioactive waste with slight concentrations of alpha emitters was emplaced at the Morsleben repository. Since the Supreme Administrative Court of Saxony-Anhalt prohibited any further emplacement on 25 September 1998, this facility has no longer accepted any waste. At present, the documents for the plan approval procedure regarding the backfilling and sealing of the Morsleben repository are being prepared.

The plan approval notice issued on 22 May 2002 for the Konrad repository became legal on 26 March 2007 following the dismissal of the cases and the rejection of the appeals raised against

it. Following a period of approx. two years in which the repository is prepared for backfitting and a further four years to carry out the backfitting, emplacement operations are expected to start as of about the year 2013. The Konrad repository may exclusively accept German radioactive waste with negligible heat generation and a waste package volume of a maximum of 303 000 m³. This radioactive waste has to be shown to fulfil the waste acceptance requirements for final disposal, including the auxiliary conditions of the plan approval notice.

As stated in the justification of the amendment of the AtG in 2002, the aim is to construct a repository in deep geological formations for the disposal of heat-generating radioactive waste around the year 2030.

B.1.5. Criteria Used to Define and Categorise Radioactive Waste

Radioactive residues are produced during the operation of nuclear facilities and installations, as well as during the decommissioning or dismantling of such facilities. These residues are composed of reusable or recyclable materials and radioactive waste. Radioactive waste refers to materials that cannot be safely re-used and which must therefore be disposed of in a controlled way (cf. term definitions in § 2 of the Atomic Energy Act and DIN 25401 [DIN 25401], regulations governing recycling and disposal in § 9a of the Atomic Energy Act, and § 29 of the Radiation Protection Ordinance (StrlSchV) [1A-8]). The aforementioned activities may also generate material which is only marginally contaminated or activated. Provided such material is proven to comply with the clearance levels stated in Annex III, Table 1 to § 29 StrlSchV, it may be released and utilised, removed, owned or forwarded to third parties as non-radioactive materials (cf. the remarks on Article 24 2. (i) and (ii)).

In Germany, the intention is that all types of radioactive waste should be stored in deep geological formations. This applies to waste from reprocessing of spent fuel assemblies from German nuclear power plants at facilities in other European countries, as well as to waste from the operation and decommissioning and/or dismantling of commercially operated nuclear facilities, together with waste originating from the use of radioisotopes in research, trade, industry and medicine.

The intention to dispose of all types of radioactive waste in deep geological formations also makes it unnecessary to differentiate between waste containing radionuclides with comparatively short half-lives and waste containing radionuclides with comparatively long half-lives. As such, there are no measures or precautions required in order to separate the radioactive waste generated in this way.

The proper registration and description of waste is an essential pre-requisite of radioactive waste management. In accordance with the German approach to disposal, the definition and categorisation of radioactive waste (i.e. its classification) must therefore comply with the requirements for safety assessment of an underground repository. In this respect, the effects of heat generation from radioactive waste on the design and evaluation of a repository system are particularly important, since the natural temperature conditions may be significantly altered by the deposited waste. In order to meet the requirements concerning the registration and categorisation of radioactive waste from the point of view of disposal, the authorities have chosen to distance themselves from the terms LAW, MAW and HAW and opted instead for a new categorisation: Initially, waste is subjected to a basic subdivision into

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

followed by a detailed classification according to the categorisation scheme established for this purpose.

This basic subdivision into heat-generating waste and waste with negligible heat generation was implemented with particular regard for repository-relevant aspects; it also applies when the waste

packages for disposal are stored in a long-term surface interim storage facility prior to transportation into a repository.

With a few exceptions, this classification of radioactive waste is used as a basis in this report. The exceptions, in which the terms "low-active waste" (LAW) or "medium-active waste" (MAW) are used, have historical reasons. These can be put down to the fact that in these cases, the waste used to be classified according to different criteria. This concerns mainly the emplacement of radioactive waste in the Asse mine and the Morsleben repository. Here, the waste categories LAW and MAW were used during the operational phase.

Heat-generating radioactive waste is characterised by high activity concentrations and therefore by high decay heat output; they pose special demands on the design and operation of a repository in deep geological formations (use of shielded facility-internal transport casks, application of special emplacement techniques, thermal design of the repository mine). This waste includes in particular the fission product concentrate, shells, structural components and feed sludge from the reprocessing of spent fuel assemblies, and the fuel assemblies themselves if there are no plans to reprocess them but instead to dispose of them directly as radioactive waste.

Waste with clearly lower activity concentrations from the operation and decommissioning/dismantling of nuclear installations and facilities as well as from the application of radioisotopes is classified among the radioactive waste with negligible heat generation. This encompasses e.g. disused plant components and defective components such as pumps or piping, ion exchange resins and air filters from waste water and exhaust air decontamination, contaminated tools, protective clothing, decontamination and cleaning agents, laboratory waste, sealed radiation sources, sludges, suspensions and oils.

The term "radioactive waste with negligible heat generation" was quantified within the scope of the planning work for the Konrad repository. This was based on the postulate that the temperature conditions prevailing underground should only be influenced to a negligible extent by the waste packages emplaced. The realisation of this planning requirement eventually led to the quantitative stipulation that the increase in temperature at the wall of the disposal chamber caused by decay heat from the radionuclides contained in the waste packages must not exceed 3 Kelvin on average. This value is roughly equivalent to the temperature difference which occurs with a difference in depth of 100 m in the natural temperature environment, and is low compared with the change of temperature caused by ventilation. The temperature difference of 3 K corresponds to an average heat output of about 200 W per m³ of waste. Compliance with the 3 Kelvin criterion was taken into account in connection with the safety-related analyses regarding the thermal influence on the host rock and is ensured by the limitation of the radionuclide-specific activity per waste package. These limits are laid down in the plan approval notice for the Konrad repository of 22 May 2002.

This classification makes it possible, in particular, to register the data for waste/waste packages required for description and characterisation, and therefore ensures the necessary degree of flexibility with respect to waste generated in future, as well as any changes/new developments in conditioning. It subdivides the different waste streams according to origin, waste container, immobilisation and waste type. With regard to the origin of the radioactive waste, generally speaking, a distinction is made between different waste producers. Canisters, cast-iron containers, concrete containers, drums or box-shaped containers are predominantly used for packaging radioactive waste, whilst glass and cement/concrete are widely used for the purposes of immobilisation. Regarding waste type, it would seem appropriate to use a standardised nomenclature (cf. Annex X of the Radiation Protection Ordinance (StrlSchV)). A more precise grouping can be achieved by further subdividing or supplementing this rough categorisation. This categorisation scheme allows the description of radioactive waste to be systematised in a way which fulfils the requirements for proper registration and description of all existing waste and waste arising in the foreseeable future.

On this basis, further elaboration, including a site-specific safety assessment for a repository in deep geological formations, eventually leads to facility-related waste acceptance requirements,

stipulating quantitative requirements governing radioactive waste which is intended for disposal. The "Requirements Governing the Acceptance of Radioactive Wastes for Disposal" (*Endlagerungsbedingungen*, last edited: December 1995, Konrad Mine) [BfS 95] is one such example. These requirements specify the final description or categorisation of waste from a repository-specific point of view.

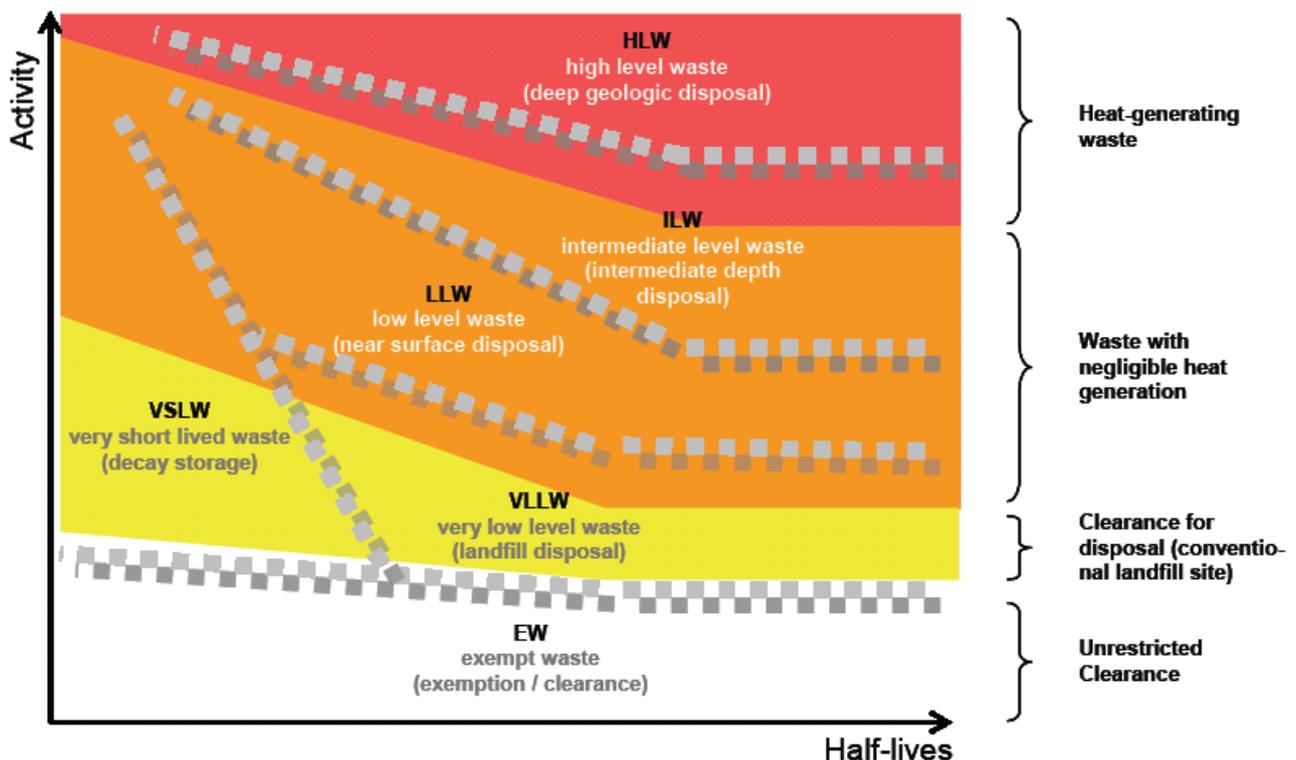
The categorisation of the waste into heat-generating waste and waste with negligible heat generation has not only proven expedient at national level, but is also applied internationally – e. g. by the Commission of the European Union – in connection with the categorisation of radioactive waste. It is compatible with the IAEA proposal for categorisation [IAEA 07] which additionally permits a further subdivision into short-lived and long-lived waste, thus allowing waste to be assigned to near-surface repositories and geological repositories.

In its Draft Safety Guide No. DS 390 "Classification of Radioactive Waste", the IAEA has proposed a classification scheme according to the following waste types:

- Exempt Waste (EW), no longer subject to nuclear regulatory supervision,
- Very Low-Level Waste (VLLW), disposal at special disposal site,
- Very Short-Lived Waste (VSLW), storage to allow decay,
- Low-Level Waste (LLW), disposal in a near-surface repository,
- Intermediate-Level Waste (ILW), disposal in a repository at medium depth, and
- High-Level Waste (HLW), disposal in a repository in deep geological formations.

Figure B-1 provides a comparison of the German classification scheme and the IAEA proposal with regard to final disposal.

Figure B-1: Comparison of the German waste classification with a proposal by the IAEA



The figure shows that the waste which according to the German classification is referred to as heat-generating waste (red area) yet reaches into the area of ILW and that certain waste referred

to as VLLW according to the IAEA already exceeds the current German release limits for elimination as conventional waste and therefore has to be disposed of in the Konrad repository. In general, however, it can be stated that the German classification blends in with the international classification with only slight deviations.

C. Scope of Application

This section deals with the obligations according to Article 3 of the Convention.

Article 3. Scope of application

- 1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.*
- 2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.*
- 3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.*
- 4. This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.*

C.1. Reprocessing of Spent Fuel Assemblies

The scope of this Article and therefore the obligation of reporting encompasses the safety of the management of the spent fuel assemblies from German nuclear power plants and research reactors which are intermediately stored with the intention of final disposal. Those German fuel assemblies which were delivered to France or the United Kingdom for reprocessing do not fall within the scope of this Article, and are therefore not subject to reporting.

Spent fuel assemblies from research reactors which are returned to their country of origin likewise fall outside the scope of this Convention and are therefore exempt from reporting in this report.

C.2. Distinction between NORM and Radioactive Waste

The Basic Safety Standards of the IAEA [IAEA 96] contain common regulations on radioactive material from nuclear installations or from other licensed uses of radioactivity, as well as waste containing only naturally occurring radioactive material (NORM) (cf. Section 2.1 of the Basic Safety Standards of the IAEA). In the Member States of the European Union, these two areas are regulated separately in the EU Basic Safety Standards [EUR 96], and in principle, different requirements (e.g. with regard to exemption provisions) apply to NORM than to radioactive material from nuclear installations and other handling, which is licensed according to nuclear or radiation protection legislation. In keeping with the Basic Safety Standards of the European Union, the German Radiation Protection Ordinance (StrlSchV) [1A-8] makes a distinction between

- *practices*, which are regulated in part 2 of the Radiation Protection Ordinance [1A-8] and which refer to the use of radioactive material and ionising radiation, and
- *work activities*, which are regulated in part 3 of the Radiation Protection Ordinance and which refer to natural sources of radiation.

The distinction between these two terms is best clarified by the definitions provided in § 3 StrlSchV:

C.2.1. Practices

Practices refer to the use of a material's radioactive properties. This may include, for example, the operation of nuclear installations, fuel assembly production, isotope production, and applications of radioactive material (especially radiation sources), e.g. in industry and research. The safety of radioactive waste management as defined by this Article of the Convention encompasses all radioactive waste from practices. This is further dealt with in this report.

C.2.2. Work Activities

Work activities refer to actions involving materials which, although they contain naturally occurring radionuclides, are not used for their radioactive properties. Examples include the use of building materials containing radionuclides from the U-238, U-235, and Th-232 decay chains, as well as the nuclide K 40, excavated materials from mining activities, fly ashes from combustion processes, residues from the flue-gas purification of coal-fired power plants etc. As until now no radioactive wastes in the sense of this Convention have originated from work activities, a short overview is given in the following.

Overview

In its part 3, the radiation protection ordinance regulates the protection of man and the environment against natural radioactivity in connection with work activities (§§ 93 to 103 StrlSchV). The regulations referring to residues from work activities are found in §§ 97 to 102 StrlSchV. The radiological protection goal for individuals of the population is set to 1 mSv per calendar year by § 97 para. 1 StrlSchV.

According to § 97 para. 1, anyone engaged or permitting engagement on his own responsibility in work activities where residues requiring surveillance accumulate and where the utilisation or disposal thereof may cause the effective dose reference criterion for the general public of 1 mSv per calendar year to be exceeded shall take measures for the protection of the general public. The requirement for surveillance of these residues is regulated in § 97 para. 2 in connection with Appendix XII part A. The catalogue of residues which have to be taken into account is given in Appendix XII part A and lists application areas and branches from which residues may arise which may in principal lead to exceeding the 1 mSv/a dose criterion. The list includes the following materials:

1. sludge and sediments from the recovery of oil and natural gas;
2. unconditioned phosphoric plasters, sludge from their preparation as well as dust and cinder from the processing of raw phosphate (phosphorite);
3. a) country rock, sludge, sand, cinder and dust
 - from the extraction and preparation of bauxite, columbite, pyrochlore, microlyth, euxenite, copper shale, tin, rare earths and uranium ores,
 - from the processing of concentrates and residues that occur with the extraction and preparation of these ores and minerals, as well asb) minerals corresponding to the above specified ores that occur with the extraction and preparation of other raw materials.
4. Dust and sludge from the smoke gas filtering with the primary metallurgic processes in the raw iron and non-ferrous metallurgy.

Residues according to § 97 are also

- a) materials in accordance with the subparas. 1 ff., when the occurrence of these materials is deliberately produced,
- b) castings from the materials specified in subparas. 1 ff., as well as
- c) excavated or cleared ground and demolition waste from the dismantling of buildings or other structures when these contain residues in accordance with the subparas. 1 ff. and are removed in accordance with § 101 after completion of the work activities or in accordance with § 118, para. 5 or from properties.

The possibility for exceeding the 1 mSv/a dose criterion has been carefully checked for each of the listed residues by extensive studies during the development phase of these regulations. These studies have been based on the actual material streams in Germany and have taken account of exposure conditions which would be typical for Germany.

Release from Surveillance

Residues from the list given above are initially assumed to require surveillance. However, if the specific activity of those residues is lower than the surveillance limits provided in Appendix XII part B, surveillance is not required. If the surveillance limits are exceeded and it can be demonstrated in a case-specific evaluation according to § 98 para. 1 that the 1 mSv/a dose criterion is not exceeded, the competent authorities of the respective Federal State may release the residues from surveillance. The criteria listed in Appendix XII part C can be applied in this procedure.

The surveillance limits provided in Appendix XII part B have been derived on the basis of extensive radiological studies. If they are complied with, it is at the same time assured that the 1 mSv/a dose criterion is not exceeded. The surveillance limits are a tiered set of specific activity values (in Bq/g) referring to the greatest values of any nuclide in the decay chains of U-238sec and Th-232sec. The limit values range from 0.2 Bq/g to 5 Bq/g, depending on the kind of intended use or disposal. When applying the surveillance limits, a summation rule has to be observed.

Residues Remaining under Surveillance

If it is not possible to release a specific kind of residues from surveillance, it has to remain in surveillance. The corresponding procedure is laid down in § 99. It says that the person who is responsible according to § 97 para. 1 must declare to the competent authority within one month the type, mass and specific activity of the residues requiring surveillance as well as any intended disposal or utilisation of these residues or delivery. The competent authority may rule that protective measures are to be taken and may specify the manner in which the residues must be disposed of.

In those cases where a disposal of the residues remaining under surveillance is required, means for storage of the residues, if necessary under institutional control, have to be created in order to comply with the protection targets.

In order to cover unforeseen cases or potential incompleteness of the regulations in Appendix XII part A, § 102 has been introduced to provide a rule for such cases where due to work with materials that are not residues according to Appendix XII part A or due to the execution of work where such materials accumulate, the radiation exposure of members of the public is increased so significantly that radiation protection activities are necessary. In such cases, the competent authority takes the appropriate measures, in particular by prescribing that certain protective measures are to be taken, that the materials are to be kept or stored at a site designated by it, or that and how the materials are to be disposed of.

Experience from Application of the Regulations

Compliance with the surveillance limits or the dose criterion with respect to the residues has been verified for a large number of companies using NORM on the basis of the regulations described above. Various material streams have been investigated. In all cases which have been dealt with so far it was found that the surveillance limits were not exceeded or compliance with the dose criterion on the basis of case specific evaluations could be demonstrated. No handover of residues which had to remain under surveillance to an institution taking care of the long-term storage of those residues has yet become necessary. There therefore is at present no need for such a storage facility.

C.3. Waste from the Military Sector

There are no spent fuel assemblies from military or defence programmes in Germany.

The treatment and interim storage of radioactive waste from military or defence programmes remains the responsibility of the armed forces and is not transferred to civil responsibility until the waste is delivered to a repository. Until this time, it is placed in interim storage as interstage product. If necessary, the waste will previously be conditioned according to the acceptance criteria of the repository. All these waste management stages are subject to the same safety provisions as those applicable in the civil sector.

D. Inventories and Lists

This section deals with the obligations according to Article 32 2. of the Convention.

Article 32 2. Reporting

2. *This report shall also include:*

- (i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;*
- (ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;*
- (iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;*
- (iv) an inventory of radioactive waste that is subject to this Convention that:*
 - (a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;*
 - (b) has been disposed of; or*
 - (c) has resulted from past practices.*

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

- (v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.*

D.1. Spent Fuel Management Facilities

An overview of spent fuel management facilities can be found in Table D-1. More detailed information on existing and planned facilities can be found in Annex L-(a). These overviews also include the cooling ponds within the reactor buildings.

The following facilities are classified as spent fuel management facilities within the meaning of the Convention:

- the dry interim storage facilities at the reactor sites,
- the interim storage facility at Greifswald (ZLN) for spent fuel from the nuclear power plants at Rheinsberg and Greifswald, and the storage facility at Jülich for spent fuel from the high-temperature reactor AVR,
- the central interim storage facilities at Gorleben (TBL-G) and Ahaus (TBL-A), and
- the pilot conditioning plant at Gorleben (PKA).

The decommissioned spent fuel reprocessing plant at Karlsruhe (WAK) is dealt with under the comments on Article 32 2. (v).

Cooling Ponds within the Reactor Buildings

The spent fuel assemblies unloaded from the reactor core are first placed in cooling ponds within the reactor building, generally for a period of five years. These pools allow the required decay of activity and heat generation until the fuel is placed in a storage cask for interim storage, and provides the operator with sufficient flexibility to operate the plant. The additional wet storage facility outside the reactor building at Obrigheim is an exceptional case. As this facility, like the cooling

ponds inside the reactor buildings, is considered part of the power plant operation from a licensing point of view, it will not be considered in any further detail for the purposes of this report. It is, however, included in Table D-1 and Table L-1 for the sake of completeness.

Onsite Interim Storage Facilities

With regard to direct disposal, a remaining period of several decades still needs to be bridged, depending on the availability of a repository and the length of time required for heat generation to decay until disposal. The Federal Government's concept envisages that in future spent fuel assemblies are without exception to be placed in interim storage at the reactor sites where they arise. They should remain there until duly conditioned and disposed of in a repository. Interim storage at the site means that fuel assembly transportations will for the time being be avoided until their disposal with prior conditioning.

Decentralised interim storage facilities for spent fuel assemblies have been licensed under atomic law, constructed and commissioned at all twelve sites with operating nuclear power plants. They are designed as dry storage facilities in which transport and storage casks loaded with spent fuel assemblies are emplaced. Various different types of interim storage facility design have been licensed (cf. Table L-4). The most important one, the WTI and the STEAG concepts, are variants of the same basic concept. They differ mainly in the configuration of the storage areas and in the thickness of the building walls. In all the different cases, the decisive factor for the choice of one or the other variant was the already available operating experience and the possible later use of modified storage casks. Those favouring the WTI concept put forward the argument of the positive operating experience with the Ahaus and Gorleben interim storage facilities and the resulting technical and economic optimisations. On the other hand, the STEAG concept with its stronger walls was developed with a view to a future new and more economical generation of storage casks. While at present the casks themselves guarantee safety with respect to external impacts, the energy utilities would in future like to rely on the thickness of the concrete walls when possibly using more economic cask types. The decision for one of the two variants was solely down to the applicants. Both concepts fulfil the requirements of the Atomic Energy Act (AtG) [1A-3] for safe storage.

The interim storage facilities are cooled by passive air convection which removes the heat from the casks without any active technical systems. The leak-proof and accident-resistant casks ensure safe enclosure as well as the necessary degree of radiation shielding and criticality safety during both normal operation and in the case of incidents. The heat is released into the environment by means of cooling fins. Protection against external impacts, such as earthquakes, explosions and aircraft crashes, is ensured by the thick walls of the casks. It was demonstrated and confirmed in the licensing procedure that the casks are suitable for at least 40 years of storage; the licences limit the storage period correspondingly. Due to the planned schedule for the availability of a repository, the question of prolonging the storage period is presently irrelevant.

The Stade nuclear power plant withdrew its application for the storage of spent fuel assemblies according to § 6 of the Atomic Energy Act (AtG) as the reactor was finally closed down in 2003. All fuel assemblies were shipped for reprocessing to France. At the Obrigheim nuclear power plant, an increase of the wet storage capacity in a pool outside the reactor building was licensed in 1998. The fuel assemblies remaining in the plant since its closure in May 2005 are stored in this wet interim storage facility for the time being. In 2005, the Obrigheim nuclear power plant applied for the on-site dry storage of the spent fuel assemblies in a total of 15 storage casks. This application was rendered more precisely in 2006 and 2007. In this case, similar to the on-site interim storage facilities that have already been licensed and taken into operation, the casks are to be stored in a yet-to-be-built storage building for a period of 40 years, starting with the emplacement of the first cask.

The temporary storage facilities used in the past years as an interim solution have in the meantime all been emptied again. The casks holding the spent fuel assemblies have been transferred to the corresponding on-site interim storage facilities. The nuclear licenses were returned or have expired.

Interim Storage Facilities at Gorleben and Ahaus

Central storage facilities containing fuel assemblies from various German nuclear power plants have been licensed at Gorleben (Figure D-1 and Figure D-2). The facilities are designed as dry storage facilities. Here too, the types of casks for fuel assemblies are in part identical with those already mentioned above in conjunction with on-site storage facilities. The Ahaus facility is additionally licensed for THTR and MTR fuel assembly casks (Figure D-3). An application has been made for extending the facility's use to accept high-pressure-compacted reprocessing, operational and decommissioning waste. The Gorleben facility is additionally licensed for canisters holding vitrified HAW.

Figure D-1: Interim storage facilities and pilot conditioning plant at the Gorleben site
(Copyright: GNS)



Figure D-2: Transport and storage casks in the Transport Cask Store Gorleben
(Copyright: GNS)



Figure D-3: CASTOR® THTR/AVR and CASTOR® MTR in the Transport Cask Store Ahaus
(Copyright: GNS)



Interim Storage Facilities at Greifswald and Jülich

There also exist storage facilities at Greifswald/Rubenow and Jülich.

The dry “Interim Storage Facility North” (ZLN) in Greifswald currently only accepts spent fuel assemblies from the Soviet-type reactors at Rheinsberg and Greifswald. An application has been made for a licence to store vitrified high-level waste from the Karlsruhe reprocessing plant (WAK) as well as spent and fresh fuel assemblies from the Compact Sodium-cooled Nuclear Reactor Plant (KNK II) in Karlsruhe as waste. The neighbouring former wet-storage facility (ZAB) has been completely emptied of fuel assemblies. The final fuel assemblies were transferred to the ZLN in 2006. The ZAB is currently being decommissioned.

The interim storage facility at Jülich contains the spent fuel spheres from the prototype AVR high-temperature reactor.

Pilot Conditioning Plant

The German reference concept for direct disposal envisages that the spent fuel assemblies should be packaged in sealed thick-walled casks and emplaced in deep geological formations. In order to demonstrate the conditioning technique, a pilot conditioning plant (PKA) was planned and constructed at Gorleben (Figure D-4). The plant is licensed for a throughput of 35 Mg HM/a. Pursuant to the agreement between the Federal Government and the utilities of 11 June 2001, the licensing procedure is complete, but use of the facility is licensed only for the repair of defect casks for spent fuel assemblies from light-water reactors and for vitrified HAW from reprocessing abroad as well as for the handling of other radioactive materials. The lawsuits filed against the operating licence that went as far as to the Federal Administrative Court were all dismissed; the license is therefore valid.

Figure D-4: Lid-welding device for the prototype POLLUX[®] final storage cask (Copyright: GNS)



Table D-1: a) Storage facilities for spent fuel assemblies (as at 31 December 2007)

Site	Storage capacity (Number of storage positions)	Storage capacity (Mg HM)	Status		Emplaced (Mg HM) as at 12/07
			Applied for	Li-censed	
Fuel pools in reactor buildings					
Nuclear power plants total	19 523 positions ¹⁾	approx. 6 044 ¹⁾		X	3 441
Onsite interim storage facilities					
Biblis	135 cask positions	1 400		X	366
Brokdorf	100 cask positions	1 000		X	62
Brunsbüttel	80 cask positions	450		X	33
Grafenrheinfeld	88 cask positions	800		X	71
Grohnde	100 cask positions	1 000		X	62
Gundremmingen	192 cask positions	1 850		X	117
Isar	152 cask positions	1 500		X	61
Krümmel	80 cask positions	775		X	92
Lingen/Emsland	130 cask positions ²⁾	1 250		X	245
Neckarwestheim	151 cask positions	1 600		X	254
Obrigheim	980 positions ³⁾	286		X	100
	15 cask positions		X		
Philippsburg	152 cask positions	1 600		X	241
Unterweser	80 cask positions	800		X	10
Centralised interim storage facilities					
Gorleben	420 cask positions ⁴⁾	3 800		X	37
Ahaus	420 cask positions	3 960		X	55 ⁵⁾
Local storage facilities outside the reactor sites					
Greifswald	80 cask positions	585		X	583
Jülich	158 casks	0.225 nuclear fuel ⁶⁾		X	0.075 ⁶⁾

¹⁾ Part of the storage capacity has to be kept free for unloaded cores

²⁾ Licensed for 125 cask positions for loaded casks and 5 cask positions for empty casks

³⁾ The Obrigheim nuclear power plant has a wet storage facility outside of the reactor building that was commissioned in 1999. A dry storage facility with 15 cask positions has been applied for.

⁴⁾ Including the positions for HAW canisters

⁵⁾ Total amount from power reactors; an additional approx. 6 Mg HM from the THTR and 2 Mg HM from the RFR Rossendorf research centre

⁶⁾ Excluding thorium

b) Conditioning plant

Facility	Site	Purpose	Maximum throughput	Status
PKA	Gorleben	Conditioning of spent fuel assemblies for direct disposal and for the treatment of radioactive waste; presently only repair of defective casks	35 Mg HM/a (conditioning)	Licensed and constructed but not yet in nuclear operation

D.2. Inventory of Spent Fuel Assemblies

An overview of the spent fuel produced in German nuclear power plants up to the end of 2007 is given in Table D-2 (classified according to place of origin) and Table D-3 (classified according to destination). Table D-4 lists the destinations of prototype reactor fuels.

17 power reactors are currently operational in Germany, all of which are light water reactors whose fuel assemblies consist of low-enriched uranium dioxide or mixed uranium-plutonium oxide (MOX). A further twelve power reactors have been shut down. Seven experimental and prototype power plants formerly operating in the Federal Republic of Germany have likewise been shut down. Two of them, HDR at Großwelzheim (completely dismantled since 1998) and VAK at Kahl, were boiling water reactors fuelled with low-enriched uranium dioxide pellets, whilst MOX was also used to a certain extent in the case of VAK. Two further reactors, AVR at Jülich and THTR at Hamm-Uentrop, were helium-cooled, graphite-moderated high-temperature reactors in which the fuel, consisting of medium- and high-enriched uranium/thorium oxide particles, was enclosed in graphite pebbles. The MZFR at Karlsruhe was a heavy-water reactor with very low enriched (0.85 %) uranium dioxide fuel. The fast breeder reactor KNK II at Karlsruhe used fuel assemblies made of highly enriched uranium oxide and mixed uranium/plutonium oxide. The nuclear power plant at Niederaichbach (KKN) was operational as a prototype plant from 1972 to 1974 with a pressure tube reactor moderated with heavy water and cooled by CO₂, which used natural uranium as fuel. Complete dismantling (leaving behind a greenfield site) was finished in 1995.

D.2.1. Spent Fuel Quantities

Power Reactors

The storage pools of the nuclear power plants (including the Obrigheim on-site interim storage facility, which has been designed as a wet-storage facility) hold a total of 3 541 Mg HM of spent fuel assemblies. In the ZAB wet-storage facility in Lubmin near Greifswald, there are no longer any fuel assemblies as these have been transferred completely to the ZLN. The former temporary storage facilities have been dissolved since the casks have been transferred to the on-site interim storage facilities. The on-site interim storage facilities, which are designed as dry-storage facilities, hold 1 614 Mg HM, and 92 Mg HM in the form of LWR fuel assemblies are stored in storage casks in the central interim storage facilities at Ahaus and Gorleben. 583 Mg HM of WWER fuel assemblies from Rheinsberg and Greifswald are likewise stored in casks at the ZLN interim storage facility in Lubmin near Greifswald. A total of 6 675 Mg HM of spent fuel assemblies from the nuclear power plants have already been shipped abroad either for reprocessing or for permanent storage there. The majority have been sent to the reprocessing plants at La Hague and Sellafield. Table D-3 gives an overview of the destinations of the fuel assemblies.

In 2005, the Obrigheim nuclear power plant was decommissioned. At the key date of 31 December 2007, a total of about 12 500 (Mg HM) had arisen in the form of spent fuel assemblies from the operation of the 17 operating and twelve decommissioned German light water reactors with capacities of > 50 MW, around 370 Mg HM of which arose in 2007 (Table D-2). Part of the fuel assemblies located in the spent fuel pools have not yet reached their final burn-up and are therefore intended for re-use in the reactors at a later point in time. However, as the Joint Convention makes no distinction in this respect, the fuel assemblies intended for re-use are counted among the spent fuel assemblies in the amounts given in this report (e.g. in Table D-2 and Table D-3).

Table D-2: Quantities of spent fuel assemblies produced in light water reactors (capacity of > 50 MW) in the Federal Republic of Germany until 31 December 2007

Type	Abbr.	Power plant, site	Total quantity	
			Number	Mg HM
BWR	KKB	Brunsbüttel	2 132	371
BWR	KKK	Krümmel	3 096	548
PWR	KBR	Brokdorf	960	519
PWR	KKU	Unterweser	1 404	753
PWR	KWG	Grohnde	1 132	613
PWR	KKE	Emsland	1 020	549
PWR	KWBA	Biblis A	1 435	768
PWR	KWBB	Biblis B	1 467	785
BWR	KKP1	Philippsburg 1	2 788	498
PWR	KKP2	Philippsburg 2	1 140	615
PWR	GKN1	Neckarwestheim 1	1 565	560
PWR	GKN2	Neckarwestheim 2	884	472
BWR	KRB-B	Gundremmingen B	3 716	648
BWR	KRB-C	Gundremmingen C	3 573	621
BWR	KKI1	Isar 1	3 216	574
PWR	KKI2	Isar 2	936	500
PWR	KKG	Grafenrheinfeld	1 284	689
Subtotal:			31 748	10 083
Decommissioned plants:				
BWR	KWL	Lingen	586	66
BWR	KRB-A	Gundremmingen A	1 028	124
BWR	KWW	Würgassen	1 989	346
PWR	KMK	Mülheim-Kärlich	209	96
PWR	KWO	Obrigheim	1 235	356
PWR	KKS	Stade	1 517	541
PWR	KKR	Rheinsberg	918	106
PWR	KGR 1-4	Greifswald 1-4	6 464	747
PWR	KGR 5	Greifswald 5	349	40
Subtotal			14 295	2 422
Total:			46 043	12 505

Note: The quantities given in Mg HM have been rounded to the nearest whole number. This may result in minor differences compared with other published figures.

Table D-3: Overview of total quantities of spent fuel from German light water reactors (capacity of > 50 MW) up to 31 December 2007

Place of storage/whereabouts	Quantity in Mg HM
Spent LWR fuel assemblies in spent fuel pools at nuclear power plants (incl. wet storage facility outside the KWO reactor building)	3 541
Dry storage of spent WWER fuel assemblies in casks at ZLN	583
Dry storage in casks at nuclear power plant sites	1 614
Dry storage in casks at the Ahaus and Gorleben interim storage facilities	92
Shipped to La Hague (France) for reprocessing	5 393
Shipped to Sellafield (United Kingdom) for reprocessing	851
Reprocessed at the WAK reprocessing plant in Karlsruhe	90
Reprocessed at the EUROCHEMIC reprocessing plant (Belgium)	14
Returned to the former USSR (WWER fuel assemblies)	283
Shipped permanently to Sweden (CLAB)	17
Reuse of WWER fuel assemblies at Paks (Hungary)	27
Total	12 505

Note: The quantities given in Mg HM have been rounded to the nearest whole number. This may result in minor differences compared with other published figures.

Apart from the above-mentioned reactors, seven experimental and prototype reactors were operated in the Federal Republic of Germany, all of which are decommissioned. These are

- AVR, Jülich
- THTR-300, Hamm
- MZFR, Karlsruhe
- KNK II, Karlsruhe
- VAK, Kahl
- KKN, Niederaichbach
- HDR, Großwelzheim

For comparative data on these reactors, please refer to Table L-14 in the Annex. Table D-4 lists the destinations and respective heavy metal quantities for storage or management of the 186 Mg HM of spent fuel assemblies thereby incurred.

Table D-4: Management of spent fuel assemblies from prototype reactors

Reactor	Quantities stored or disposed of (in Mg HM) at								Total
	WAK	BNFL	SKB	CEA	EURO-CHEMIC	FZ Jülich	TBL Ahaus	Others	
VAK	7.9	0.1	6.5		7.4			0.1	22.0
MZFR	89.6	10.6	0.4						100.6
KKN				46.3					46.3
KNK II				1.9				0.2	2.1
AVR						1.8			1.8
THTR							6.9		6.9
HDR	6.9								6.9
Total	104.4	10.7	6.9	48.2	7.4	1.8	6.9	0.3	186.6

Most of the spent fuel assemblies listed in the above table were reprocessed at WAK Karlsruhe, at BNFL or at EUROCHEMIC in Belgium. A smaller part of the fuel assemblies was shipped to SKB in Sweden and to CEA in France and will remain there. The THTR fuel pebbles have already been declared as radioactive waste (cf. the remarks on Article 32 2. (iv)) and are currently being stored at the Ahaus interim storage facility. The 6.9 Mg of heavy metal are contained in 617 629 spheres which are stored in 305 casks. The AVR fuel pebbles are stored at the Jülich research centre, where 290 000 fuel pebbles with 1.8 Mg of heavy metal (including thorium) are to be emplaced in 152 casks. The proper waste management of the spent fuel assemblies from prototype reactors has thereby been ensured.

Research Reactors

Ten training and research reactors are in operation in Germany. These are:

- two materials test reactors (MTRs) (Berlin and Geesthacht)
- one high-flux reactor (Munich),
- one TRIGA reactor (Mainz)
- six training / educational reactors, including five Siemens educational reactors (SUR).

The Jülich research reactor (FRJ-2) was finally shut down on 2 May 2006 and is currently in the post-operational phase. Furthermore, eight reactors with thermal outputs in excess of 1 MW have been shut down and are in varying stages of decommissioning. Five Siemens educational reactors (SUR) and one training reactor still have a valid operating licence. Of these, three (Stuttgart, Ulm, Furtwangen) are intended to continue in operation in the longer run. The other two SURs (Aachen, Hanover), are to be decommissioned. A precondition for their decommissioning is the removal and disposal of their reactor cores. Several other lower-output reactors have been decommissioned or have already been dismantled. A list of the decommissioned research reactors can be found in the Annex to this report, cf. Table L-15 and Table L-16.

In October 2007, there were still approx. 0.8 Mg of spent fuel assemblies from these reactors waiting for disposal.

It is intended to dispose of the fuel assemblies from the MTR facilities Berlin, Geesthacht and Jülich in the US. However, according to the current legal situation, this disposal path is only an option for fuels that have been irradiated by May 2016. Should the reactor core continue to be operated beyond that date and should there be no prolongation of this time window for shipping the waste to the US, then the fuel assemblies will be put in central interim storage at Ahaus. The same

applies to the TRIGA reactor in Mainz, which according to current plans is to remain in operation at least until 2020. As for the FRM II research reactor, the current legal situation obstructs the path to the US. Its fuel assemblies will therefore also be put in interim storage at Ahaus with the aim of their direct final disposal.

So far, four SUR cores (München, Darmstadt, Hamburg, Bremen) have been incinerated at the Institute for Radiochemistry of Munich Technical University and blended for lower enrichment. They are then treated further in connection with the fabrication of fuel assemblies for power reactors. The SURs from Aachen, Berlin, Hanover and Kiel are to be treated in the same way.

D.2.2. Activity Inventory

The activity of the spent fuel assemblies (reference date: 31 December 2007) stored on-site at the reactors and in the cask storage facilities can be estimated based on the following assumptions:

In an initial approximation, only uranium dioxide fuel is considered. The fuel assemblies are divided into different categories on the basis of age: for those fuel assemblies unloaded prior to 1998, the assumed mean burn-up is 40 GWd/Mg HM, whilst for those unloaded between 1999 and 2006, the mean burn-up is defined as 50 GWd/Mg HM.

Based on these assumptions, the radioactive inventories may be estimated as follows:

- Inventory of spent fuel stored in NPP cooling ponds 1.4·10²⁰ Bq
(corresponding to 3 540 Mg HM)
- Spent fuel assemblies in casks and interim storage facilities 3.7·10¹⁹ Bq
(corresponding to 2 292 Mg HM)

Thus, the total activity of all spent fuel assemblies currently in storage as per the reference date is approximately 1.8·10²⁰ Bq.

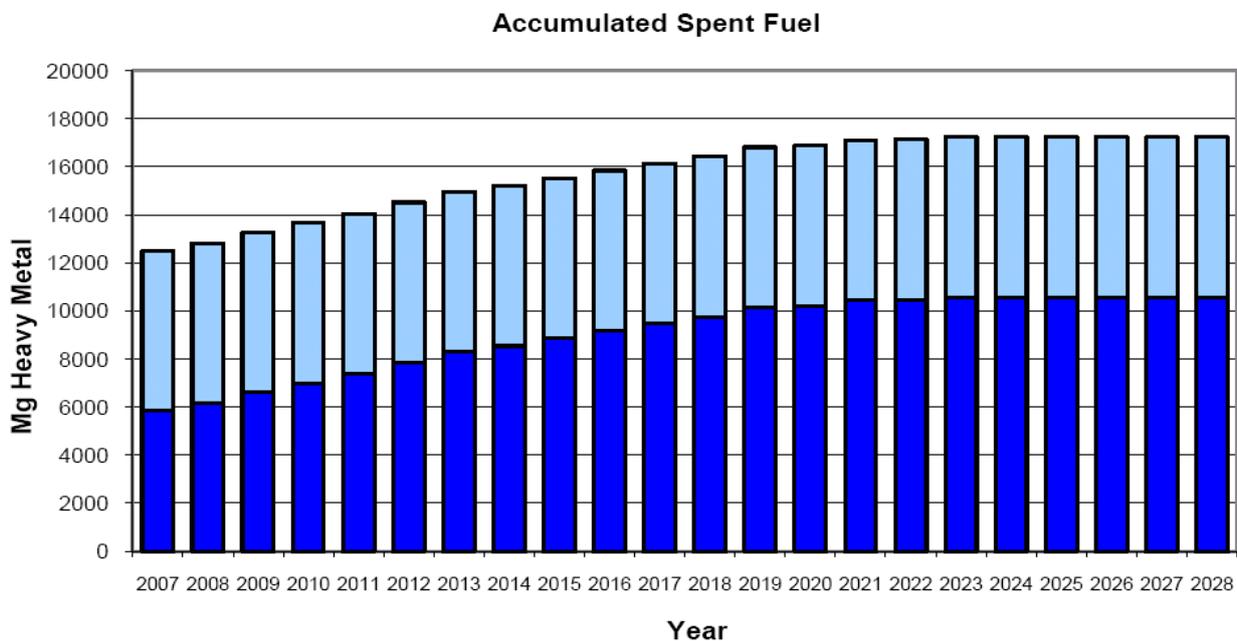
The activity of Sr-90/Y-90 can be estimated at 3.8·10¹⁹ Bq, whilst the activity of Cs-137/Ba-137m can be estimated at 5.4·10¹⁹ Bq.

D.2.3. Predicted Amounts

The energy utilities inform the respective competent regulatory authorities every year about the amounts of spent fuel assemblies probably arising from each nuclear power plant until their final closure. It follows from this information that as of 1 January 2008 until the final closure of all plants, about another 4 730 Mg HM (including rest cores) of spent fuel assemblies will arise. Together with the spent fuel assemblies that have already arisen until 31 December 2007, this amounts to a total of around 17 200 Mg HM, of which around 10 500 Mg HM have to be conditioned and disposed of in a repository. The remaining amount was disposed of via different paths, the large majority by re-processing abroad.

The projected time history of the future spent fuel assembly arisings is shown in Figure D-5.

Figure D-5: Cumulated spent fuel assembly arisings (dark: proportion of spent fuel assemblies intended for direct final disposal; light: proportion of reprocessed fuel assemblies)



D.3. Facilities for the Treatment of Radioactive Waste

D.3.1. Conditioning Plants

Detailed data on the available conditioning facilities, interim storage facilities and repositories for radioactive waste can be found in Annex L-(b).

Due to the operation and decommissioning of nuclear facilities and installations, and the use of radioisotopes in research, trade, industry and medicine, radioactive waste is continuously produced in the Federal Republic of Germany and must be intermediately stored until the repository is commissioned.

The conditioning of radioactive waste may start with primary waste – possibly pre-treated – which has been specifically collected and sorted, or with an interim product. Conditioning comprises the treatment and/or packaging of radioactive waste. Conditioning comprises a variety of procedures and facilities, some of which have been tested over a period of many years, as follows:

- Solid primary waste (which may be pre-treated) and interim products are processed by means of crushing, packaging, drying, burning, pyrolysis, melting, compacting or cementing.
- Liquid waste (which may be pre-treated) is processed by means of drying, cementing or vitrification.
- Generally speaking, the packaging of waste products is based on a system of standardised waste containers which have been carefully designed to meet safety-related and operational requirements and agreed between all the parties involved (cf. Figure D-6).

Figure D-6: Examples of standardised waste containers (Konrad container on the left, cast-iron container on the right) (Copyright: GNS)



Frequently used stationary waste conditioning facilities are located in Braunschweig, Duisburg, Jülich, Karlsruhe, Krefeld and Lubmin near Greifswald. These comprise decontamination and dismantling facilities, drying facilities, evaporator facilities, high-pressure compaction facilities, melting facilities and cementing facilities that are also available for the processing of waste from external waste producers. Mobile waste management facilities are also available which can be installed on site at a waste producer's premises in order to process radioactive waste held in storage there. Some nuclear power plants have their own additional waste management facilities, such as high-pressure compactors and drying facilities.

Karlsruhe Vitrification Plant

One major prerequisite for the complete dismantling of the Karlsruhe reprocessing plant (WAK) is the disposal of the liquid high-active waste (HAWC) that arose in connection with the former operation of the WAK. Around 60 m³ of liquid high-active waste solution are stored within the grounds of the WAK. The HAWC has to be rendered into a form that allows safe interim storage and later also disposal in a repository. The state of the art is to vitrify such waste. For the vitrification of the high-active waste concentrate, the Karlsruhe vitrification plant (VEK) has been constructed.

The high-active liquid waste solution is bound in molten boron-containing glass in a remote-controlled, electrically heated melting furnace. The melter of the vitrification facility keeps the special boron silicate glass at a temperature of about 1 150 °C. The liquid waste is added to this molten pool; in the process, the liquid component evaporates, and the radioactive solids are embedded in the glass melt. The melt is then filled into 1.3 m-high 150-l stainless steel canisters. Once the canisters have cooled down, they are welded gastight. This solidification brings with it a reduction in volume from 60 m³ to just less than 20 m³.

Construction of the VEK began at the beginning of 1999. Interior fitting of the VEK and thus also the installation of the process technology systems was begun in 2002. At the end of 2004, the largest part of the fitting was complete, and function testing began. The VEK began non-nuclear operation in 2006 with the aim to train the personnel in the operation of the VEK, test the interplay of the technical installations, and verify the practicability of the operating instructions. Hot commissioning is planned for 2009.

Over a period of approx. 300 days of operation, the existing HAWC is to be filled into approx. 130 stainless-steel canisters (cf. Figure D-7). Once they have been welded, these canisters will be

transferred to an operational buffer store of the VEK. The canisters are to be loaded into CASTOR® HAW 20/28 CG transport and storage casks and shipped to the Interim Storage Facility "Nord" (ZLN), where they are to be put in interim storage until their final disposal in a repository. The VEK will subsequently be decommissioned and dismantled again.

Figure D-7: Glass discharge in the Karlsruhe vitrification plant (VEK) (Copyright: WAK)



D.3.2. Interim Storage Facilities

Until its shipment to a repository, radioactive waste from the operation and decommissioning of nuclear power plants has to be put in interim storage in facilities that have to be erected and operated by the facility operator according to the polluter-pays principle. Apart from the interim storage of radioactive waste materials, another aim of interim storage is the radioactive decay of the waste to allow easier processing at a later stage and perhaps the release of the materials so that the demand for the necessary repository volume can be reduced.

At present, apart from the facilities at the power plant sites, facilities available for the interim storage of the waste are the Unterweser external storage building, the decentralised on-site interim storage facility at Biblis (the duration of interim storage is limited to ten years from the first emplacement of a waste package), the Transport Cask Store Ahaus, the Gorleben Interim Storage Facility/Waste Store (ALG), the EVU building of the Mitterteich interim storage facility, the interim storage facilities of the Nuclear + Cargo Service GmbH (NCS) company in Hanau, the interim storage facility "North" (Zwischenlager Nord, ZLN) near Greifswald and the interim storage of the Decontamination Plants Division (*Hauptabteilung Dekontaminationsbetriebe* = HDB) in Karlsruhe. The licences for these interim storage facilities contain restrictions regarding delivery. For example, only waste originating from Bavarian nuclear facilities may be brought to Mitterteich, waste mainly originating from the nuclear facilities in Greifswald and Rheinsberg currently in the process of decommissioning may be brought to the ZLN, and only waste originating from operation and decommissioning of facilities of the FZK and decommissioning wastes of the nuclear power plant at Niederaichbach may be brought to the HDB for longer-term interim storage. Radioactive waste from the reprocessing of German spent fuel abroad will be stored in the central interim storage facilities in Gorleben and Ahaus (licence applied for).

Radioactive waste from large research institutions is generally conditioned and stored intermediately at its place of origin. Waste from research, industry and medicine may be delivered to eleven regional *Land* collecting facilities operated by the *Länder* (Federal States). The waste is either accepted as primary waste and then conditioned on site, or has already been conditioned and is delivered in a form suitable for disposal. Private conditioning and waste management companies, among them QSA Global GmbH, are additionally available for waste from research, medicine and industry. This company collects radioactive residues from the whole of Germany, conditions the radioactive waste and puts it in interim storage at its storage facility in Leese (Lower Saxony). Waste from the nuclear industry is conditioned on site in a form suitable for disposal and put in interim storage either in the Gorleben Waste Store, in the EVU building at Mitterteich or in the interim storage facility of NCS in Hanau.

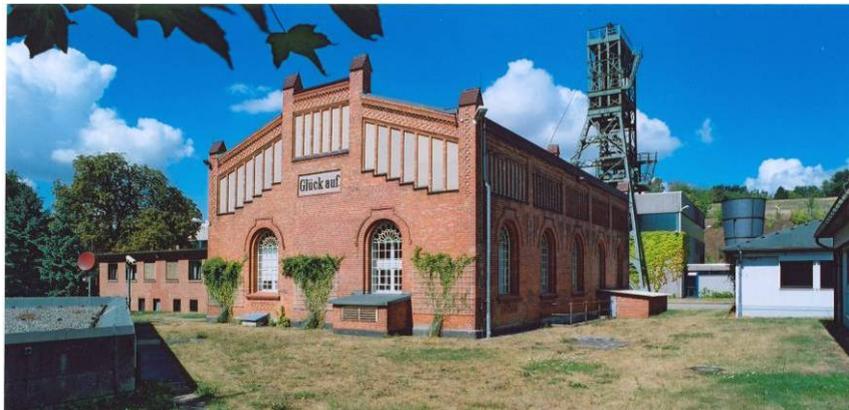
D.3.3. Repositories

All radioactive waste in interim storage which cannot be released once activity has subsided is intended for subsequent disposal in a repository. The radioactive waste will be disposed of in deep geological formations.

Asse Mine

Development work in the repository field began with the establishment of the Asse mine in a former salt mine near Wolfenbüttel (Lower Saxony), where the disposal of low-level and medium-level waste was trialled from 1967 until the end of 1978. After that, emplacement techniques intended for the Gorleben repository project were tested. In 1992, the research activities were ended. The backfilling of the Asse mine has been going on since 1995.

Figure D-8: Asse mine (Copyright: Asse mine)



Morsleben Repository for Radioactive Waste (ERAM)

In former GDR, the Morsleben repository for radioactive waste (ERAM) in Sachsen-Anhalt was available since the first test emplacement in 1971 for the final disposal of low- and medium-level waste; following German reunification, the ERAM was adopted and received such waste from Germany until September 1998. The ERAM (a former salt mine) took in waste from nuclear power plants as well as waste from research, medical and industrial application. At present, the documents for the plan approval procedure for the backfilling and sealing of the Morsleben repository are being prepared.

Figure D-9: Morsleben repository for radioactive waste (ERAM) (left: aerial view, right: emplacement chamber with stacked drums holding low-level waste) (Copyright: BfS)



Konrad Repository

In 1982, an application was filed for a plan approval procedure to use the Konrad mine, a former iron ore mine in Lower Saxony, as a repository for radioactive waste with negligible heat generation. This plan approval procedure has been concluded. The plan approval notification was served on 22 May 2002.

With its ruling of 8 March 2006, the Lüneburg Supreme Administrative Court rejected the complaints against the plan approval decision and refused to allow an appeal in front of the Federal Administrative Court (BVerwG). The complaints by the plaintiffs against the non-admission of an appeal were rejected by the Federal Administrative Court on 26 March 2007. There is thus a definitive and incontestable plan approval decision for the Konrad repository.

In a letter by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) dated 30 May 2007, the BfS was tasked with retrofitting the Konrad mine to convert it into a repository. Construction of the Konrad repository will last about six years, which means that commissioning can be expected for 2013. More than 600 auxiliary conditions have to be observed and already existing design documents have to be revised for the retrofitting. On 15 January 2008, the main operating plan for the construction of the Konrad repository was approved by the Lower Saxon regional mining, energy and geology authority. The main operating plan allows the necessary mining-related and structural work to be carried out and thus represents an essential step in the conversion of the former iron ore mine into a repository. So far, around € 900 million have been invested in the Konrad repository project. The ongoing conversion into a repository will cost yet another approx. € 900 million.

Figure D-10: Konrad repository in Salzgitter (Copyright: BfS)

Konrad Schacht 1



Initial situation

Fresh air supply

**Person and material
Transportation**



Planning

Konrad Schacht 2



Initial Situation



Planning

Exhaust air release

**Transportation of waste
packages into the repository**

The Konrad repository may only accept German radioactive waste with negligible heat generation and a maximum waste package volume of 303 000 m³. The emplacement drifts are located at a depth of between 800 m and 1 300 m. The waste will represent 90 % of the total waste to be disposed of in a repository but a mere 0.1 % of the total expected activity.

Gorleben

The site of Gorleben (Lower Saxony) was identified for a nuclear waste management centre in the year 1977 (cf. Chapter H.3.3). The above-ground exploration of the maiden salt dome began in 1997. A step-wise study programme initially concentrated on the examination of the hydrogeological situation, while at a later stage the core and flank areas of the salt dome were explored by means of six deep drillings. The underground exploration that was to show whether the salt dome was suitable especially for the final disposal of heat-generating radioactive waste began in 1986 with the sinking of the shafts down to a depth of about 800 metres. In 1995, the driving of horizontal drifts was begun, and the two shafts were connected with each other in 1996. Until 1 October 2000, which is when the moratorium began, drifts with a total length of about seven kilometres had been driven. In all, about 1.5 billion euros have been invested so far in exploring the Gorleben salt dome and keeping the mine open.

The geological findings so far do not contradict the suitability of the site. However, it has not yet been possible to make a definitive statement on the suitability of the Gorleben salt dome as a repository especially for heat-generating radioactive waste. Such a statement can only be made following further examinations of the site and once the safety analyses have been concluded. After the conclusion of the exploration and a conclusion that the salt dome is suitable as a repository, a plan approval procedure including an environmental impact assessment and public involvement would have to be carried out.

Figure D-11: Gorleben exploratory mine (Copyright: GNS)



D.4. Inventory of Radioactive Wastes

In the Federal Republic of Germany, radioactive waste is generated from

- the operation of nuclear power plants,
- uranium enrichment and the production of fuel assemblies (nuclear industry),
- the decommissioning and dismantling of nuclear power plants, research, demonstration and educational reactors, and other nuclear installations,

- basic and applied research,
- the use of radioisotopes in other research institutions, universities, trade and industry companies, hospitals and medical practices,
- other waste producers, such as the military sector,
- the future conditioning of spent fuel assemblies to prepare them for direct disposal.

The Federal Republic of Germany shall accept the return of the following radioactive waste:

- According to contractual agreements with the reprocessing companies AREVA-NC, formerly COGEMA – Compagnie Générale des Matières Nucléaires (France), and Sellafield Ltd., held by BNFL – British Nuclear Fuels plc (United Kingdom), Germany must accept the return of an equivalent amount of radioactive waste obtained from the reprocessing of spent fuel from light-water reactors. Whilst return of the vitrified fission product concentrate France commenced in May 1996 and will continue at regular intervals, the return delivery of radioactive waste from the United Kingdom is currently still at the planning stage.
- Further contracts were concluded with the United Kingdom (UKAEA) to reprocess a limited number of spent fuel assemblies from research reactors. Spent fuel assemblies from German research reactors a (PTB Braunschweig, TU München, GKSS Geesthacht, HMI Berlin, FZJ and FZK) with a total amount of approx. 1 810 kg were shipped for reprocessing to the British facility at Dounreay, Scotland, where they were reprocessed between 1992 and 1996. The liquid waste resulting from dissolution in nitric acid is conditioned by UKAEA at Dounreay by way of cementing. This cemented waste has to be returned to Germany.

The following sections contain an overview of the inventory of untreated radioactive residues, together with the inventory of intermediate waste products and conditioned waste as per 31 December 2007 as well as a prognosis of the volume of waste expected to arise until the year 2080. An overview of the radioactive waste disposed of in the ERAM repository at Morsleben and the waste emplaced in the Asse mine is also provided.

D.4.1. Inventory of Radioactive Wastes and Prediction

The inventory of radioactive waste is determined for radioactive waste with negligible heat generation as well as for heat-generating radioactive waste. Table D-5 contains the summarised data for the year 2007 with regard to raw waste (primary waste), interim products (treated waste) and waste packages (conditioned waste). This list does not include the inventory of spent fuel assemblies (cf. remarks on Article 32 2. (ii)). The data on conditioned waste refer to the waste package volume.

Table D-5: Overview of the volumes of radioactive waste in interim storage as at 31 December 2007 [m³]

Type of residue	With negligible heat generation	Heat-generating
Untreated waste (raw waste with residues yet to be recycled)	18 506	61
Interim products	8 541	1 252
Conditioned waste	91 077	544

Waste with Negligible Heat Generation

In total, 18 506 m³ of radioactive residues and untreated waste was held in storage by all waste producers. The inventory of interim products with negligible heat generation totalled 8 541 m³, most

of which was held in storage at the waste producers, with a small portion being held at interim storage facilities. The inventory of conditioned radioactive waste with negligible heat generation totalled 91 077 m³ as per 31 December 2007. This inventory was likewise held in storage both at the waste producers and in interim storage facilities.

Table D-6 shows the inventory (volume) of waste with negligible heat generation according to the individual waste producers.

Table D-6: Overview of the inventory of radioactive residues and untreated primary waste, interim products and conditioned waste with negligible heat generation as per 31 December 2007, given in m³

Waste producer group	Untreated primary waste	Interim products	Conditioned waste
Research institutions	6 225	2 655	39 526
Nuclear industry	884	2 120	6 884
Nuclear power plants	3 830	710	16 034
Decommissioned nuclear power plants	4 859	836	11 478
<i>Land</i> collecting facilities	899	144	3 291
Others	1 553	0	0
Reprocessing	256	2 076	13 864
Waste producer group	18 506	8 541	91 077

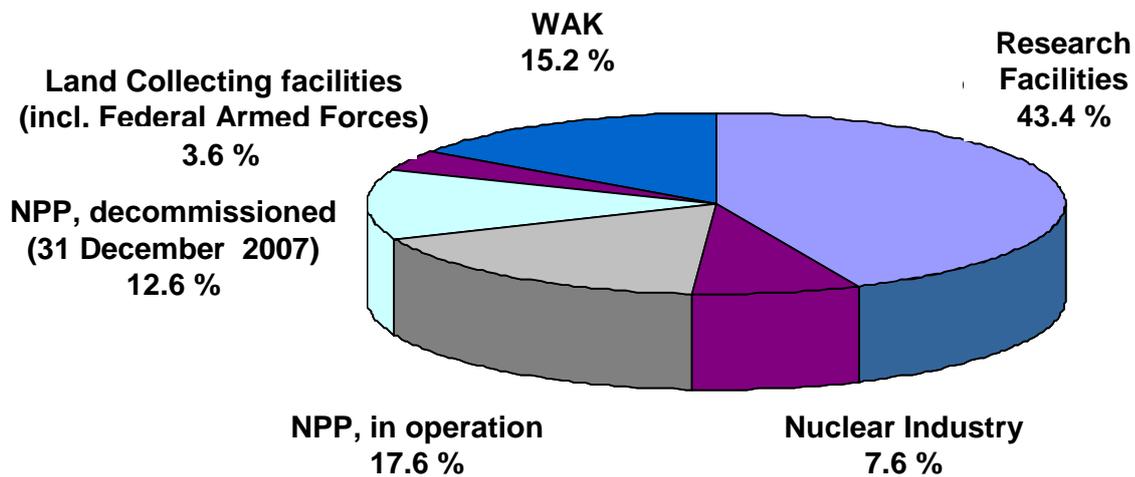
Table D-7 gives an overview of distribution of the inventory of the conditioned waste with negligible heat generation among the different interim storage options.

Table D-7: Interim storage of conditioned waste with negligible heat generation as per 31 December 2007, given in m³

Interim storage facility	Waste volume
Research centres including clients	54 171
Nuclear industry	10
Energiewerke Nord, Zwischenlager Nord	3 644
Light water reactors	6 995
Decommissioned reactors	2 971
<i>Land</i> collecting facilities	1 598
Interim storage facility at the Unterweser nuclear power plant	1 148
Interim storage facility of the utilities at Mitterteich	4 925
GNS Gorleben facility (ALG)	6 201
NCS	6 588
GNS and other interim storage facilities	2 826
Total	91 077

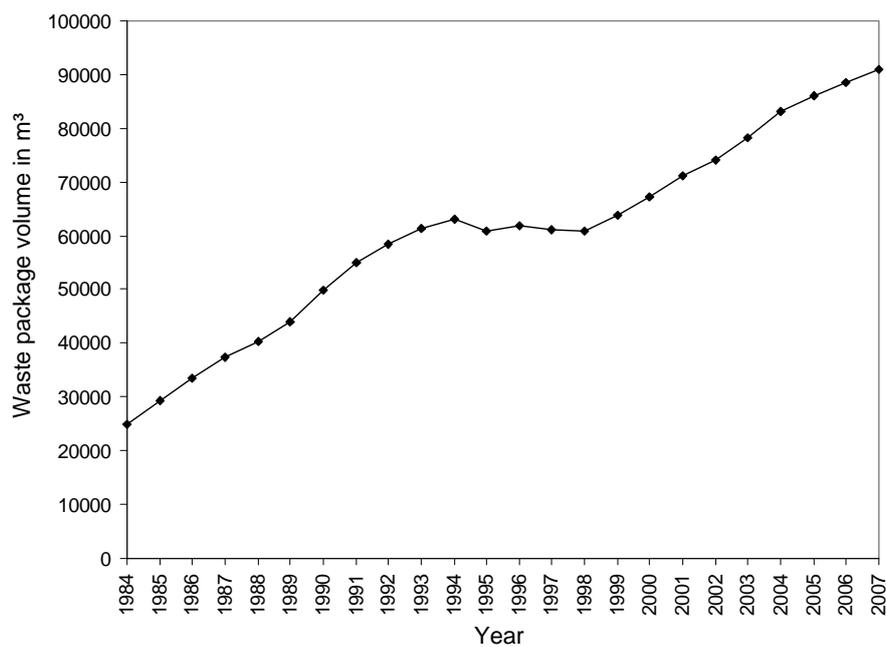
Figure D-12 shows the distribution of the inventory of the conditioned waste with negligible heat generation in 2007 among the different waste producers.

Figure D-12: Distribution of the inventory of the conditioned waste with negligible heat generation among the different waste producers as per 31 December 2007, total volume: 91 077 m³



The average annual amount of conditioned waste with negligible heat generation totals approx. 4 440 m³. Figure D-13 shows the development of the amount of conditioned waste with negligible heat generation cumulated at the end of each year.

Figure D-13: Development of the cumulated amount of conditioned radioactive waste in Germany since 1984



There was no increase in the inventory between 1995 and 1998 as it was possible until the end of 1998 to emplace radioactive waste in the Morsleben repository (ERAM). Since the termination of emplacement operations in the ERAM, there has again been a steady increase in the inventories of the waste producers.

Heat-Generating Radioactive Waste

Apart from the inventory of radioactive waste with negligible heat generation, there were approx. 63 m³ of heat-generating primary waste, 1 252 m³ of interim products and 544 m³ of heat-generating conditioned waste stored in the Federal Republic of Germany as per 31 December 2007. The primary waste is mainly the fission product concentrate from the decommissioned WAK. The Karlsruhe vitrification plant (VAK) was built for its treatment for disposal; commissioning of this plant is planned for 2009. This inventory is added by the spherical fuel assemblies of the AVR Jülich (1.5 Mg HM) that are in storage at the Jülich Research Centre (FZJ).

The spherical fuel assemblies unloaded from the THTR are to be disposed of directly in a repository. At present, they are in interim storage and considered as interim products. The largest part of the conditioned heat-generating waste comes from reprocessing. The reconditioned waste from reprocessing is enclosed in 75 casks (one Type-TS 28 V cask and 74 casks of the CASTOR[®] type) holding a total of 2 100 canisters with vitrified fission product concentrate from the reprocessing of spent fuel assemblies at AREVA NC. The other heat-generating radioactive waste consists i.a. of highly-activated components and fuel assembly parts from the WAK, concentrate, and unsorted waste, e.g. from the dismantling of the WAK and the KNK II. The distribution of the inventory of heat-generating waste is shown in Table D-8.

Table D-8: Overview of the inventory of heat-generating waste as per 31 December 2007, given in m³

Waste producer group	Untreated primary waste	Interim products	Conditioned waste
Research institutions	7	-	90
Nuclear industry	-	-	-
Nuclear power plants	-	-	2
Decommissioned nuclear power plants	-	1 252	-
<i>Land</i> collecting facilities	-	-	19
Others	-	-	-
Reprocessing	56	-	433
Total	63	1 252	544

The conditioned radioactive waste - both with negligible heat generation and heat-generating - is put in interim storage at the waste producers' in internal as well as in centralised storage facilities.

Prognoses

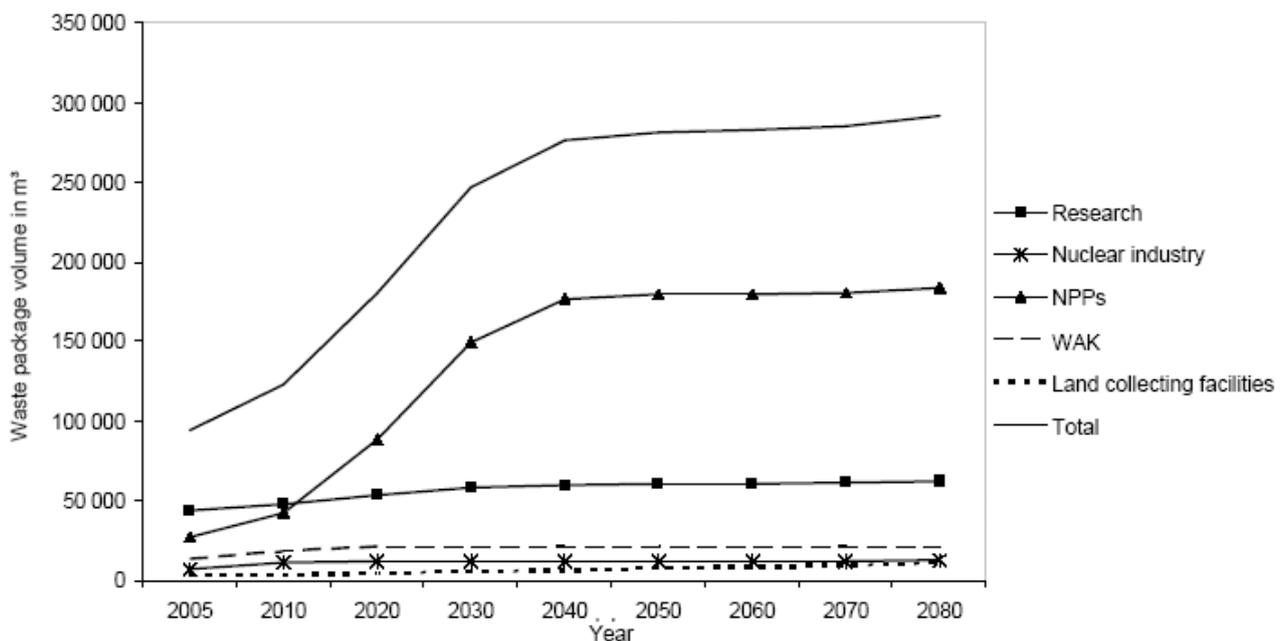
Regarding the work involved in planning a repository, it is necessary to make predictions of the future waste arisings and to update these when boundary conditions change. The waste producers provide the information about the expected waste volumes. This information always also comprises the respective predicted waste volumes that will arise in connection with the decommissioning and dismantling of nuclear installations. What is provided are planning values that have uncertainties attached to them and which will have to be reviewed and adapted in the future.

For the prognosis of the volumes of waste with negligible heat generation arising, the following boundary conditions were assumed: For each nuclear power plant unit, the operational waste is

assumed to amount to a waste package volume of 45 m³ per annum. During a transitional phase of four years from operation until decommissioning, the licensing procedure for the decommissioning of the installation is performed. During this period, there is further operational waste arising. For the decommissioning itself, an average 5 700 m³ per light water reactor has been estimated. The amount of decommissioning waste arising depends on when the decommissioning licence has been granted and on the decommissioning concept (immediate dismantling or later dismantling after a period of safe enclosure). It is expected that the volume of decommissioning waste will be reduced further due to the progressing improvement of methods. It furthermore has to be taken into account that great efforts are undertaken to clear materials for release and that mainly only those materials will be counted among the radioactive waste which even after a longer decay period cannot be cleared for release (e.g. active components that used to be close to the core). It is expected that the largest waste flow volume will come from the decommissioning of the nuclear power plants.

The time-dependent distribution of the future waste arisings expected by the waste producers is modelled in Figure D-14.

Figure D-14: Time-dependent distribution of the cumulated future arisings of radioactive waste with negligible heat generation as waste package volumes in m³ until the year 2080



It can be seen from this illustration that according to today's estimates that are guided by the applicable boundary conditions (limited operating times of the NPPs) no further large amounts of waste are to be expected after 2040.

As already mentioned in Chapter D.2, approx. 12 500 Mg HM of spent fuel assemblies had arisen in Germany until 31 December 2007. Until all NPPs will have been decommissioned, a total of approx. 17 200 Mg HM will arise. Taking the already disposed of amounts (reprocessing) into account, the estimate is that there will be a total of approx. 10 500 Mg HM arising for direct disposal in a repository.

The cumulated amount of heat-generating waste in the year 2080 is estimated at a total of approx. 28 000 m³ assuming a lifetime of the nuclear power plants of 32 years of power operation, taking the residual operating times into account. This amount is composed of

- approx. 20 800 m³ of packaged fuel assemblies from light water reactors for direct final disposal (this estimate is based on the assumption of direct disposal in POLLUX casks as present reference concept),
- approx. 780 m³ of vitrified waste (HAW from France, the United Kingdom and Karlsruhe as well as vitrified waste from liquid waste processing at the French La Hague reprocessing plant),
- approx. 950 m³ of structural parts and sleeves (CSD-C) from the reprocessing of spent fuel assemblies in foreign reprocessing plants and from the WAK,
- approx. 1 970 m³ of packaged fuel assemblies from the THTR and the AVR (final disposal in 457 CASTOR[®] THTR/AVR casks),
- approx. 170 m³ of packaged fuel assemblies from the VKTA, HMI and FRM II (for the remaining fuel assemblies from research reactors, it is assumed in the context of this prognosis that they will be shipped to the US) and
- approx. 3 400 m³ of waste packages from the PKA with structural parts of the spent fuels that will go to direct final disposal.

D.4.2. Disposed of Radioactive Waste

ERAM

During the period from 1971 to 1991 and from 1994 to 1998, low-level and medium-level radioactive waste with comparatively low concentrations of alpha-emitters was emplaced in the Morsleben repository for radioactive waste (ERAM).

This waste originated from

- the operation of nuclear power plants,
- the decommissioning of nuclear facilities,
- the nuclear industry,
- research institutions,
- *Land* collecting facilities or directly from small waste producers, and
- other users of radioactive materials.

In total, some 36 753 m³ of solid waste and 6 617 sealed radiation sources were emplaced in the repository. As a general rule, the emplaced radioactive waste is packaged in standardised containers, such as 200- to 570-l drums and cylindrical concrete containers. The sealed radiation sources are not subjected to further treatment nor are they packaged. In addition to the disposed of radioactive waste, sealed cobalt radiation sources, some caesium radiation sources, and small quantities of solid medium-level waste (europium waste) in seven special containers (steel cylinders) with a volume of 4 litres each and one 280-l drum containing Ra-226 waste are intermediately stored in deep boreholes at the ERAM facility. Within the scope of the licensing procedure for the decommissioning of the ERAM repository, an application was submitted to dispose of this intermediately stored waste.

The waste from nuclear power plants primarily refers to waste created during the operation of these facilities, such as mixed waste (contaminated work materials, protective clothing, tools, plastic film, filter paper, wire wool, insulating materials), building rubble, filters, metallic waste such as fittings, pipes and cables, dried evaporator concentrates, cemented evaporator concentrates and filter resins, as well as contaminated soil. The solid waste was packaged in a compacted or uncompact state in drums or cylindrical concrete containers. In addition to this waste, sealed radiation sources were also disposed of.

Radioactive waste from *Land* collecting facilities consists primarily of pressed or unpressed mixed waste such as metals, filter materials, contaminated laboratory waste and laboratory equipment, resins, building rubble, cemented concentrates or solutions, and sealed radiation sources. This waste was packaged in drums or disposed of as radiation sources.

Building rubble, contaminated soil, cemented mixed waste both pressed and unpressed, metallic waste, combustion residues, contaminated laboratory waste, cemented rinse solutions and immobilised radiation sources were supplied to the ERAM repository as radioactive waste by research institutions and other waste producers. Most of the radioactive waste from these waste producers is packaged in 200-l drums.

Waste data on the radioactive waste is documented and archived. The total activity of all emplaced radioactive waste is in the magnitude of 10^{14} Bq, with the activity of the alpha-emitters being in the region of 10^{11} Bq. Table D-9 provides an overview of the activity of the relevant radionuclides contained in the waste emplaced in the ERAM repository, including waste currently placed there for interim storage. The activity data refer to 31 December 2007.

Table D-9: Radionuclide inventory of relevant radionuclides in the ERAM repository as at 31 December 2007

Radionuclide	Activity in Bq	Radionuclide	Activity in Bq
H-3	$2.7 \cdot 10^{12}$	Th-229	$4.5 \cdot 10^5$
C-14	$3.2 \cdot 10^{12}$	Th-230	$1.8 \cdot 10^6$
Cl-36	$3.9 \cdot 10^9$	Th-232	$5.8 \cdot 10^6$
Ca-41	$7.3 \cdot 10^7$	Pa-231	$1.6 \cdot 10^6$
Co-60	$1.2 \cdot 10^{13}$	U-233	$5.0 \cdot 10^6$
Ni-59	$1.8 \cdot 10^{11}$	U-234	$1.1 \cdot 10^9$
Ni-63	$1.5 \cdot 10^{13}$	U-235	$8.2 \cdot 10^7$
Se-79	$1.9 \cdot 10^8$	U-236	$4.8 \cdot 10^7$
Rb-87	$2.8 \cdot 10^7$	U-238	$4.3 \cdot 10^8$
Sr-90	$5.5 \cdot 10^{12}$	Np-237	$8.3 \cdot 10^7$
Zr-93	$9.3 \cdot 10^9$	Pu-239	$6.9 \cdot 10^{10}$
Nb-94	$2.7 \cdot 10^{10}$	Pu-240	$6.6 \cdot 10^{10}$
Mo-93	$2.5 \cdot 10^8$	Pu-242	$1.2 \cdot 10^8$
Tc-99	$1.0 \cdot 10^{11}$	Pu-244	$2.1 \cdot 10^4$
Pd-107	$6.7 \cdot 10^7$	Am-241	$2.2 \cdot 10^{11}$
Sn-126	$2.4 \cdot 10^8$	Am-243	$9.5 \cdot 10^7$
I-129	$2.1 \cdot 10^8$	Cm-244	$6.0 \cdot 10^9$
Cs-135	$3.7 \cdot 10^8$	Cm-245	$2.3 \cdot 10^6$
Cs-137	$7.2 \cdot 10^{13}$	Cm-246	$2.6 \cdot 10^6$
Sm-151	$2.7 \cdot 10^{11}$	Cm-247	$2.6 \cdot 10^4$
Pu-241	$1.2 \cdot 10^{12}$	Cm-248	$2.2 \cdot 10^7$
Ra-226	$3.9 \cdot 10^{11}$		

The bulk of the emplaced waste volume originates from operational and decommissioned nuclear power plants. As the limit for the activity of alpha-emitters was very low at ERAM ($4 \cdot 10^8$ Bq/m³), the portion of the waste originating from the nuclear industry, research centres and reprocessing is

low. Table D-10 shows the volume of waste emplaced in the ERAM repository, classified according to individual waste producers.

Table D-10: Volume emplaced in the Morsleben repository (ERAM) according to individual waste producers

Waste producer	Volume in m ³
Nuclear power plants	23 816
Decommissioned nuclear power plants	6 528
Research institutions	2 592
Nuclear industry	159
Land collecting facilities	3 090
Others	523
Reprocessing	45
Total	36 753

Asse Mine

In 1967, the emplacement of low-level waste began in the former Asse salt mine; in 1972, medium-level waste followed. In 1978, the limited emplacement licences expired, and research and development in the field of final disposal was continued without any further emplacement of radioactive waste. Until then, a total of 47 000 m³ of radioactive waste from the delivering parties had been emplaced in various different waste package types:

- 124 494 waste packages holding low-level waste with a total activity of approx. $1.6 \cdot 10^{15}$ Bq (as at 31 December 2007). These represent approx. 60 % of the total activity in the Asse mine and are distributed over eleven rooms at the 750-m level and one room at the 725-m level.
- 1 293 drums holding medium-level waste with a total activity of around $1.1 \cdot 10^{15}$ Bq (as at 31 December 2007). These represent approx. 40 % of the total activity and are stored at the 511-m level.

Table D-11 gives a survey of the delivering parties (waste origin) of the waste packages emplaced and of their activity.

Table D-11: Percentages of the waste packages emplaced in the Asse mine with regard to number and activity by delivering party (waste origin)

Delivering party (waste origin)	Waste packages [%]	Total activity [%]
Karlsruhe research centre	50	90
Jülich research centre	10	2
Nuclear power plants	20	3
Other delivering parties	20	5
Total	100	100

The low-level waste was mainly emplaced in drums with volumes of between 100 and 400 litres or in cylindrical concrete containers. For the emplacement of medium-level waste, only 200-l drums were used.

The low-level waste emplaced contains solidified or dried former aqueous waste, such as evaporator concentrates, filter residues, sludges, ion-exchanger resins, furthermore solid waste such as scrap metal, rubble and mixed waste. As regards the medium-active waste, only filters and solidified former aqueous waste was emplaced apart from scrap metal. The percentages of the waste packages (number of packages) emplaced with regard to the different kinds of waste is given in Table D-12 for LAW and MAW. No high-level waste was emplaced in the Asse mine. Eight drums filled with intermediate level waste from FZJ contain, among other items, parts of irradiated fuel rod segments and in one case AVR fuel elements.

Table D-12: Percentages of the waste packages with regard to the different kinds of waste for LAW and MAW

Kind of waste	LAW packages [%]	MAW packages [%]
Filters, filter aids, sludges, evaporator concentrates, resins, ...	30	35
Metals, scrap metal, iron, steel metal, structural parts, piping, ...	20	65
Rubble, gravel, floor coverings, ...	10	-
Mixed waste, paper, film, overalls, galoshes, cleaning rags, wood, glass, ...	40	-
Total	100	100

The data pertaining to the radioactive waste emplaced have been documented and archived. The overall 125 787 waste packages emplaced, which have a gross waste package volume of approx. 47 000 m³ and a total mass of approx. 89 000 Mg, had a total activity of $7.8 \cdot 10^{15}$ Bq at the time of emplacement. Table D-13 gives a survey of the activities of the relevant radionuclides in the waste emplaced in the Asse mine as per 31 December 2007. At that time, the total activity was $2.7 \cdot 10^{15}$ Bq including an alpha activity of approx. $2 \cdot 10^{14}$ Bq.

Table D-13: Radionuclide inventory of relevant radionuclides in the Asse mine as per 31 December 2007

Radionuclide	Activity in Bq	Radionuclide	Activity in Bq
H-3	$9.1 \cdot 10^{11}$	Ra-226	$2.0 \cdot 10^{11}$
C-14	$3.9 \cdot 10^{12}$	Th-232	$3.5 \cdot 10^{11}$
Cl-36	$9.0 \cdot 10^9$	U-234	$1.3 \cdot 10^{12}$
Co-60	$6.7 \cdot 10^{13}$	U-235	$5.2 \cdot 10^{10}$
Ni-59	$5.9 \cdot 10^{12}$	U-236	$1.3 \cdot 10^{10}$
Ni-63	$7.3 \cdot 10^{14}$	U-238	$1.3 \cdot 10^{12}$
Se-79	$4.1 \cdot 10^9$	Np-237	$3.0 \cdot 10^9$
Sr-90	$2.9 \cdot 10^{14}$	Pu-239	$1.9 \cdot 10^{13}$
Zr-93	$1.7 \cdot 10^{10}$	Pu-240	$2.2 \cdot 10^{13}$
Nb-94	$7.5 \cdot 10^{10}$	Pu-241	$8.3 \cdot 10^{14}$
Tc-99	$1.5 \cdot 10^{11}$	Pu-242	$4.4 \cdot 10^{10}$
Sn-126	$5.4 \cdot 10^9$	Am-241	$1.0 \cdot 10^{14}$
I-129	$3.2 \cdot 10^8$	Cm-244	$1.6 \cdot 10^{12}$
Cs-135	$3.8 \cdot 10^9$	Cm-245	$4.3 \cdot 10^8$
Cs-137	$5.0 \cdot 10^{14}$	Cm-246	$5.1 \cdot 10^8$
Sm-151	$4.0 \cdot 10^{12}$		

D.4.3. Inventory from Former Activities

Materials from former activities have been conditioned and have either been brought to an interim storage site (cf. the remarks on Article 32 2. (iv) (a)) or to final disposal (cf. the remarks on Article 32 2. (iv) (b)).

On measures related to former practices it is reported in Chapter H.2.2.

D.5. List of Decommissioned Installations

D.5.1. Overview

Within the context of Article 32 2. (v) of the Convention, the report should include details of a nuclear facility (excluding final repositories) if the operator of such a facility has applied for a licence for decommissioning under § 7, para. 3 of the Atomic Energy Act (AtG) or if such a licence has been granted (cf. the remarks on Article 26). Within the meaning of this Convention, such facilities are classified as “in the process of being decommissioned”.

Table D-14 provides an overview of those facilities in Germany which are currently in the process of decommissioning or which have already been fully removed. A complete list of facilities can be found in Annex L-(c), Table L-14 to Table L-18.

Over the past two decades, Germany has acquired considerable experience in the decommissioning and dismantling of nuclear installations. Many research reactors and all prototype nuclear power plants, as well as a few larger nuclear power plants and fuel cycle facilities, are currently at varying stages of decommissioning. Some facilities have been fully removed and the site has been cleared for re-use.

Table D-14: Overview of installations in Germany currently in the process of decommissioning or released from nuclear regulatory control or control under radiation protection law

Type of installation	In the process of decommissioning	Fully removed or released from control
Reactors with electrical power generation (incl. prototype reactors)	17 reactors	2 reactors
Research reactors \geq 1 MW thermal power (incl. nuclear ship Otto Hahn)	8 reactors	1 reactor
Research reactors < 1 MW thermal power	1 reactor	26 reactors
Fuel cycle facilities (primarily commercial production and reprocessing of fuel assemblies)	2 facilities	4 facilities
Research and prototype fuel cycle facilities	-	3 facilities

D.5.2. Power Reactors

The 17 power reactors which are currently in the process of decommissioning or for which a decommissioning licence has been applied for include seven prototype and demonstration facilities, as well as the nuclear power plants at Greifswald (KGR), Rheinsberg (KKR), Würgassen, Mülheim-Kärlich (KMK), Stade (KKS) and Obrigheim (KWO). In addition, the nuclear power plant Niederaichbach (KKN) and the Heißdampfreaktor Kahl (HDR) have been fully dismantled and the sites have been cleared for non-nuclear use.

In future, further nuclear power plants will be shut down and decommissioned as a result of Germany's phase-out of nuclear power as laid down in the Atomic Energy Act.

D.5.3. Research Reactors

Eight research reactors with a thermal output of 1 MW or more are in various stages of decommissioning, one reactor has been fully dismantled and removed. 25 out of the 27 research reactors with a thermal output of less than 1 MW have already been fully removed, including a number of zero-output reactors for educational purposes. One facility was rebuilt and rededicated as a new educational reactor. For another facility, decommissioning is planned.

D.5.4. Fuel Cycle Facilities

The six fuel cycle facilities which are currently in the process of decommissioning or which have been removed in Germany comprise the reprocessing plant WAK at Karlsruhe as well as five fuel fabrication plants at Hanau and Karlstein. Four of these five fuel fabrication plants have been completely removed, one plant has been converted to conventional use.

Additional non-commercial fuel cycle facilities located at research centres have also been fully dismantled.

D.5.5. Status of Current Decommissioning Projects

The Nuclear Power Plants at Greifswald (KGR) and Rheinsberg (KKR)

Eight nuclear power plant units of Soviet design, each with an electrical output of 440 MWe, had been planned for the nuclear power plant complex at Lubmin near Greifswald (KGR). At the time of final shut-down in 1989, the first four units (type VVER-440/W-230) had been in commercial operation since the 70s (unit 1 since 1974), whilst the fifth (type WWER-440/W-213) had been in trial operation for a few months when it was shut down in 1989. Units 6 to 8 were still under construc-

tion. Apart from the reactor units, the complex also comprises the "Interim Storage for Spent Fuel" (ZAB) and the "Central Active Workshop" (ZAW).

The decision to shut down all existing units and to halt commissioning of the remainder was taken on the basis of financial considerations, because under federal atomic energy law, their continued operation would have required major structural conversions. Certain special features of the plant needed to be taken into account when preparing the concept for decommissioning and dismantling. Under § 57 of the Atomic Energy Act (AtG) [1A-3], the operating licence from the former GDR remained valid until the decommissioning license was granted on 30 June 1995.

Dismantling of the entire complex is expected to take around 18 years, at which time it will be released from the purview of the Atomic Energy Act. The decision to opt for direct dismantling was based on a variety of factors, including technical and legal viability, the preservation of as many jobs as possible and hence also of available expert knowledge of the plant, and the avoidance of substantial rebuilding work to facilitate safe enclosure.

For the most part, the decommissioning and dismantling of KGR is carried out by permanent staff from the operational period in order to make best possible use of their expert technical and plant knowledge.

A vital part of the overall concept for decommissioning has been the construction of the Interim Storage Facility North (*Zwischenlager Nord*, ZLN) at the KGR site. The spent fuel assemblies from the cooling ponds in the reactor buildings and from the ZAB as well as from the nuclear power plant at Rheinsberg (KKR) have been stored in the ZLN. In addition, the ZLN serves as an interim storage facility for radioactive waste from KGR and KKR until they can be emplaced in a repository, for storage of the unsegmented reactor pressure vessels (RPV) from units 1 to 5 of KGR and from KKR as well as for a part of the reactor internals, making use of radioactive decay for several decades, but no longer than the end of the operating period of the Konrad repository. The logistics for the transports of the unsegmented RPVs from the reactor buildings to the ZLN have been very demanding. These transports have been carried out using a heavy goods vehicle on the internal roads of the site, requiring additional shielding measures especially around the centre part of the RPVs.

With their installations for conditioning and segmentation, ZLN and ZAW also contribute to a large part to the managing the large quantities of material from the decommissioning of KGR, as the segmentation of large components like steam generators can be uncoupled from the dismantling of the rest of the plant. This separation of dismantling and decay storage of large components has proved to be an essential part of the whole material concept of KGR.

Transport of nuclear fuel from the ZAB into the ZLN has been completed since the last Review Meeting. Decommissioning of the ZAB was started immediately afterwards.

Those parts of the site that are no longer required have been and will be cleared (if necessary after decontamination) for industrial or commercial purposes in order to develop the site. After completion of the decommissioning work, the remaining parts of the nuclear site can be cleared so that the licenced site will be confined to ZLN and ZAW.

The Rheinsberg nuclear power plant (KKR) was the first nuclear power plant of the former GDR. It was equipped with a pressurised water reactor of VVER type with 70 MWe (gross), which was in operation from 1966 to 1990. The former Ministry for the Environment, Nature Conservation and Regional Planning of Brandenburg as the competent Federal State authority issued a licence for the decommissioning and partial dismantling of KKR in April 1995. Decommissioning is carried out in several licensing steps.

Dismantling was started in 1995. The predominant task was to empty those parts of the plant where the steam generators and the main circulation pumps were located in order to clear a space required for the preparation for transport of the CASTOR[®] casks. This work was completed in August 1998. The further dismantling of the main components and auxiliary systems of the primary

circuit as well as of installations in the turbine hall was completed except for a few residual systems. In total, the entire secondary circuit including auxiliary systems and more than 80 % of the components and systems of the primary circuit have been removed. In addition, the full dismantling of the storage facility for solid and liquid waste has been started. The former storage facility for solid waste has already been entirely removed. The building structures of the storage facility for liquid waste are currently being dismantled using temporary enclosures.

Decommissioning of KKR has to be seen in direct context with KGR, as the radioactive waste, the reactor pressure vessel and a part of the material eligible for clearance are treated or stored at the facilities at the KGR site, mainly ZLN, ZAW and the measurement facilities used for clearance. Transport of the material to Lubmin is carried out with lorries or in larger quantities with freight trains. Transport of the unsegmented reactor pressure vessel to the ZLN was accomplished on 30 October 2007 with a heavy goods rail car (see Figure D-15).

Figure D-15: Transport of the RPV from the Rheinsberg nuclear power plant to the ZLN (Copyright: EWN)



The decommissioning of KGR and KKR can be seen as an exemplary and successful large-scale decommissioning project, which generates valuable experience for the safe and efficient decommissioning of nuclear power plants with VVER reactors, being operated in the states of Central and Eastern Europe as well as in the CIS.

Obrigheim Nuclear Power Plant (KWO)

The Obrigheim nuclear power plant (KWO), a pressurised water reactor with an electrical power of 357 MWe (gross), started operation in 1968. This plant reached its assigned electricity quantity as defined in the Atomic Energy Act in 2005, so that power generation was terminated on 11 May 2005. Since then, decommissioning and dismantling of the plant are being planned and prepared.

The application for a licence for decommissioning and dismantling has been filed. The procedure for involvement of the public has already been completed, and no objections have been raised. Since 1 January 2007, KWO has been operated by EnBW Kernkraft GmbH (EnKK), like the two plants in Neckarwestheim and Philippsburg. The principal owner of EnKK is EnBW Kraftwerke AG.

The decommissioning strategy that has been chosen for KWO is early dismantling, which is planned in three steps and will last until 2020. The decommissioning strategy is, however, influenced by a number of site-specific factors, of which storage of spent fuel assemblies is the most important one especially during the initial phase of decommissioning. The fuel, which is currently stored in a wet fuel storage facility available at the site, is to be transferred into a dry storage facility still to be constructed at the site. A licence application for construction and operation of such a storage facility has been filed at the Federal Office for Radiation Protection (BfS) as the competent authority, according to § 6 of the Atomic Energy Act. The 15 CASTOR[®] casks are to be stored vertically in a hall, as in the storage facilities at operating nuclear power plants.

Würgassen Nuclear Power Plant (KWW)

The Würgassen nuclear power plant (KWW), a boiling-water reactor with an electrical output of 670 MWe (gross), started operation in 1971. The decision for decommissioning was taken at the end of May 1995, after cracks in the core shroud had been discovered during maintenance work in 1994.

Direct decommissioning was chosen as the decommissioning option. Decommissioning was separated into six phases, each covered by an individual licence. This step-by-step approach was designed to shorten the period of time required until granting of the first licence and to optimise the subsequent procedure by preparing for subsequent stages parallel to carrying out the already licensed stages.

Decommissioning work is currently well under way, with dismantling of the reactor pressure vessel, the biological shield and the pressure removal system. In the near future, the remaining technical equipment will be removed from the buildings, so that radiological characterisation of the buildings and decontamination of the building surfaces can be carried out as required. Clearance of the buildings will be the final step of the decommissioning process, followed by conventional demolition. The end of this work is envisaged for 2014. The buildings housing the interim storage for radioactive wastes will remain in place until the waste will be transported to final disposal in the Konrad repository.

Residual materials like scrap metal, building rubble etc. are generally decontaminated and are then subjected to a clearance procedure outlined in § 29 of the Radiation Protection Ordinance (StrlSchV) [1A-8], which ends with a final measurement on which the clearance decision is based. Experience shows that most of this material can be cleared; only a small percentage of the total mass requires treatment and disposal as radioactive waste.

Stade Nuclear Power Plant (KKS)

The Stade nuclear power plant (KKS) was equipped with a pressurised water reactor with an electrical output of 672 MWe (gross) and additionally provided long-distance heating to a salt works. The plant started operation in 1972 and was finally shut down on 14 November 2003. Early dismantling was chosen as decommissioning strategy. A licence covering decommissioning, residual operations, dismantling phase 1 and the interim storage facility for radioactive waste was issued on 7 September 2005. The entire dismantling phase is scheduled to last from 2005 until around 2014. Dismantling is structured into several phases, similar to those of e.g. the Würgassen nuclear power plant. After termination of nuclear supervision, conventional dismantling of the buildings leading to a green-field state could be reached by the end of 2015.

The fuel assemblies were fully removed prior to the start of decommissioning and have been shipped for reprocessing. The last transport was carried out on 27 April 2005. The radioactive waste is stored at a storage facility at the KKS site until it can be transferred into a repository.

Currently, the plant is in the second decommissioning phase, covering dismantling of large components inside the containment. The licence according to the Atomic Energy Act covering this work was issued on 15 February 2006.

As part of the removal of large components, the four steam generators with a total mass of 660 Mg were shipped to Sweden in September 2007 for non-detrimental recycling. Figure D-16 shows the loading of one steam generator onto the transport vessel MS Sigyn using a floating crane as preparation for shipment to Sweden.

Figure D-16: Loading operation of a steam generator with a floating crane onto the transport vessel MS Sigyn for transport to Sweden (Copyright: GNS)



The further phases have been planned as follows:

Phase 3: removal of the reactor pressure vessel and the biological shield,

Phase 4: dismantling of the residual contaminated components, demonstration of absence of contamination, release of the remaining structures from surveillance,

Phase 5: conventional demolition of the buildings.

Kahl Experimental Nuclear Power Plant (VAK)

The Kahl experimental nuclear power plant (Versuchsatomkraftwerk Kahl, VAK), a boiling-water reactor with an electrical output of 16 MWe (gross), started operation in 1960. On 17 June 1961, this nuclear power plant for the first time provided electrical current produced from nuclear energy to the public power grid.

After 25 years of operation, the VAK was shut down on 25 November 1985. The first decommissioning work started in 1988. Decommissioning of the various sections of the plant has been carried out under four decommissioning licences according to § 7 of the Atomic Energy Act (AtG). This work has also been used for testing and development of dismantling techniques for nuclear power plants. As a last and prominent part of the plant, the stack with a height of 53 m was demolished in July 2007. Meanwhile, dismantling of VAK has reached its final phase. Measurements for clearance of the remaining building structures of the controlled area, especially the multi-purpose hall and the radwaste building, are almost completed. The cleared buildings will be conventionally demolished after release from the purview of the Atomic Energy Act. Measures for the release of the VAK site, like e.g. taking of soil samples, probing as well as decision measurements on paved and open ground by the operator have not been fully completed yet. Release of the VAK plant from the purview of the Atomic Energy Act is, however, envisaged for 2008. Figure D-17 shows the successive dismantling of the reactor.

Figure D-17: Successive dismantling of the reactor building of the Kahl experimental nuclear power plant (Copyright: NUKEM and BMU)



Karlsruhe Reprocessing Plant (WAK)

The Karlsruhe reprocessing plant (*Wiederaufarbeitungsanlage Karlsruhe*, WAK) was used for entry into the nuclear fuel cycle in Germany, and was operational from 1971 to 1990. The first decommissioning licence has been granted in 1993. In the course of re-structuring of the decommissioning project WAK, the proprietor of the *Wiederaufarbeitungsanlage Karlsruhe Betriebsgesellschaft mbH* (WAK BGmbH) changed on 2 March 2006, becoming effective on 1 January 2006 retroactively. With this change, EWN GmbH is now the sole proprietor of WAK BGmbH.

The uranium and plutonium that were separated during operation were used for the production of new fuel assemblies, whilst the separated high-level liquid waste has been put into interim storage at WAK until its vitrification. In total, some 207 Mg of spent fuel from research and power reactors were reprocessed at WAK using the PUREX process (*Plutonium Uranium Recovery by Extraction*). The plant was originally constructed with the aim of researching the basic principles for construction of an industrial-scale commercial reprocessing plant in Germany (like e.g. the WAW plant planned at Wackersdorf, whose construction had already begun) and developing a process management system. Following the decision in 1989 to halt the reprocessing of nuclear fuels in Ger-

many and instead ship the spent fuel to reprocessing plants abroad, the continued operation of WAK and the construction of WAW became superfluous.

A key pre-requisite for the decommissioning of WAK is the separation of decontamination and dismantling operations in the former process buildings from the handling and conditioning of the high-level liquid waste. Much of the dismantling work at WAK is carried out using remote-controlled tools because of the high dose rates. Before applying them at WAK itself, the manipulator systems and their handling were tested on full-scale test rigs of process cells. As far as possible, the dose rate in specific areas of the plant is also reduced by decontamination to levels that allow the use of manual segmenting techniques. Removal of the components is generally followed by decontamination of the building structure and its subsequent clearance. Once it has been released from supervision under the Atomic Energy Act, the WAK will be demolished conventionally. The whole decommissioning project is subdivided into several stages, some of which are carried out in parallel:

1. Deregulation: shutdown of redundant process systems and/or adaptation to the reduced requirements. The licence for this stage has been implemented and the work has since been completed.
2. Initial dismantling activities in the process building, hands-on dismantling of process systems, shutdown of operations, and removal of plant components already decommissioned. Work on this step began in early 1996 and was finished in 1997.
3. Gradual dismantling of all equipment in the process building not related to HAWC storage and disposal with the aim of abandoning the controlled area. The remotely controlled dismantling of the process cells was finished at the end of 2001. During this time, the laboratory for the analysis of high-active waste was relocated and the separation of the HAWC reserve storage from the process building was completed. This has been and still is followed by dismantling of the auxiliary systems including the barriers, and decontamination of all rooms to an acceptable level for clearance so that the controlled area can be cancelled.
4. Deregulation of the HAWC storage facility and the VEK following the removal of HAWC.
5. Gradual dismantling of HAWC storage facilities and the VEK, followed by all auxiliary equipment; contamination and clearance measurement of all remaining rooms with the aim of cancelling the remaining controlled and radiation protection areas.
6. Demolition of the buildings after cancellation of the controlled and radiation protection areas, and recultivation of the site.

The decommissioning project is currently in an advanced stage of phase 3.

The presence of a broad spectrum of alpha emitting nuclides and fission products in varying proportions makes clearance of the rooms and the material more difficult, because complex radiological characterisation and measurement procedures are needed.

The decommissioning and dismantling of WAK differs from the decommissioning of other fuel cycle installations in terms of overall scope, the effort involved, the need for remote controlled dismantling and segmenting techniques, as well as materials and waste management. The specific plant design and procedural peculiarities are leading to an above-average effort and hence cost for the WAK project. The project is currently expected to be completed by the year 2023.

Gundremmingen Nuclear Power Plant Unit A (KRB-A)

The Gundremmingen nuclear power plant unit A (KRB-A) has been the first commercial boiling-water reactor in Germany. It had an electrical power of 250 MWe (gross) and was in operation between 1966 and 1977. Dismantling started in 1984. The decommissioning licence was granted on 26 May 1983. Dismantling is carried out in separate phases, where phase 1 pertains to the turbine hall, phase 2 to the contaminated systems of the reactor building, phase 3 to the activated components in the reactor building, like reactor pressure vessel and biological shield, and phase 4 to the

decontamination and demolition of the buildings. The decommissioning process has already commenced very far. Segmentation of the reactor pressure vessel has been completed, and the segmented metallic parts have been packaged into cast-iron packages and are stored in the interim storage facility Mitterteich. The biological shield has been segmented and disposed of. The activated part of the concrete has been packaged into containers for final disposal, together with metallic parts of the reactor. In this way, all activated components have been removed from the reactor building, and the decontamination of the building structures has been started.

As the Gundremmingen site comprises two other nuclear power plants with boiling-water reactor in operation, it has been decided to make use of the buildings of unit A as a technology centre for the operational needs of the site. A licence for the operation of this technology centre was granted on 5 January 2006. With the exception of the reactor building, this licence comprises the use of the radwaste building, of the turbine hall, the service building, the workshop and storage building, the diesel emergency power building and the storage hall for processing the material for clearance, for conditioning of radioactive waste, for maintenance of components, for manufacturing and storage of tools and equipment and for the storage and preparation for transport of conditioned and unconditioned waste until processing or shipment.

Before use of the technology centre, consent of the licensing authority is required, which will only be granted when dismantling in the buildings concerned has been completed to a large extent. This will probably be the case around mid-2008.

Experimental Reactor at Jülich (AVR)

The experimental reactor Jülich of the *Arbeitsgemeinschaft Versuchsreaktor GmbH (AVR)* at Jülich (in close vicinity to the Research Centre Jülich), North Rhine Westphalia, was a pebble-bed high-temperature reactor with an electrical power of 15 MWe (gross), which was in operation between 1966 and 1988. The initial application for a decommissioning licence included a period of "safe enclosure". In Germany this term refers to a safe state of a nuclear facility with almost no maintenance, into which it is transferred after final shut-down and removal of the fuel and in which it is kept for a certain time before it is dismantled. Implementation of this licence, however, was very difficult, mainly due to the very narrow space inside the plant, leading to a considerable delay with respect to the initial time schedule.

In May 2003, the EWN GmbH became sole proprietor of the *Arbeitsgemeinschaft Versuchsreaktor AVR*. After this transfer, the strategy was changed from "implementation of safe enclosure" to "dismantling to green-field". This change also caused a modification of the decommissioning procedure. It is now planned to remove the reactor vessel in one piece and to store it in a hall on the premises of the Research Centre Jülich for making use of the radioactive decay. The reactor pressure vessel will be filled with low-weight aerated concrete, by which handling is facilitated and the radioactive inventory (internals and graphite dust) is fixed.

A transfer building has been constructed as an extension of the reactor building in order to accomplish removal of the reactor vessel (cf. Figure D-18). This annex, which is markedly higher than the old reactor building, will allow opening of the building structure of the reactor building for subsequent removal of large components, mainly of the reactor vessel, lifting and lowering of the reactor vessel and tilting it into a horizontal position suitable for transport. Contamination of structures of the transfer building will be prevented by appropriate measures against contamination spread, so that later clearance of the transfer building will be possible and generation of additional radioactive waste will be avoided.

Figure D-18: Extension of the reactor building of the AVR by a transfer building (Copyright: EWN)



Lingen Nuclear Power Plant (KWL)

The shut-down Lingen nuclear power plant (KWL) is located close to the Emsland nuclear power plant and its interim storage facility for spent fuel on the power plant site. The KWL was a boiling-water reactor with an electrical power of 252 MWe (gross). Operation started in 1968. As a consequence of numerous technical faults, mainly fuel element damage, the plant was finally shut down in 1977. After removal of the spent fuel, the Kernkraftwerk Lingen GmbH, a wholly owned subsidiary of RWE Power AG, applied for dismantling of the turbine building and other redundant conventional auxiliary systems and for safe enclosure of the residual part of KWL remaining under surveillance, for approximately 25 years. The licence was granted on 21 December 1985.

With a licensing notice of 14 November 1997, KWL was granted a licence for modification of the plant, the safe enclosure and the operation under safe enclosure conditions mainly for the purposes of disposing of the operational waste still present inside KWL and for optimisation of the safe enclosure.

According to the current licensing situation, Kernkraftwerk Lingen GmbH would have to apply for a licence for dismantling of the KWL plant according to § 7 of the Atomic Energy Act, while dismantling work would have to commence in 2013 at the latest.

On 21 December 2004, the Kernkraftwerk Lingen GmbH has filed an application according to § 7 of the Atomic Energy Act for continuation of the safe enclosure until a federal repository will be op-

erational, but not later than 31 December 2040. This application has been withdrawn with letter of 19 September 2007.

Thorium High-Temperature Reactor at Hamm-Uentrop (THTR-300)

The THTR-300 was equipped with a helium-cooled 308 MWe (gross) pebble-bed high-temperature reactor and started operation in 1983. Decommissioning of the plant was decided in September 1989, after the plant had been shut down for annual routine inspection on 29 September 1988. A framework contract concerning the phasing-out work for the project THTR-300 was signed on 13 November 1989 between the Federal Government, the Federal State North Rhine-Westphalia, the operating company HKG and their proprietors. The first partial licence for decommissioning, removal of the fuel elements from the reactor core and the dismantling of components was granted on 22 October 1993. Since this time, the spherical fuel elements have been removed from the reactor core and transferred into the central interim storage facility at Ahaus in CASTOR[®] casks. Unloading of the reactor core was finished in 1995. The licence for operation of the safe enclosure (care and maintenance operation) was granted on 21 May 1997. Since October 1997, the plant has been kept in safe enclosure, which is envisaged to last for about 30 years.

D.6. Progress and Major Changes since the Last Review Meeting

D.6.1. Storage of Spent Fuel

Interim storage facilities have been taken into operation at twelve nuclear power plant sites. All temporary storage facilities (so-called *Interimslager*) have been cleared, and the casks with the spent fuel assemblies have been transferred into the interim storage facilities.

The wet storage of fuel assemblies in the ZAB Greifswald has been terminated, and the fuel assembly casks have been transferred into the ZLN.

D.6.2. Konrad Repository

The plan approval decision Konrad, which was granted in May 2002, became definitive on 26 March 2007, after dismissal of all claims and rejection of all appeals lodged against this refusal.

With letter of 30 May 2007, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) charged the Federal Office for Radiation Protection (BfS) with the conversion of the Konrad mine into a repository.

The main operating plan according to mining law for the construction of the Konrad repository was approved on 15 January 2008.

E. Legislative and Regulatory System

This section deals with the obligations according to Article 18 to 20 of the Convention.

E.1. Article 18. Implementing Measures

Article 18. Implementing measures

Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

E.1.1. Implementation of the Obligations under the Convention

Within the framework of its national law, the Federal Republic of Germany has already taken all the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention. The specific individual measures are described in connection with the comments on Article 19 of the Convention.

E.2. Article 19. Legislative and Regulatory Framework

Article 19. Legislative and regulatory framework

1. *Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.*
2. *This legislative and regulatory framework shall provide for:*
 - (i) *the establishment of applicable national safety requirements and regulations for radiation safety;*
 - (ii) *a system of licensing of spent fuel and radioactive waste management activities;*
 - (iii) *a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;*
 - (iv) *a system of appropriate institutional control, regulatory inspection and documentation and reporting;*
 - (v) *the enforcement of applicable regulations and of the terms of the licences;*
 - (vi) *a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.*
3. *When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.*

E.2.1. Legislative and Regulatory Framework

The Federal Republic of Germany is a Federal State. Responsibilities for law-making and law-enforcement are assigned differently to the organs of the Federation and the *Länder* according to the respective regulatory duties. Specifications are regulated by the provisions in the Basic Law [GG 49] of the Federal Republic of Germany.

For the peaceful use of nuclear energy, the legislative competence lies with the Federal Government. So far, the Federal Government had competing legislation in areas concerning the Convention. The Federal Government extensively made use of this competing legislation and thus excluded the *Länder* from legislation. After coming into force of the federalism reform on 1 September 2006, the Federal Government now has exclusive legislation for the matter mentioned according to Art. 73 (1) No. 14 of the Basic Law. Therefore, the Federal Government has not to show a need, as

required so far, to have the right and duty to legislate. The Atomic Energy Act (AtG) [1A-3] is implemented in accordance with Art. 87c, 85 of the Basic Law as has been the case up to now – apart from exceptions – by the *Länder* on behalf of the Federal Government. With respect to the lawfulness and appropriateness of their action, the competent *Land* authorities are subject to the supervision by the Federal Government. The competent authority for nuclear safety and radiation protection is the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). In this role, the BMU also sees to that the *Länder* fulfil their licensing and supervisory functions according to the same standards. The *Länder* Committee for Nuclear Energy, which convenes competent representatives from federal and regional levels for regular meetings, serves as an instrument for preparatory co-ordination of the associated activities.

The competent supervisory and licensing authorities report to the Federal Government on law enforcement. The Federal Government has the right to demand additional information and reports, the right to full access to records and may issue binding directives to the *Land* authority in the individual case. The Federal Government may assume the competence for the subject matter, i.e. the decision on the merits, by exercising his right to issue directives. However, the competence of execution, i.e. the implementation of the decision towards the applicant or licensee, remains with the competent *Land* authority.

Within the framework of nuclear procedures, other legal regulations also have to be considered, such as immission control legislation, water legislation, building legislation. Legal regulations for assessing the environmental impact are, in general, part of the nuclear licensing procedure.

In Germany, those concerned, e.g. applicants or licensees or also concerned third parties of the public, may take legal action against decisions of the public administration, so-called administrative acts, before the administrative courts (right to apply to the courts according to Art. 19 (4) Basic Law). Action is brought against the authority which issued the ruling/administrative act, i.e. the competent *Land* authority. This is also applicable to the case that the *Land* decided pursuant to a directive of the Federal Government. Also in case of failure of the authority to act, those concerned may take legal action. So, e.g., the operators may bring an action for granting of licenses applied for or the residents for cessation of operation of a nuclear installation.

In Germany, legislation and the implementation thereof must also take account of all binding requirements arising from European Union regulations. With respect to radiation protection, these include the EURATOM Basic Safety Standards [1F-1] for the protection of the health of workers and the general public against the dangers arising from ionising radiation issued on the basis of Articles 30 ff. of the EURATOM Treaty. In accordance with Articles 77 ff. of the EURATOM Treaty, any utilisation of ores, source material and special fissile material is subject to the surveillance of the European Atomic Energy Community.

Regarding nuclear liability, the Federal Republic of Germany is also a contracting party of

- the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960,
- the Brussels Supplementary Convention of 1963, and
- the Joint Protocol of 21 September 1988 Relating to the Application of the Vienna Convention and the Paris Convention.

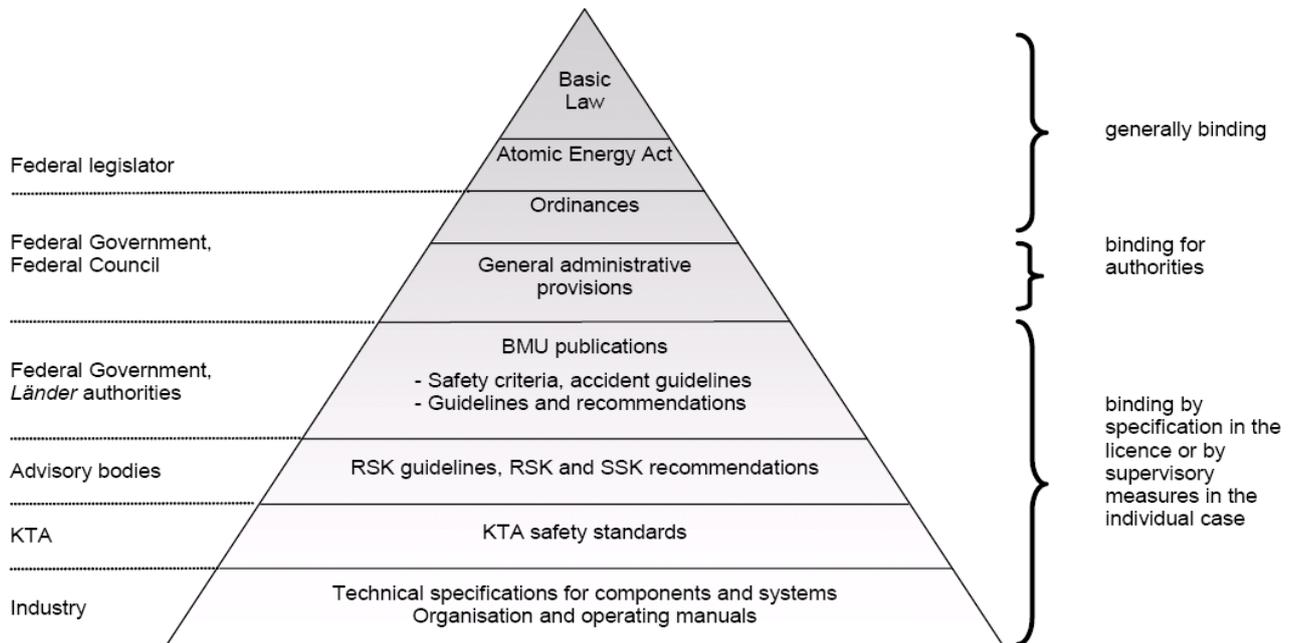
Further development of nuclear legislation and the legal regulations adopted on the basis thereof, the general administrative provisions and guidelines is a task of the Federal Government.

E.2.2. Safety Provisions and Regulations

Hierarchical Structure of the Regulations

Figure E-1 shows the hierarchy of the national regulations, the authority or institution adopting the regulation and its degree of bindingness.

Figure E-1: Regulatory pyramid



Nuclear regulations, with the exception of laws, ordinances and general administrative provisions, only have regulatory relevance by virtue of the legal requirement concerning the state of the art in science and technology. According to legal practice, it can be presumed that the nuclear rules and regulations accurately reflect the state of the art. Consequently, a verified scientific advancement will displace the application of a standard which has been rendered obsolete by said advancement without needing to suspend this standard. Thus, the dynamic improvement in safety requirements required by law is not bound by the formal development of standards.

In this report, reference will be made to the contents of the individual regulations when addressing the respective Articles of the Convention. The Appendix entitled "Reference List of Nuclear Rules and Regulations" lists the most important current regulations applicable to the treatment of spent fuel assemblies and radioactive waste in the aforementioned hierarchical order. All of the listed regulations are accessible to the public and are published in official publications of the Federal Government.

In essence, the structure and content of the safety provisions and regulations described herein were developed in the Seventies. Since then, they have been applied in all nuclear licensing and supervisory procedures and have been further developed, where necessary, in line with the state of the art in science and technology.

Acts, in Particular the Atomic Energy Act

The Atomic Energy Act (AtG) [1A-3] was promulgated on 23 December 1959 and, in the meantime, amended several times. The purpose of the Atomic Energy Act according to the 2002 amendment is to phase out the use of nuclear energy for commercial electricity generation in a carefully coordinated process and to ensure undisturbed operation until this has been achieved as well as to protect life, health and property against the hazards of nuclear energy and the detrimental effects of ionising radiation and, furthermore, to provide for the compensation for any damage and injuries incurred. It also serves the purpose of preventing the internal or external security of the Federal Republic of Germany from being endangered by the utilisation of nuclear energy. Another purpose of the Atomic Energy Act is to ensure that the Federal Republic of Germany meets its international obligations in the field of nuclear energy and radiation protection.

The Atomic Energy Act includes the general national regulations for protection and precautionary measures, radiation protection and the management of radioactive waste and spent fuel assemblies in Germany and constitutes the basis for the associated ordinances.

Besides its purpose and general regulations, the Atomic Energy Act also comprises surveillance regulations, liability regulations and fine regulations.

In order to protect against the hazards emanating from radioactive substances and control their use, the Atomic Energy Act requires that the construction and operation of nuclear installations is subject to regulatory licensing. Prerequisites and procedure for the granting of licences and for the performance of supervision are regulated, including regulations on the consultation of experts (§ 20 AtG) and on the charging of costs (§ 21 AtG).

However, most of the regulations provided there are not to be regarded as exhaustive but are further concretised, both in the area of procedures and the substantive requirements, by ordinances as well as by the sub-statutory regulatory framework.

The Atomic Energy Act concretely requires that certain activities are subject to licensing. So, for example, § 7 AtG stipulates that the erection, operation or the ownership of a stationary installation for the production, processing, treatment or fission of nuclear fuels, a material alteration of such installation or its operation and also decommissioning require a licence. There are similar stipulations in § 6 AtG for the storage of nuclear fuels, in § 9 AtG for the treatment, handling and other use of nuclear fuel outside of the facilities specified in § 7 AtG, and in § 9b AtG for facilities for securing and disposal of radioactive wastes.

The Atomic Energy Act is supplemented by the Precautionary Radiation Protection Act of 1986 [1A-5], which was prompted by the Chernobyl disaster. It specifies, among others, the tasks of environmental monitoring in case of events with significant radiological effects (cf. also the remarks on Articles 24 and 25 of the Convention).

Another legal basis to be mentioned is the Act on the Establishment of a Federal Office for Radiation Protection (*Gesetz über die Errichtung eines Bundesamtes für Strahlenschutz*) [1A-6]. According to § 2 of this act, the Federal Office is responsible, among others, for the Government custody of nuclear fuels, the erection and operation of federal installations for the disposal of radioactive wastes and for licensing for the storage of nuclear fuels.

Ordinances

For further concretisation of the legal regulations, the Atomic Energy Act includes authorisations for the promulgation of statutory ordinances. These statutory ordinances require the consent of the *Bundesrat* (Upper House of the Federal Parliament). The *Bundesrat* is a constitutional organ of the Federal Government in which the governments of the *Länder* are represented.

In this regard, several ordinances were passed which are also relevant for spent fuel and radioactive waste. The most important ones pertain to:

- radiation protection (Radiation Protection Ordinance) (StrlSchV) [1A-8],
- the licensing procedure (Nuclear Licensing Procedure Ordinance) (AtVfV) [1A-10],
- the transfer of radioactive wastes into or out of the territory of the Federal Republic of Germany (Nuclear Waste Transfer Ordinance) (AtAV) [1A-18],
- advance payments for the construction of radioactive waste disposal facilities (Waste Disposal Advance Payments Ordinance) (EndlagerVfV) [1A-13],
- provisions for sufficient coverage (Ordinance on the Financial Security Pursuant to the Atomic Energy Act) (AtDeckV) [1A-11].

- the reporting of notifiable events (Nuclear Safety Officer and Reporting Ordinance) (AtSMV) [1A-17], and
- the Gorleben Development Freeze Ordinance (GorlebenVSpV) [1A-22].

The safety provisions and regulations of the Atomic Energy Act and associated ordinances are further concretised by general administrative provisions, guidelines, safety standards of the Nuclear Safety Standards Commission (KTA), recommendations by the Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK), and conventional technical standards.

General Administrative Provisions

Statutory ordinances may contain additional authorisations for the promulgation of general administrative provisions. Such regulate the actions of the authorities but they only have a direct binding effect for the administration. They have a direct external effect since they are referred to as a basis for administrative decisions.

With respect to nuclear technology, six general administrative provisions are relevant which deal with the following topics:

- the calculation of radiation exposure during specified normal operation of nuclear facilities [2-1],
- radiation passports [2-2],
- environmental impact assessments [2-3],
- environmental monitoring [2-4],
- monitoring of food [2-5]nd
- monitoring of fodder [2-6].

Announcements by the Federal Ministry for the Environment

Guidelines are issued by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) following consultations with the *Länder* and generally by way of consensus with them. These guidelines are designed to provide a detailed specification of selected technical and administrative issues arising from the licensing and supervisory procedure (cf. the remarks on Article 20 of the Convention). They outline the opinion of the BMU and the nuclear supervisory and licensing authorities of the *Länder* on general issues relating to nuclear safety and administrative practice, and provide orientation for the authorities of the *Länder* in their execution of the Atomic Energy Act. However, unlike general administrative provisions, these guidelines are not binding for the authorities of the *Länder* but they are applied by them without any exception. There are currently some 60 guidelines in the field of nuclear technology. The part which also applies to the treatment of spent fuel assemblies and radioactive waste can be found in Appendix L (f) ([3-1] and following).

Related to the management of spent nuclear fuel and radioactive waste are, in particular,

- the Safety Criteria for the Permanent Storage of Radioactive Wastes in a Mine [3-13],
- the Guideline on the Monitoring of Emissions and Immissions Resulting from Nuclear Facilities [3-23],
- the Guideline on Control of Radioactive Wastes with Negligible Heat Production Not Delivered to a *Land* Collecting Facility [3-59],
- the Guide to Decommissioning of Facilities under § 7 of the Atomic Energy Act (AtG) [3-73],

- the Guideline of Physical Radiation Protection Control for the Determination of the Body Dose, Part 1: Determination of the Body Dose From External Radiation Exposure (§§ 40, 41, 42 StrlSchV; § 35 RöV) GMBI 2004, p. 410. [3-42-1],
- the Guideline of Physical Radiation Protection Control for the Determination of the Body Dose, Part 2: Determination of the Body Dose From External Radiation Exposure (incorporation monitoring) (§§ 40, 41 and 42 StrlSchV) of 12 January 2007 (GMBI 2007 p. 623) [3-42-2],
- the Guideline for Radiation Protection of Personnel during Activities of Maintenance, Alteration, Disposal and the Dismantling in Nuclear Installations and Facilities, Part 2: Radiation Protection Measures during Operation and Decommissioning of an Installation or Facility (IWRS II) (GMBI 2005, p. 258) [3-43-2].

Guidelines and Recommendations of the RSK and SSK

The recommendations of the Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK) play an important role with respect to licensing and supervisory procedures. Both of these independent expert commissions advise the Federal Environment Ministry (BMU) on issues relating to nuclear safety and radiation protection. By appointing experts in different technical fields, it is intended that the full bandwidth of scientific knowledge should be reflected in these two bodies (cf. the remarks on Article 20 of the Convention).

The RSK and SSK submit their results of consultations to the Ministry in the form of statements or recommendations which are prepared in subcommittees. Via publication in the Federal Gazette (*Bundesanzeiger*) these recommendations become part of the nuclear rules and their application is recommended by circulars of the BMU. The system of the BMU being advised by independent experts from various disciplines has proved effective.

For spent fuel and radioactive waste management, the following guidelines prepared by the RSK are of particular importance:

- the Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks [4-2], and
- the Safety Requirement on the Interim Storage of Low and Intermediate Level Waste in the Longer Term [4-3].

KTA Safety Standards

The Nuclear Safety Standards Commission (KTA), founded in 1972, formulates regulations containing detailed, concrete specifications of a technical nature. Such regulations are produced wherever "experience leads to a uniform opinion among experts from within the groups of manufacturers, construction companies, and licensees of nuclear installations, together with expert organisations and the authorities." Each of these groups is represented in the KTA. Regular reviews and amendment where necessary of adopted safety standards at intervals of no more than five years ensure that standards are adapted in line with the state of the art in science and technology. In themselves, KTA safety standards are not legally binding. However, by virtue of their process of origination and their high level of detail, their practical effect is wide-ranging as state of the art in science and technology. To date, the KTA has issued a total of 90 safety standards already issued and two standard drafts; an additional 15 standard drafts are currently under preparation, and 37 safety standards are in the process of being revised [KTA 08]. Most of these standards refer to nuclear power plants, although some also apply analogously to facilities for spent fuel and radioactive waste management.

Quality assurance is a key issue, and one which is addressed in most of the safety standards. The term quality assurance as used in the KTA safety standards also encompasses the area of ageing, which is now treated as a separate issue at international level (cf. the remarks on Article 23 of the Convention).

Conventional Technical Standards

As is the case with the design and operation of all technical installations, conventional technical standards likewise apply, particularly the national standards of the German Institute for Standardisation (DIN) and the international standards of the ISO and IEC, provided these conventional standards reflect the state of the art in science and technology.

Other Legal Areas

When licensing nuclear installations, other legal requirements outside of nuclear safety and radiation protection legislation must also be taken into account. In particular, these include:

- the Construction and Regional Planning Act (*Bau- und Raumordnungsgesetz*) [1B-2],
- the Federal Immission Control Act (*Bundes-Immissionsschutzgesetz*) [1B-3],
- the Federal Water Act (*Wasserhaushaltsgesetz*) [1B-5],
- the Federal Nature Conservation Act (*Bundesnaturschutzgesetz*) [1B-6],
- the Closed Substance Cycle and Waste Management Act (*Kreislaufwirtschafts- und Abfallgesetz*) [1B-13],
- the Environmental Impact Assessment Act (*Gesetz über die Umweltverträglichkeitsprüfung*) [1B-14].

The following is also important in the licensing procedure for repositories in deep geological formations:

- the Federal Mining Act (*Bundesberggesetz*) [1B-15].

E.2.3. Licensing System

With respect to protection against the hazards of radioactive materials and supervision of their utilisation, the Atomic Energy Act (AtG), as well as the Radiation Protection Ordinance (StrlSchV) in certain areas, requires that the construction and operation of nuclear installations is subject to regulatory licensing. The licensing requirement is stipulated in various provisions of the nuclear rules and regulations, depending on the type of installation and operation.

- § 7 of the Atomic Energy Act (AtG): The management of spent nuclear fuel and radioactive wastes within stationary installations for the production, handling, treatment or fission of nuclear fuel (e.g. in nuclear power plants) is normally covered by the licence granted to such installations under § 7 AtG, provided these management phases are directly related to the purpose of the facility. This applies in particular to the storage of spent fuel assemblies in the cooling pond of the reactor and to the treatment and interim storage of operational wastes. The pilot conditioning plant (PKA) at Gorleben, whose primary purpose is the treatment of spent fuel assemblies, likewise falls under the licensing requirement pursuant to § 7 AtG. Licensing and supervision of the plant are carried out by the competent authority in the *Land* where the facility is located; in the case of the PKA, this is the *Land* of Lower Saxony.
- § 3 AtG: The import and export of nuclear fuel requires a permit under § 3 AtG. A decision on the application is made by the Federal Office of Economics and Export Control (BAFA). The supervision of imports and exports is the responsibility of the Ministry of Finance or designated customs offices.
- § 6 AtG: The storage of nuclear fuel, including spent fuel assemblies and radioactive wastes with significant contents of fissile material, requires a licence under § 6 AtG. This refers, for example, to on-site interim storage facilities at the nuclear power plants and the central storage facilities for spent fuel casks at Gorleben and Ahaus. The licensing authority in this instance is

the Federal Office for Radiation Protection (BfS), whilst supervision is performed by the competent authority of the respective *Land*.

- § 9 AtG: The treatment, handling and other use of nuclear fuel outside of the facilities specified in § 7 AtG, e.g. the handling of nuclear fuel on a laboratory scale for research purposes, requires an authorisation under § 9 AtG. The respective *Land* is responsible for licensing and supervision of the facility.
- § 9b AtG: The securing and disposal of radioactive wastes, which is the responsibility of the Federal Government according to the Atomic Energy Act, requires plan approval under § 9b AtG. The nuclear plan approval authority is the competent supreme *Land* authority of the respective *Land*. Plan approval is required for the repository site, a process which differs significantly from a licensing procedure under §§ 6 or 7 AtG in a number of respects. The applicant and subsequent operator is the Federal Office for Radiation Protection. According to § 9a AtG, the Federal Government may avail itself of the services of third parties or may transfer the execution of its tasks with the necessary sovereign competencies either wholly or partially to third parties, provided their proper fulfilment is guaranteed. These activities are subject to Federal Government supervision.
- § 7 of the Radiation Protection Ordinance (StrlSchV): The handling of radioactive wastes requires a licence under § 7 StrlSchV, unless already covered by one of the licences mentioned above. This category includes, in particular, the waste collecting facilities of the *Länder*, and interim storage facilities for radioactive wastes at research centres and conditioning facilities. Licensing and supervision are the responsibility of the competent authorities of the *Länder*. For clarification of the licence obligation it is stated in § 9c AtG that the licensing provisions AtG and of the ordinances decreed on its basis referring to the handling of radioactive materials also apply to the storage or treatment of radioactive waste in waste collecting facilities of the *Länder*.

The licensing system with regard to decommissioning is described under Article 26.

Responsibilities relating to the licensing of nuclear installations are summarised in Table E-1. It shows that for licensing and supervision of the different facility types and activities, in some cases different authorities are responsible. A uniform interpretation of the legal requirements and a harmonised licensing practice is ensured by the legal and expediency supervision by the BMU described more detailed in E.2.1.

Table E-1: Responsibilities relating to the licensing and supervision of nuclear installations and activities in the Federal Republic of Germany

Material	Activity	Facilities (examples)	Legal basis	Licensing	Supervision
Nuclear fuel and radioactive waste containing fissile material	Treatment	PKA	§ 7 AtG	Land authority	Land authority
	Treatment or use	Activities outside of facilities governed by § 7 AtG (e.g. laboratory-scale handling of nuclear fuel for research purposes)	§ 9 AtG	Land authority	Land authority
	Storage	Gorleben, Ahaus, on-site storage facilities	§ 6 AtG	BfS	Land authority
	Import and export	--	§ 3 AtG	BAFA	Federal Government
Radioactive waste, without fissile material	Handling and storage	Collecting facilities of the <i>Länder</i> , interim storage facilities, conditioning facilities	§ 7 StrlSchV ¹⁾	Land authority (e. g. Trade Supervisory Office)	Land authority (e. g. Trade Supervisory Office)
Radioactive waste, general	Disposal	Repositories at Morsleben, Konrad	§ 9b AtG	Land authority	Federal Government

1) Unless the activity is already included in a licence under §§ 6, 7, 9 or 9b AtG.

Under the Atomic Energy Act, a licence may only be granted if the licensing conditions laid down in the corresponding section of the Act are met by the applicant. This includes, in particular, the required precautions against damage in accordance with the state of the art in science and technology.

Furthermore, it should be noted that any handling of radioactive material is subject to the binding provisions on supervision and protection outlined in the Radiation Protection Ordinance (StrlSchV). The StrlSchV includes regulations on the designation of responsible individuals by the licensee and the dose limits of radiation exposure for plant personnel and the general public during specified normal operation.

In order to ensure safety, licences for nuclear installations may be subject to certain conditions. The operation and ownership of, essential modifications to or decommissioning of a nuclear installation without the necessary licence are offences liable to prosecution.

The licensing of nuclear installations (except for nuclear fuel storage facilities licensed by the BfS under § 6 AtG) is the responsibility of the individual *Länder*. In most of the *Länder*, ministries are the supreme authorities responsible for licensing; in the individual case, subordinate agencies (e.g. factory and trades supervision offices in the case of waste collecting facilities of the *Länder*) may be commissioned with it. The Federal Government supervises implementation of the Atomic Energy Act and radiological protection regulations by the *Länder* (federal supervision). In particular, it has the right to issue binding directives to the *Land* concerned on factual and legal issues in each individual case.

The actual details and procedure of licensing in accordance with § 7 AtG are specified in the Nuclear Licensing Procedures Ordinance [1A-10]. It deals specifically with the application procedure, the submission of supporting documents, participation of the general public and the option of splitting the procedure into several stages (partial licences). Furthermore, it also addresses the assessment of environmental impacts [1B-14] and the consideration of other licensing requirements (e.g. non-radioactive emissions into the air or discharges into water). In the case of other nuclear licensing and plan approval procedures (according to §§ 6 or 9b AtG), the Nuclear Licensing Pro-

cedure Ordinance is applied analogously. The option of splitting the licensing procedure into several phases (with individual partial licences) is usually taken up for large-scale facilities which take longer to be built and commissioned. The advantage is that the most recent state of the art in science and technology can be applied in each individual procedural step. For example, the first step may include the licensing of the site, the safety concept and the most important structures. Further steps might be the installation of safety-relevant systems, nuclear start-up, and full power operation.

In accordance with § 20 AtG, the competent authorities may consult authorised experts on technical or scientific matters related to regulatory licensing and supervision. Such experts have similar rights to the authorities with regard to the performance of inspections and requests for information. However, the authority is not bound by the assessments of their authorised experts.

The current nuclear liability regulations have translated the Paris Convention on Third Party Liability in the Field of Nuclear Energy [1E-11], amended by the Brussels Supplementary Convention [1E-12], into national law. Details of the required financial security are regulated by a statutory ordinance [1A-11]. In Germany, this means that licensees are generally required to take out liability insurance policies for a maximum financial sum specified in the individual nuclear licensing procedure.

The Nuclear Licensing Procedure as Illustrated by the Example of the Procedure according to § 7 AtG

According to § 7 AtG, erection, operation or ownership of a stationary installation for the production, processing, treatment or fission of nuclear fuels, a material alteration of such installation or its operation and also decommissioning require a licence. Such a licence may only be granted if the licensing requirements stated in § 7, para. 2 AtG are complied with, i.e. if

- the necessary precautions have been taken in the light of the state of the art in science and technology to prevent damage,
- reliability and the necessary knowledge of the responsible persons is given,
- it is assured that the persons who are otherwise engaged in the operation of the installation have the necessary knowledge concerning the safe operation of the installation, the possible hazards and the protective measures to be taken,
- the necessary protection has been provided against disruptive action or other interference by third parties,
- the necessary financial security has been provided to comply with the legal liability to pay compensation for damage, and
- the choice of the site of the installation does not conflict with overriding public interests, in particular in view of its environmental impacts.

These requirements for licensing are also assessment criteria for supervision.

The undefined legal terms used by the legislator, such as the “the necessary precautions in the light of the state of the art in science and technology“, were chosen to facilitate a dynamic further development of the precautions according to the latest state of the art. Thus, legislation largely left it to the executive - be it by way of ordinances according to the relevant authorisations, be it in case of individual decisions also under consideration of the non-legally binding regulatory guidance instruments - to decide on the kind and, in particular, the extent of risks to be accepted or not to be accepted. The Atomic Energy Act does not include specific regulations about the procedure for the assessment of such risks.

The actual details and procedure of licensing in accordance with the Atomic Energy Act are specified in the Nuclear Licensing Procedure Ordinance [1A-10]. It deals specifically with the application

procedure, with the submittal of supporting documents, with the participation of the general public and with the possibility to split the procedure into several licensing steps (partial licences). It deals, furthermore, with the assessment of environmental impacts [1F-12] and with the consideration of other licensing requirements (e.g. regarding the possible release or discharge of non-radioactive pollutants into air or water).

Licence Application

The licence application is submitted in written form to the competent licensing authority of the *Land* in which the nuclear installation is to be erected. The licence application is accompanied by documents containing all the relevant data required for evaluation purposes. The documents which should be enclosed with the application are listed in the Nuclear Licensing Procedures Ordinance [1A-10]. The required format is specified in guidelines. One important document is the safety analysis report which describes the plant, its operation and the related effects, including the effects of design basis accidents and the associated precautionary measures. It contains site plans and assembly drawings. In order to meet the prerequisites for licensing, further documents must also be submitted, including supplementary plans, drawings and descriptions.

§ 3 of the Nuclear Licensing Procedures Ordinance (AtVfV) defines the character and scope of the documents. It states that documents should be enclosed which allow verification of compliance with the licensing pre-requisites, in particular:

1. a safety report outlining the consequences of the project which are relevant to the decision on the application with regard to nuclear safety and radiation protection, and which will enable third parties in particular to evaluate whether their rights could be violated by the facility or the impacts resulting from its operation. For this purpose, as far as this is necessary for a judgement of the project's admissibility, the safety report must include the following information:
 - a) a description of the facility and its operation including site plans and drawings;
 - b) a description and explanation of the concept (basic design features), the safety relevant design principles, and the function of the facility including its operational and safety systems;
 - c) an outline of the precautionary measures taken to meet the requirements of § 7, para. 2, subpara. 3 of the Atomic Energy Act (AtG), i.e. precautions against damage caused by the erection and operation of the facility in accordance with the state of the art in science and technology;
 - d) a description of the environment and its constituents;
 - e) information on the direct radiation and emission of radioactive substances associated with the facility and its operation, including releases from the facility in the case of accidents as defined in §§ 49 and 50 of the Radiation Protection Ordinance (StrlSchV) (design basis accidents);
 - f) a description of the impacts of direct radiation and the emission of radioactive substances referred to under e) on the protected entities outlined in § 1a of the Nuclear Licensing Procedures Ordinance; these are human beings, animals and plants, soil, water, air, climate and landscape, cultural assets and other entities, including interactions with other substances;
2. complementary schemes, drawings and descriptions of the facility and its parts;
3. information on the provisions to protect the facility and its operation against malevolent acts or other illegal interference by third parties in accordance with § 7, para. 2 subpara. 5 AtG;
4. information which will enable verification of the reliability and technical knowledge of the persons responsible for erection of the facility and for management and supervision of its operation;

5. information which will enable verification of the existence of the necessary knowledge of other persons involved in the operation of the facility in accordance with § 7, para. 2, subpara. 2 AtG;
6. a list of all information relevant to the safety of the facility and its operation, the precautions taken for the control of accidents and damages, and a framework plan for the checks foreseen at safety-relevant parts of the facility (safety specifications);
7. proposals on precautions to comply with obligations on statutory liability for damages;
8. a description of the amounts of radioactive residues and information on precautions taken
 - a) to avoid accumulation of radioactive residues;
 - b) for the non-hazardous utilisation of radioactive residues and removed or dismantled radioactive components;
 - c) for the orderly disposal of radioactive residues or removed radioactive components as radioactive waste, including their intended treatment, and for the anticipated storage of radioactive wastes until their disposal;
9. information on other environmental impacts of the project required for verification pursuant to § 7, para. 2, subpara. 6 AtG for any approval decisions included in the licensing decision in individual cases, or for any decisions to be made by the licensing authority according to regulations on nature protection and landscape conservation. On this basis, it is necessary to verify that there are no overwhelming public interests, in particular with regard to environmental impacts, opposed to the choice of the site for the facility.

Furthermore, a short description of the planned facility, including information on the estimated consequences for the population and the environment, should be included with the licence application for the purpose of participation by the general public.

Examination of the Application

On the basis of the submitted documents, the licensing authority examines whether or not the licence prerequisites have been met. All federal, *Länder*, local and other regional authorities whose jurisdiction is affected are to be involved in the licensing procedure, including in particular the authorities responsible for civil engineering, water, regional planning and off-site disaster control. Given the broad scope of the safety issues to be examined, it is common practice to engage expert organisations to support the licensing authority in the evaluation and examination of the application documents. These organisations prepare expert reports outlining whether or not the requirements regarding nuclear safety and radiation protection have been met; they do not have any decision-making authority.

In this regard, the licensing authorities of the *Länder* refer, in particular, to the technical inspection agencies.

Within the framework of federal executive administration, the Federal Environment Ministry (BMU) may submit a statement from the point of view of federal supervision before the licence is granted (with or without having been requested by the licensing authority of the individual *Land*). In performing its function of federal supervision, the BMU consults the Reactor Safety Commission (RSK), the Commission on Radiological Protection (SSK), and in many cases the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), for advice and technical support. The *Land* licensing authority must take the BMU's statement into account when making its decision.

Participation of the General Public

The licensing authority involves the general public in the licensing procedures, including in particular those citizens who might be affected by the planned facility. Details are regulated in the Nuclear

Licensing Procedures Ordinance (AtVfV) [1A-10]. Public participation is not limited to the citizens of the *Land* in which the facility is to be erected.

According to § 4 AtVfV, the project is published in the official Publication Gazette and in local newspapers once the documents to be submitted are complete. According to § 5 AtVfV, this announcement should include details of where and when the application will be available for public inspection, a request to submit any objections in writing to the competent authority within the specified period, and the date of the public hearing or reference to the fact that this date will be announced in future.

According to § 6 AtVfV, the application, the safety report, a short description of the project, information on radioactive residues and other environmental impacts of the project, as described under points 8 and 9 of § 3 AtVfV above, are to be laid out for public inspection over a period of two months.

According to § 7 AtVfV, objections may be raised in writing or for recording at the competent authorities.

The public hearing is regulated in §§ 8 to 13 AtVfV. At the hearing, any objections that have been duly raised are to be discussed insofar as this may be important for an examination of the licensing requirements. Any individuals who have raised objections are to be given the opportunity to explain them.

The licensing authority takes these objections into account when making its decision, and addresses them in the licence findings.

In case of material amendments to a nuclear licence, public participation may not be necessary if the modification applied has no adverse effects for the population.

Environmental Impact Assessment

The Environmental Impact Assessment Act [1B-14], in conjunction with the Atomic Energy Act and Nuclear Licensing Procedures Ordinance based on it, regulate the need to conduct an environmental impact assessment and its procedure within the nuclear licensing procedure for the construction, operation and decommissioning of a nuclear installation to be licensed according to § 7 of the Atomic Energy Act (AtG) or for an essential modification of the facility or its operation. The construction and operation of spent fuel management facilities are also subject to an environmental impact assessment according to Numbers 11.1 and 11.3 of Annex 1 of the Environmental Impact Assessment Act. According to § 3, para. 2 of the Nuclear Licensing Procedures Ordinance, the following documents should therefore additionally be included with the application:

1. a summary of the main technical alternatives examined by the applicant, including the main reasons in favour of the preferred solution, insofar as this information may be significant when assessing the admissibility of the project under § 7 of the Atomic Energy Act;
2. references to any difficulties which may have arisen when compiling information for the examination according to § 1a, i. e. an examination of the environmental impact assessment requirements, in particular insofar as these difficulties are attributable to a lack of knowledge and methods of examination or technical loopholes.

The competent authority performs a final evaluation of the environmental impacts which provides the basis for a decision on the project's admissibility with regard to effective environmental protection.

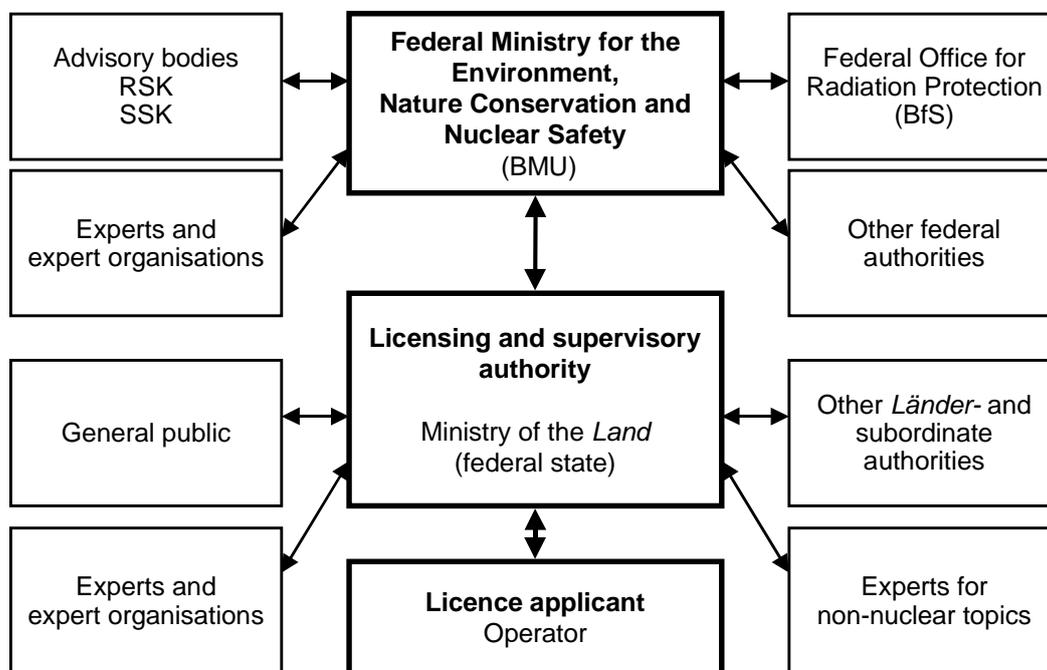
Licensing Decision

The final decision of the licensing authority is based on the entirety of application documents, evaluation reports by the authorised experts, the opinion of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the opinions of the authorities involved, and the

findings from objections raised in the public hearing. One prerequisite for the legality of this decision is that all procedural requirements of the Nuclear Licensing Procedures Ordinance must have been observed. Action may be brought against the decision of the licensing authority before an administrative court by each citizen as far as at least the potential violation of own rights to life, health and property is claimed. Appeals, if applied for and admitted may be brought up to the Federal Administrative Court. In the case of a licence with immediate enforcement, a court action cannot prevent use being made of the licence. However, action may be brought against immediate enforcement.

The interaction between the various authorities and organisations involved in the nuclear licensing procedure and the participation of the general public is shown in Figure E-2. This creates a broad and differentiated decision-making basis which allows all interests to be taken into account when reaching a final decision.

Figure E-2: Parties involved in the nuclear licensing procedure (using the procedure according to § 7 AtG as an example)



Plan Approval Procedure

According to § 23, para. 1, subpara. 2 of the Atomic Energy Act (AtG), the Federal Office for Radiation Protection (BfS) is responsible for the construction and operation of facilities for the safe-keeping and disposal of radioactive wastes. According to § 9a, para. 3 AtG, the BfS may employ the services of a third party to fulfil its tasks. The BfS exercises this option. The third party in question is the *Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe (DBE) mbH* (German Service Company for the Construction and Operation of Waste Repositories).

According to § 9b AtG, the construction and operation of radioactive waste repositories requires a special licence known as plan approval (*Planfeststellung*). The plan approval to a facility for disposal of radioactive wastes shall be given if the requirements referred to in § 7, para. 2, subparas. 1 to 3 and 5 AtG (see E2.3 above) are complied with. Plan approval shall be denied if

- the erection or operation of the proposed installation suggest that the common welfare will be impaired and that such impairment cannot be prevented by restrictions and obligations, or

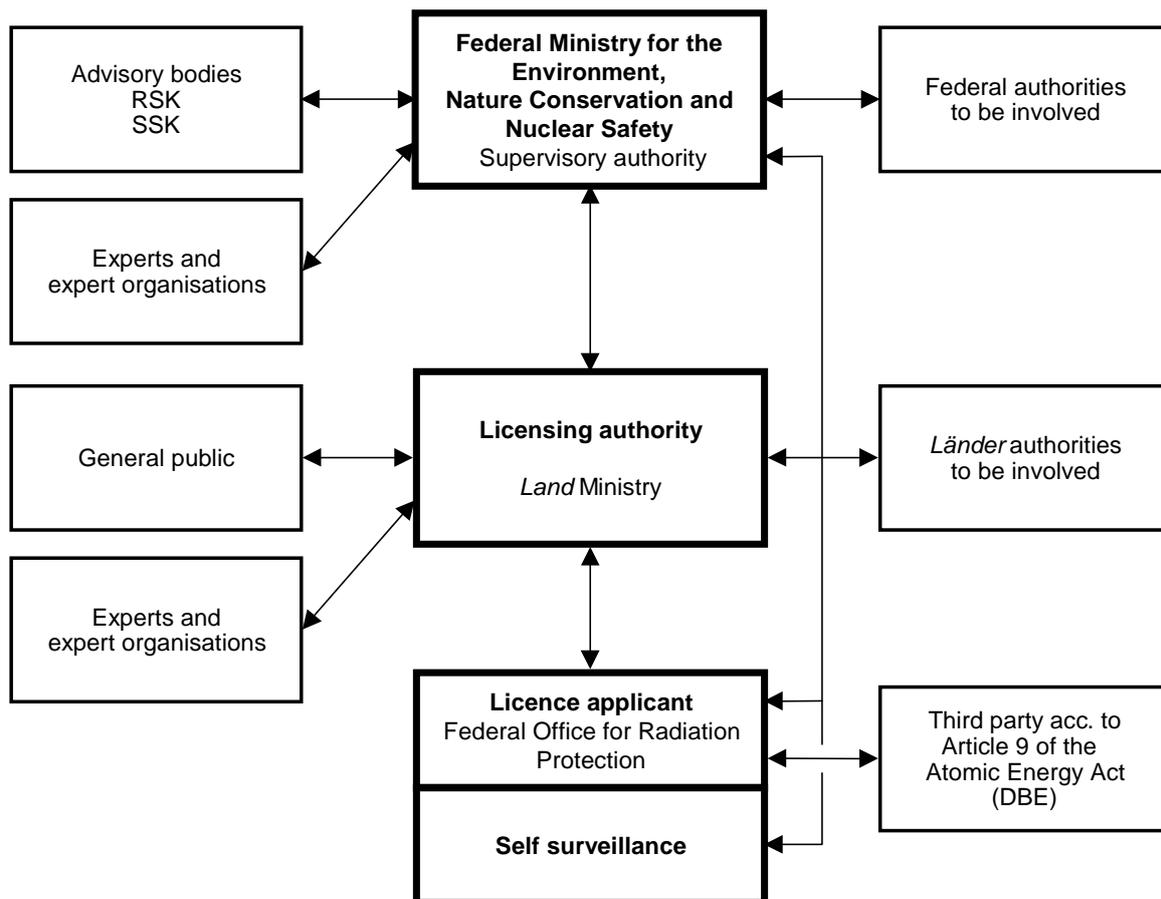
- the erection or operation of the installation conflicts with other provisions of public law, in particular with respect to the environmental impact of the installation.

Contrary to licensing pursuant to § 7 AtG, liability provisions are not required since the state itself is responsible for such installation. § 13, para. 4 AtG explicitly states that the Federal Government and the *Länder* are not obliged to make liability provisions.

The main peculiarity of the plan approval procedure for radioactive waste repositories is that all legal areas are concentrated within one single procedure. As such, unlike other nuclear licensing procedures, the licence incorporates all the other licences required, e.g. under the terms of water legislation, building legislation or nature conservation legislation. According to § 9b, para. 5, sub-para. 3 AtG, there is only one exception, namely, that plan approval does not cover the legitimacy of the project under the provisions of mining law. This aspect must be decided by the competent authority. The participants in a plan approval procedure for radioactive waste repositories are shown in Figure E-3.

In exercising its tasks, the BfS performs a twofold function. On the one hand, the federal office is the applicant in a plan approval procedure according to § 9b AtG; on the other, it performs a self-supervisory role during the construction and operation of a radioactive waste repository (“self-surveillance”). Self-surveillance is a separate organisational unit within the BfS.

Figure E-3: Participants in a plan approval procedure for a radioactive waste disposal facility



E.2.4. System of Prohibition of the Operation of a Facility

Prohibition of the operation of a spent fuel or radioactive waste management facility without a licence is derived from the requirements contained in the Penal Code, the Atomic Energy Act and

the nuclear ordinances. These issues are addressed in greater detail in the section referring to Article 19 2. (v).

E.2.5. Regulatory Inspection and Assessment (Supervision)

Over their entire lifetime, from the start of construction to the end of decommissioning with the corresponding licenses, nuclear installations are subject to continuous regulatory supervision in accordance with the Atomic Energy Act (AtG) and related nuclear ordinances. As with the licensing procedure, a distinction is made between the matters of handling pursuant to §§ 6 and 9 of the Atomic Energy Act, and the installations licensed pursuant to § 7 of the Atomic Energy Act and waste repositories that are subject to plan approval under § 9b.

In the case of nuclear installations or the handling of nuclear fuel licensed under §§ 6, 7 or 9 AtG, the *Länder* exercise nuclear supervision. In this respect, they are also acting on behalf of the Federal Government. In other words, the Federal Government has the right to issue binding directives on factual and legal issues in each individual case. As in the licensing procedure, the *Länder* are assisted by independent authorised experts.

As in licensing, the supreme objective of government supervision is to protect the general public and the people engaged in these installations against the hazards associated with operation of the installation.

In particular, it is the duty of the supervisory authority to monitor

- compliance with the provisions, obligations and other ancillary provisions imposed by the licensing notices,
- compliance with the requirements of the Atomic Energy Act, the nuclear ordinances and other nuclear safety standards and guidelines, and
- compliance with any supervisory orders issued.

To ensure safety, the supervisory authority also monitors the following with the aid of its authorised experts or by other authorities:

- compliance with operating procedures,
- the performance of in-service inspections of components and systems important to safety,
- the evaluation of reportable events,
- the implementation of modifications to the nuclear installation or its operation,
- radiation protection monitoring of the personnel,
- radiation protection monitoring in the vicinity of the nuclear installation,
- compliance with the authorised plant-specific limits for radioactive discharge,
- the measures taken against malevolent acts or other illegal interference by third parties,
- the trustworthiness and technical qualification and maintenance of the qualification of the responsible individuals, as well as of the knowledge of other staff working at the installation,
- the quality assurance measures.

The Atomic Energy Act stipulates that the supervisory authority and the authorised experts consulted by it shall have access to the nuclear installation at any time, and are authorised to perform necessary examinations and to demand pertinent information.

Contrary to the standard practice for nuclear installations licensed under §§ 6, 7 or 9 AtG, the regulations governing the supervision of radioactive waste repositories once a licence has been issued are somewhat different. In such cases, supervision is carried out by the Federal Government itself.

To this end, an independent organisational unit – the so-called “Self-Surveillance” department – has been established within the Federal Office for Radiation Protection (cf. the remarks on Article 20 2.).

The legal basis for the documentation and reporting of radioactive waste is § 70 StrlSchV (Bookkeeping and Declaration). It requires the bookkeeping and declaration within one month of any extraction, production, acquisition, delivery or other whereabouts of radioactive substances, also stating their kind and activity. In addition, the current inventory has to be declared annually. The competent authority is entitled to verify the correctness of the bookkeeping any time. It may in individual cases grant total or partial exemptions from the requirement to keep books and make declarations.

Much more detailed provisions are included in the guideline on the control of radioactive waste with negligible heat generation that is not handed over to a *Land* collecting facility (Waste Control Guideline) [3-59]. This guideline entered into force in 1989. Some of the contents were adopted into the new Radiation Protection Ordinance of 2001; the parts of the guideline that were not adopted into the StrlSchV continue to apply. There are plans to issue a new guideline that is to regulate only those aspects that are not covered by the Radiation Protection Ordinance.

In §§ 72 and 73 StrlSchV, the plant operators and those handling with nuclear fuels are committed to preparing a documentation about the arising and whereabouts of waste and to submitting it to the authorities. The documentation is prepared by the plant operators with the help of various computerised systems, such as the Waste Flow Tracking and Product Control System (AVK) of GNS GmbH. Another system is the Waste Flow Tracking and Control System ReVK of ISTec GmbH for the documentation, tracking and administration of residues and waste arising e. g. in connection with the operation and dismantling of nuclear facilities. As these systems also fulfil other tasks than merely documentation duties, they are much more detailed than required by the StrlSchV.

At the reference date of 31 December each year, the BfS queries the inventories of radioactive waste in Germany as well as the existing storage capacities and their occupancy with the help of standardised form sheets (computer-based). The forms completed by the waste proprietors are then sent back via the competent *Land* authority to the BfS and are evaluated there.

A reporting obligation to the corresponding supervisory authority also exists for measures taken by the operators to re-use any radioactive residues arising in a non-hazardous manner or dispose of them in an orderly manner as radioactive waste in accordance with § 9a, para 1 AtG. In particular, it has to be shown that adequate provisions to fulfil these obligations have been made for already existing and for future arising spent fuels as well as for the waste to be taken back from reprocessing (§ 9a, para. 1a). This proof has to be provided annually. For the orderly disposal of the spent fuel as well as of the radioactive waste from reprocessing, it has to be shown that safe storage in interim storage facilities is ensured until their final disposal in a repository (§ 9a, para. 1b). Realistic plans have to be submitted with regard to the expected need for interim storage capacity. The availability of the expected interim storage capacity that is needed has to be demonstrated for the following two years. If the non-hazardous re-use of the plutonium from reprocessing is intended, it also has to be shown that the re-use of the plutonium in the nuclear power plants is ensured (§ 9a, para. 1c). This proof has been furnished if realistic plans for processing, fuel assembly fabrication and fuel assembly use have been provided and their feasibility has been demonstrated. As for the uranium from reprocessing, its safekeeping has to be demonstrated by realistic planning of sufficient interim storage capacities (§ 9a, para. 1d).

In order to give the BMU an overall survey of the management of the spent fuel assemblies and the nuclear fuels to be recycled, the operators' demonstrations are submitted by the *Länder* to the BMU.

All safety-related events in installations licensed according to § 7 AtG and during handling of nuclear fuels according to § 6 AtG have to be reported to the authorities in accordance with the

AtSMV [1A-17]. A corresponding reporting obligation for other plants ensues from § 51, para. 1 StrlSchV. The regulations and procedures relating to reportable events and their evaluation are described in the remarks on Article 9.

E.2.6. Enforcement of Provisions and Terms of the Licences

In order to enforce the valid provisions, the Penal Code [1B-1], the Atomic Energy Act [1A-3] and the nuclear ordinances contain sanctions in case of violations:

Criminal Offences

Any violation that is classed as a criminal offence is dealt with in the Penal Code. For example, anyone who:

- operates, otherwise holds, changes or decommissions a nuclear installation without the required licence,
- knowingly constructs a defective nuclear installation,
- handles nuclear fuel or waste containing nuclear fuel without the required licence,
- releases ionising radiation or causes nuclear fission processes that may cause damage to life and limb of other persons,
- procures or manufactures nuclear fuel, radioactive material or other equipment for himself with the intent of performing a criminal offence
- is liable to imprisonment or fines.

Administrative Offences

The Atomic Energy Act and related ordinances deal with administrative offences and provide for the imposition of fines on the perpetrators. An administrative offence is deemed to have been committed by anyone who:

- erects a nuclear installation without a licence permit,
- acts in violation of a regulatory order or provision,
- handles radioactive material without a valid licence permit,
- as the ultimately responsible person fails to ensure compliance with the protective and surveillance regulations of the Radiation Protection Ordinance.

The Atomic Energy Act and related ordinances require that the individuals who are ultimately responsible for the handling of radioactive material, for the operation of nuclear installations or for their supervision should be named. A person committing an administrative offence is personally liable for a fine up to €50 000. A legally effective fine against a person may cast doubt on the personal trustworthiness that was a prerequisite for the licence and may therefore require the removal of such individuals from office (cf. the remarks on Article 21 of the Convention).

Enforcement by Regulatory Order, Particularly in Urgent Cases

In the case of non-compliance with legal provisions or the terms of the licence permit, and also in case of a suspected threat to the life, health or property of third parties, the competent nuclear licensing and supervisory authority is authorised by § 19 AtG to decree,

- that protective measures must be applied and, if so, which ones,
- that radioactive material must be stored at a place prescribed by the authority, and

- that the handling of radioactive material, the construction and operation of nuclear installations must be interrupted or temporarily – or, in the absence or revocation of the licence, permanently - suspended.

Enforcement by Modification or Revocation of the Licence

Under certain conditions, stipulated in § 17 AtG, the nuclear licensing and supervisory authority may retrospectively decree certain conditions in order to safeguard safety. If the nuclear installation poses a major hazard endangering the persons engaged at the plant or the general public, and if this hazard cannot be eliminated within a reasonable period of time by means of appropriate measures, then the licensing authority must revoke the issued licence. Revocation is also possible if certain prerequisites for the licence permit cease to be met at a later date, or if the licensee violates legal regulations or decisions by the authorities.

Experiences

Due to the intensive regulatory supervision (cf. Chapter E.2.5) of planning, construction, commissioning, operation and decommissioning of nuclear installations in Germany, inadmissible states and conditions are generally identified in advance and their removal ordered and performed before taking of measures provided by law, as e.g. obligations, orders and proceedings relating to an administrative or criminal offence, becomes necessary.

The instruments presented have proved to be effective since, as a rule, they ensure that the authorities have appropriate sanction possibilities and competencies for the enforcement of provisions and regulations, if required.

E.2.7. Responsibilities

The management of spent fuel assemblies and radioactive waste is based on the polluter-pays principle. According to § 9a, para. 1 AtG, the producers of residual radioactive material are required to ensure their non-hazardous recycling or their orderly disposal as radioactive waste. This also means that, as a general principle, the producers are responsible for the conditioning and interim storage of the spent fuel assemblies and the radioactive waste. When delivering radioactive waste to a *Land* collecting facility, the ownership is transferred to this facility. Thus, the responsibility for conditioning is assumed by the operator of the *Land* collecting facility.

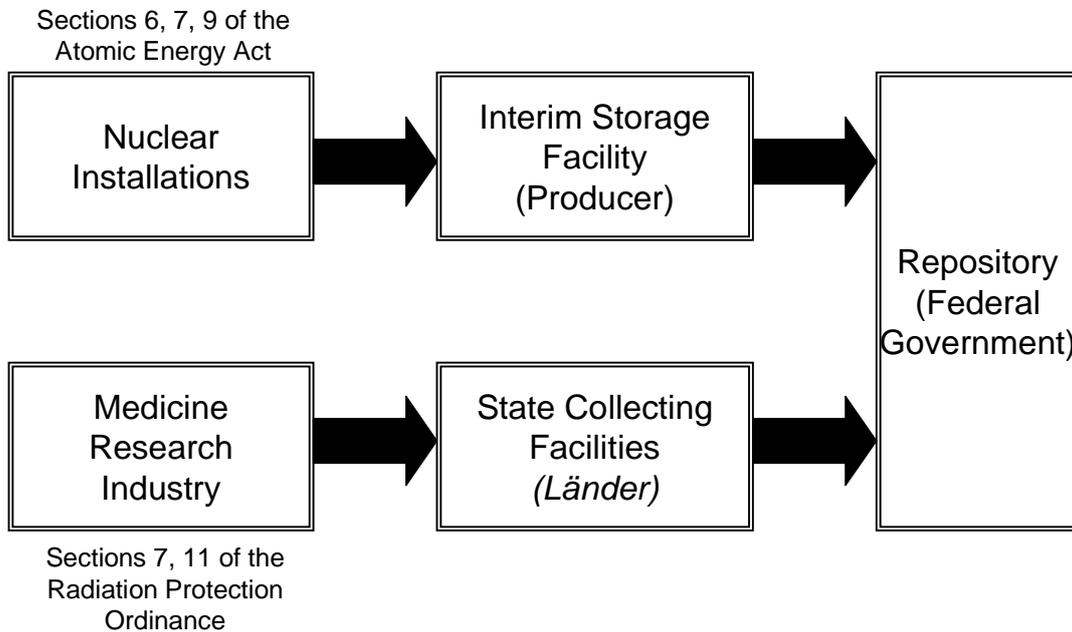
According to § 9a, para. 2 AtG, as a general principle, anyone possessing radioactive waste must deliver it to a repository or to a *Land* collecting facility (cf. Figure E-4).

According to § 9a, para. 3 AtG, the *Länder* are required to establish *Land* collecting facilities for the storage of radioactive wastes arising within their territory.

According to § 9a, para. 3 AtG, the Federal Government is required to establish radioactive waste repositories. According to § 23 AtG, the BfS is responsible for the planning, construction and operation of radioactive waste repositories as well as for their supervision. The other waste management facilities are supervised by the *Länder* within the frame of federal executive administration. The licences for waste management facilities, with the exception of interim storage facilities for nuclear fuel, are granted by the *Länder*. Interim storage facilities for nuclear fuel are licensed by the Federal Government (Federal Office for Radiation Protection).

The polluter-pays principle also applies to the financing of spent fuel and radioactive waste management activities. Though the Federal Government initially bears the necessary expenses for the planning and construction of radioactive waste disposal facilities, it refinances these costs by means of advance payments on contributions or partial payments on advance payments. The use of radioactive waste repositories and *Land* collecting facilities is financed or refinanced by charges and fees that are payable by the waste producers.

Figure E-4: Obligation for the delivery of radioactive wastes and responsibilities (diagrammatic representation)



E.3. Article 20. Regulatory Body

Article 20. Regulatory body

1. *Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
2. *Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organisations are involved in both spent fuel or radioactive waste management and in their regulation.*

E.3.1. Regulatory Body

Competence and Authority

The Federal Republic of Germany is a Federal State (Art. 20 (1) of the Basic Law (GG) [GG 49]), in which the individual *Länder* have the right of legislation except where specifically allocated to the Federal Government in the Basic Law (Art. 70 (1) of the GG). One special case concerns the area of competing legislation, where the *Länder* have the right of legislation provided the Federal State does not make use of its competence (Art. 72 (1) of the GG). Until entry into force of the federalism reform 2006, nuclear legislation falls into this category (Art. 74 (1) no. 11a of the GG (old)). Now, nuclear legislation falls into the category of exclusive power of the Federal Government (Art. 73 (1) no. 14 GG). In this respect, the *Länder* only have legislative power if and as far they are explicitly authorised in a federal act. Thus, the “regulatory body” consists of authorities of the Federal Government and the *Länder*.

In adopting the Act on the Peaceful Utilisation of Atomic Energy and the Protection against its Hazards (Atomic Energy Act (AtG)) [1A-3] on 23 December 1959, the Federal Government made

use of the concurrent legislative competence. The Atomic Energy Act was comprehensively amended by an Amending Act dated 19 July 2002.

The third chapter of the Atomic Energy Act lists the regulatory bodies responsible for the implementation of and compliance with the provisions of this Act and related statutory ordinances:

- According to § 22 AtG, the Federal Office of Economics and Export Control (BAFA) is responsible for licences/approvals involving transboundary transportation and withdrawal or revocation thereof, while supervision is the responsibility of the Federal Ministry of Finances or the customs authorities designated by it.
- According to § 23 AtG, the Federal Office for Radiation Protection (BfS) is responsible for the following with regard to the treatment of spent fuel assemblies and radioactive waste:
 - the construction and operation of federal facilities for the safekeeping and disposal of radioactive waste, the transfer of tasks to third parties by the Federal Government, and the supervision of such third parties,
 - the licensing of nuclear fuel storage outside of federal custody, where this does not constitute preparation or part of an activity subject to licensing under §§ 7 or 9 AtG, and the withdrawal or revocation of such licences,
 - decisions concerning exceptions from the duty to construct an interim storage facility on the site of a commercial nuclear power plant or in close proximity to it when an application for decommissioning has been filed (§ 9a (2) AtG).
- According to § 23a AtG, the Federal Office of Administration is responsible for decisions regarding preservation orders to secure plans for repository projects or continue a site investigation for facilities intended for disposal of radioactive wastes pursuant to § 9g AtG. Such a preservation order shall prevent that at a potential repository site, essentially value-increasing changes or changes which substantially impede the project are performed. It is specified for a maximum of ten years and may be extended two times by a maximum of ten years in each case.
- § 24 AtG regulates the competence of the *Länder* authorities (excerpt):
 - (1) The other administrative tasks under the Second Section and the resultant statutory ordinances are performed by the *Länder* on behalf of the Federal Government.
 - (2) The supreme *Länder* authorities designated by the *Länder* governments are responsible for licensing pursuant to §§ 7, 7a and 9 AtG and the withdrawal and revocation thereof, as well as for plan approval pursuant to § 9b AtG and the reversal thereof. These authorities also exercise supervision of nuclear installations pursuant to § 7 AtG and the use of nuclear fuels outside these installations. In individual cases they may mandate subordinate authorities to carry out such tasks. The supreme *Länder* authority decides on any complaints against their orders. Insofar as provisions outside this Act confer supervisory authority upon other authorities, this competence shall remain unaffected.
 - (3) For matters relating to the official duties of the Ministry of Defence, the competencies outlined in paragraphs 1 and 2 shall be carried out by said Ministry or other authorities designated by it in collaboration with the federal ministry responsible for nuclear safety and radiation protection.

§ 19 of the Atomic Energy Act (AtG) outlines the provisions of governmental supervision, which is executed by the *Länder*, with the exception of the supervision of repositories, of transboundary shipment of radioactive materials and the area of operations of the *Bundeswehr* (German Federal Armed Forces).

Governmental supervision extends to the handling and trafficking of radioactive materials, the construction, operation and ownership of stationary facilities for the production or for treatment and processing or fission of nuclear fuels or the reprocessing of irradiated nuclear fuels, as well as to

facilities for the production of ionising radiation (facilities of the type mentioned in §§ 7 and 11 (1), subpara. 2 AtG), the handling and trafficking of facilities, instruments and devices which contain radioactive materials or generate ionising radiation (facilities, instruments and devices of the type mentioned in § 11 (1), subpara. 3 AtG), the transportation of such materials, facilities, instruments and devices, the appropriated addition of radioactive materials and the activation of materials, insofar as requirements in this respect exist under the AtG or by virtue of a statutory ordinance based on this act, as well as all work with ionising radiation of natural origin (work according to § 11 (1) subpara. 7 AtG).

§ 19 AtG also specifies the powers of the supervisory authority.

The *Länder* implement the Atomic Energy Act and the statutory ordinances issued thereunder on behalf of the Federation pursuant to § 24, para. 1, sentence 1 AtG in conjunction with Art. 87 c GG. According to Art. 85, para. 4 GG, the consequence of this is that responsibility for supervision of the *Länder* with respect to the lawfulness and appropriateness of measures taken lies with the Federal Government.

With regard to federal supervision, nuclear legislation and ordinances refer to the “minister responsible for nuclear safety and radiation protection” – the ministry. § 9 of the Federal Government’s Rules of Procedure stipulates that the competencies of the ministries are assigned according to the Federal Chancellor’s authority on matters of general policy. In this instance, responsibility for nuclear safety and radiation protection has been assigned to the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Personnel

All regulatory bodies are obliged to give an account of their human resources by drawing up job plans. The costs depend on the extent of the activities, i. e. different numbers of staff are employed in the various *Länder* depending on the number of nuclear facilities to be supervised there. The required funds for this purpose are established by the *Länder* parliaments and the *Bundestag* (Lower House of Parliament) in their respective budgets.

Nuclear Authority of the Federation

The nuclear authority of the Federation is a technical department of the BMU – the Directorate-General for Reactor Safety (RS). It comprises three directorates. The unit of the Directorate-General RS dealing with the fulfilment of the obligations under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management is the Directorate RS III. In the middle of 2007, Directorate RS III and its four divisions has 28 staff members, 15 of them in the higher grade of the civil service, five in the upper grade and seven in the middle grade.

As subordinate authority of the BMU, the BfS performs implementation tasks of the Federation in accordance with the Atomic Energy Act and the Radiation Protection Ordinance, fulfils tasks in the fields of radiation protection, nuclear safety, the transport of radioactive material and the disposal of radioactive waste. The BfS supports the BMU technically and by scientific research in its responsibility, among others, regarding the disposal of radioactive waste. At the BfS, these tasks are mainly performed by the Department SE Safety and Nuclear Waste Management. The Department SE is divided into three divisions, two of them being responsible for the performance and steering of the projects/facilities. For dealing with generic plant- and site-related issues, the third division was established with the aim to perform handling and inspection as efficient as possible by pooling of expertise.

At present, the Department SE and its three divisions (“Interim Storage Facility and Transport Licensing Procedures”, “Repositories” and “Safety and Planning”) has 73 staff members. In addition, there is a working group in this department in the field of finances and controlling with 12 staff members.

For the conversion of the Konrad mine to the Konrad repository, a project group has been set up headed by the Vice-president of the BfS with ten members.

For supervision of the compliance with the requirements under nuclear law and the stipulations in the plan approval, the department of self-surveillance was set up for the Morsleben repository and the planned Konrad repository as well as quality assurance surveillance with a total of six staff members.

From the staff members of the Department SE, the project group Konrad, the self-surveillance and the quality assurance surveillance, 59 are in the higher grade of the civil service, 18 in the upper grade and 24 in the middle grade.

The Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH is a central expert organisation. GRS performs scientific research in the field of nuclear safety, predominantly under federal contracts, including radioactive waste management and disposal, and support the BMU in technical issues. In this field, about 62 staff members of GRS are working for the BMU and the BfS.

Within the framework of product control of radioactive waste, the BfS is supported by independent experts who perform product control on behalf of the BfS. About ten experts of the Product Control (*Produktkontrollstelle - PKS*) and 20 experts of the TÜV NORD EnSys GmbH are working in this field.

Nuclear Authorities of the *Länder* and Authorised Experts of the *Länder*

In the 16 *Länder*, there are about 80 staff members of the higher grade of the civil service, about 42 of the upper grade and about eleven of the middle grade working on issues related to radioactive waste management. Another 153 staff support the nuclear authorities of the *Länder* either at subordinate authorities or as authorised experts. The personnel strength of the different *Länder* varies according to the concrete tasks: e.g., *Länder* with larger nuclear facilities have a larger licensing and supervisory authority than those with no or only very small nuclear facilities.

Operation of the Konrad and Morsleben Repositories and the Asse Mine: Keeping Available the Gorleben Repository Project

For fulfilling its tasks related to the construction and operation of repositories for radioactive wastes, the BfS currently employs the services of the *Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe (DBE)* mbH (German Service Company for the Construction and Operation of Waste Repositories) as third party. At the DBE, about 570 staff members are working in the field of waste management/disposal in connection with the Morsleben and Konrad repositories and the Gorleben repository project.

The Helmholtz Zentrum München employs about 210 persons in connection with the operation of the Asse mine; they are to be kept on staff also after the operator's change to BfS. Another 60 staff shall be employed for sealing of the shafts.

Advisory Commissions and Authorised Experts

The RSK was founded in 1958 and advises the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) on issues relating to nuclear safety and physical protection. For dealing in depth with the various key issues, the RSK has established corresponding committees. Issues of decommissioning and radioactive waste management are dealt with in depth by the "Committee on Supply and Waste Handling". The RSK is also involved in the advanced development of safety standards in nuclear installations. It normally consists of 12 members, who are generally appointed for a period of two years.

The SSK was founded in 1974 and gives recommendations to the BMU with regard to the protection of the population as well as employees in medical facilities, research, industry and nuclear installations against ionising and other radiation. The SSK's 14 members are generally appointed for a period of three years.

Financial Resources of the Regulatory Body

The financial means available to the authorities for their own personnel and for the consultation of experts are fixed by the *Bundestag* (Federal Parliament) in the respective budgets.

The BMU can dispose of an approximate annual €22 million for studies related to reactor safety, including nuclear fuel supply and waste management, and another €9 million in the field of radiation protection. These funds are used for the financing of the work of the advisory commissions (RSK, SSK), for the direct support of the BMU, for scientific and technical support as well as for the participation of external experts in international co-operation. Further, projects are financed from these funds that also serve the maintenance of competence of GRS as expert organisation of the Federation in the field of nuclear safety.

The Federal Ministry of Economics and Technology (BMW_i) provides an account of approximately €26 million annually for reactor safety research. Two thirds of this account are allocated to reactor safety research in the framework of which about 100 research projects are performed in parallel at an average. In the field of basic research on the final disposal of radioactive waste, about 70 projects are performed in parallel with one third of the account.

Moreover, the Federal Institute for Geosciences and Natural Resources (BGR), a subordinate authority of the BMW_i, is charged with geoscientific issues for German repository projects. The BGR is generally financed from the BMW_i budget. However, special tasks in the field of final disposal are refinanced by the waste producers.

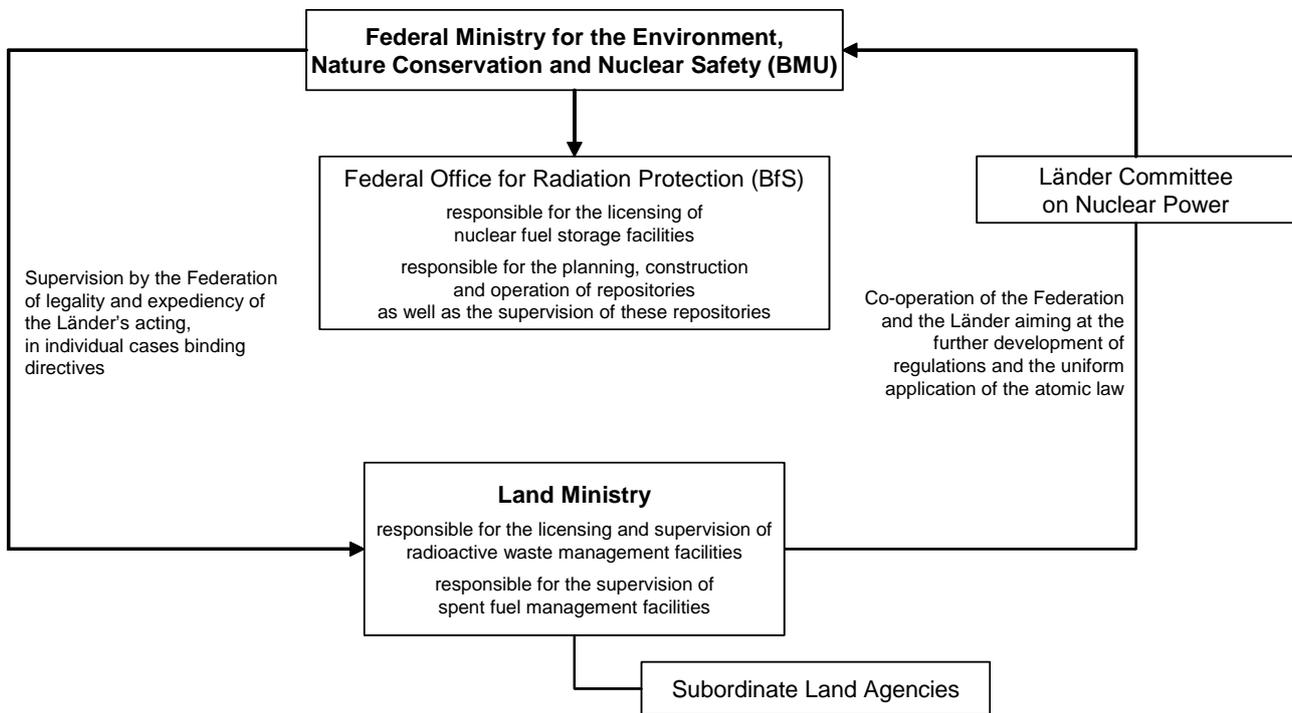
To cover the necessary expenses for federal facilities, the Federal Office for Radiation Protection collects advance payments for cost-covering contributions to be paid in accordance with § 21b AtG according to the Ordinance Concerning Prepayments for the Erection of Federal Facilities for the Long-Term Engineered Storage and Disposal of Radioactive Waste (*Endlagervorausleistungsverordnung - EndlagerVIV*) from the future users of a repository. The determination of the contributions to be paid is based on the eligible expenses of the federal authorities for the repository projects.

An expert opinion prepared at the end of 2006 on behalf of the BMU shows the narrow limits of levying fees regarding the scope of tasks of the BMU at issue here, and only few and very limited discretionary powers regarding further review. Nevertheless, these reviews shall be performed to identify and implement all possibilities of fee financing of tasks.

Co-operation between the Authorities of the Regulatory Body - Länder Committee for Nuclear Energy

The *Länder* Committee for Nuclear Energy (LAA) is a permanent Federation-*Länder* Committee composed of representatives from the *Länder* nuclear licensing and supervisory authorities and the BMU. It serves for the preparatory co-ordination of Federal and *Länder* authorities in connection with the execution of the Atomic Energy Act as well as for the preparation of amendments and the further development of legal and administrative provisions as well as of the non-legally binding guidance instruments. The BMU chairs the LAA and also manages its affairs. For preparing decisions to be taken by the General Committee, the *Länder* Committee for Nuclear Energy avails itself of several technical committees on the issues of "Legal Matters", "Nuclear Safety", "Radiation Protection" and "Fuel Cycle Matters". The technical committees convene at least twice a year and more frequently if necessary. The general committee convenes at least once a year.

Figure E-5: Regulatory bodies



E.3.2. Effective Independence of the Regulatory Functions

The economic use of nuclear energy lies in private hands and not in the public sector. Supervision, on the other hand, is a state function. Thus there is a separation of spheres of interest.

The only instance where a conflict of interests might be conceivable is in situations where financial promotion or the subsidising of scientific research occurs in the same government sector as the supervision of the corresponding nuclear facilities. However, at Federal Government level there is no such risk of a conflict of interests since functions are assigned to different departments. Nuclear licensing and supervision generally lies within the responsibility of the *Länder*; supervision of legality and expediency is performed by the BMU. Economic aspects of the nuclear energy industry in Germany, reactor safety research and basic research on the final disposal of radioactive waste fall within the responsibility of the BMWi.

A special case in Germany is the planning, construction and operation of repositories for radioactive waste. According to § 9a, para. 3 AtG, this is a Federal Government task allocated to the Federal Office for Radiation Protection for execution.

The licensing procedure for such a federal repository takes the form of a so-called plan approval procedure (cf. Chapter E.2.3), for which the supreme *Länder* authority designated by the respective *Land* government is responsible. In this case, the Federal Office for Radiation Protection is the applicant and as such is subject to the decisions taken by the licensing authority. Legal and expediency supervision regarding the application of nuclear law by the respective *Land* is performed by the federal ministry responsible for nuclear safety (federal supervision). The corresponding *Land* authority decides on plan approval.

The supervision of the compliance with the requirements under nuclear law and the stipulations in the plan approval is carried out by the organisational unit "self-surveillance" set up at the BfS, being independent of those responsible for the construction and operation of repositories. Any possible conflicts of interest are precluded by the internal organisational separation of the organisational units in charge of repository planning and the "self-surveillance" unit in charge of supervision. Al-

though “self-surveillance” is an organisational unit of the BfS, it is independent and not subject to directives of the organisational units planning the repositories. The unit's staff has no other functions.

E.4. Progress and Major Changes since the Last Review Meeting

Safety Requirements for the Final Disposal of Radioactive Wastes

The Safety Criteria for the Permanent Storage of Radioactive Wastes in a Mine [3-13] published at the beginning of 1983 in the Federal Gazette had the task to concretise the requirement to take the necessary precautions which is currently included in § 7, para. 2, sentence 1, subpara. 3 AtG. In the time following, international recommendations and standards on radiation protection and final disposal of radioactive wastes were substantially revised and updated according to new findings. Against this background, the BMU set itself the objective to adapt these criteria to today's state of the art in science and technology.

The revision is limited to safety requirements for the final disposal of heat-generating wastes in deep geological formations. In its framework, international developments and recommendations shall be considered in particular, such as the step-wise proceeding regarding repository planning and safety assessment, repository safety optimisation and also the criteria regarding other subjects of protection (e.g. protection of the environment). The technical bases for such a revision and update of the safety criteria of 1983 are available.

AtSMV

Within the framework of the revision of the Ordinance on the Nuclear Safety Officer and Reporting of Accidents and Other Events (AtSMV), specific reporting criteria have now be developed for the interim storage facilities for spent fuel elements and for facilities in the process of decommissioning as own category of facilities in this ordinance. The amended ordinance will enter into force after the revision of the reporting criteria for nuclear power plants has been finalised.

F. Other General Safety Provisions

This section deals with the obligations according to Articles 21 to 26 of the Convention.

F.1. Article 21. Responsibility of the Licence Holder

Article 21. Responsibility of the licence holder

- 1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.*
- 2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.*

F.1.1. Responsibility of the Licence Holder

The licensee has primary responsibility for the safety of a spent fuel management facility or a radioactive waste management facility. He may only be issued with a licence if he meets all the legal prerequisites for licensing. In the case of handling of nuclear fuels licensed under § 6 AtG (e.g. interim storage facilities for spent fuel assemblies) [1A-3] or facilities licensed under § 7 AtG (e.g. conditioning plants for spent fuel assemblies), one such prerequisite is the trustworthiness and technical qualification of the responsible individuals. Certified proof of this prerequisite and its acknowledgement by the authorities provide the basis for responsible performance under the licence.

In the case of companies with a number of board members authorised to represent it, the name of the ultimately responsible individual must be reported to the authority. This same person is also responsible for ensuring a functioning organisational structure and the deployment of qualified personnel at the facility.

The holder of a licence issued according to § 31, para. 1 StrlSchV [1A-8] is responsible for the entire field of radiation protection. In addition, § 31, para. 2 StrlSchV stipulates that radiation protection commissioners must be appointed for technical activities and monitoring of operation. Together with the radiation protection supervisor, these ensure due compliance with all protection and supervisory provisions of the Radiation Protection Ordinance (cf. the remarks on Article 24 of the Convention). According to § 32, para. 5 StrlSchV, the radiation protection commissioners must not be hindered in the performance of their duties or suffer any disadvantages by virtue of their activities.

In order to better meet the specific requirements of nuclear safety at installations licensed under § 7 AtG (e.g. plants for the conditioning of spent fuel assemblies), the additional position of nuclear safety officer has been created as part of the organisational structure of the plant [1A-17]. It is his responsibility to supervise nuclear safety issues in all areas of operation, and in doing so must act independently of the corporate interests of cost-effective plant operation. He should be involved in all activities concerning modifications, should assess any reportable events and the evaluation of operating data, and has the right to report directly and at any time to the plant manager.

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

The actual structure of the plant organisation is at the sole discretion of the licensee, provided it accommodates the requirements of the aforementioned responsible individuals and their duties, as well as the general requirements pertaining to quality assurance.

Any enforcement measures on the part of the competent authorities will always be directed in the first instance at the holder of the licence, with the objective that the ultimately responsible individu-

als will personally meet their respective obligations. If this is not the case, the authority can question the trustworthiness of such individuals, which is a prerequisite for granting the licence. Consequently, in such cases, any proceedings relating to an administrative or criminal offence will be directed at individual persons (cf. comments on Article 19 2. (v)).

F.1.2. Responsibility if there is no Licence Holder

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

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

In cases where the direct owner of nuclear fuels has no authorisation for possession, he shall establish authorised possession pursuant to § 5, para. 2. In the case that such authorised possession cannot be established, the Federation According to § 5, para. 3 AtG, in such cases the Federal Government shall temporarily take the nuclear fuels into its charge ("Government custody"). Such a situation may also arise if nuclear fuels are found or in case of loss of authorisation on the part of the private licensee (e.g. in case of insolvency of the former owner or revocation of the licence). However, if otherwise provided by the supervisory authority under § 19, para. 3 AtG, then this provision shall have priority over government custody. Whoever is responsible for nuclear fuels under government custody shall also ensure authorised possession outside Government custody (§ 5, para. 3, sentence 2 AtG). This does not only apply to the direct owner who delivered to the authority responsible for custody but also to the owners of utilisation and consumption rights to nuclear fuel held in Government custody, and to anyone who is required to accept or accept the return of nuclear fuel from a third party § 5, para. 3, sentence 3 AtG).

According to § 23, para. 1 AtG [1A-3], the BfS is responsible for the execution of government custody. The BfS may cause the private licensees to (re-)assume their responsibility with regard to the handling of nuclear fuels by issuing directives stipulating that nuclear fuels under government custody are to be returned to the charge of the private owners. This indicates that government custody of nuclear fuels is an exceptional case in the handling of these materials.

F.2. Article 22. Human and Financial Resources

Article 22. Human and financial resources

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;*
- (ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;*
- (iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.*

F.2.1. Personnel

The safe operation of nuclear installations, including spent fuel and radioactive waste management facilities, requires a high degree of competence of all those involved, i.e. operators, manufacturers, research institutions, authorities and authorised experts. For safe operation of nuclear installations, the operators are responsible for providing the necessary competence.

According to § 7, para. 2, subparas. 1 and 2 of the Atomic Energy Act (AtG) [1A-3], a licence for the erection or operation of a facility may only be granted if

- there are no known facts which could cast doubt on the reliability of the applicant and of the persons responsible for the erection and management of the installation and the supervision of its operation; and the persons responsible for the erection and management of the installation and the supervision of its operation have the required technical qualifications,
- measures have been taken to ensure that the persons otherwise engaged in operation of the installation have the necessary expert knowledge concerning the safe operation of the installation, the potential hazards, and the protective measures to be taken.

§ 30 of the Radiation Protection Ordinance (StrlSchV) [1A-8] contains regulations concerning the required scope of expert knowledge in the field of radiation protection as well as its acquisition and conservation.

The Ordinance on the Nuclear Safety Officer and on the Reporting of Accidents and Other Events (AtSMV) regulates the appointment of nuclear safety officers for nuclear installations licensed under § 7 AtG.

The legal bases are further specified within the framework of guidelines. This is realised, in particular by guidelines on the required technical qualification of the responsible personnel and on the assurance of the necessary knowledge of the persons otherwise engaged in the operation of nuclear installations but also by requirements regulating the exchange of information and knowledge, including experience feedback.

In addition, there is the Guideline on Technical Qualification in Radiation Protection [3-40] which specifies the extent and required proof of the technical qualification of radiation protection supervisors and radiation protection commissioners.

Further, there is the Guideline Relating to the Assurance of the Necessary Knowledge of Other Persons Engaged in the Operation of Nuclear Power Plants [3-27]. The contents of this guideline can be applied analogously to other nuclear installations.

Implementing the content of these regulations results in a hierarchy of responsibilities, each of which has varying requirements with respect to technical qualification and expert knowledge. Accordingly, there are four distinct groups with different requirements in terms of education and expert knowledge:

- A completed education at a university, college or technical college in a relevant technical or mathematical-scientific area is required for plant managers and their deputies. They must have completed a course in radiation protection and have acquired the necessary knowledge in the nuclear regulatory framework. In addition, practical professional experience is also required. Persons in this group include the Head of the Radioactive Waste Repository Projects department at the Federal Office for Radiation Protection (BfS), the Head of the Waste Acceptance and Quality Control department, the manager of the repository and their respective deputies.
- For other persons engaged in the operation of nuclear power plants and who must possess the necessary expert knowledge in radiation protection, the requirements for vocational training may be restricted according to their specific activities. However, the other requirements are the same as for the first group. Concerning a repository, examples of persons in this second group include the head of physical protection [3-57], the facility manager, the head of mining operation, the head of disposal of radioactive waste, the head of surface work, and the head of radiation protection.
- § 31, para. 4 of the Radiation Protection Ordinance (StrlSchV) stipulates that proof is required that radiation protection officers who are appointed by the radiation protection supervisor according to § 31, para. 2 StrlSchV possess the necessary technical qualification. Radiation protection officers are responsible for the management or supervision of measures designed to

ensure compliance with the radiation protection principles and protective measures as laid down in the StrISchV.

- The last group comprises all “other” persons engaged in a nuclear facility. These persons are not obliged to have specific expertise in radiation protection, although they must have an adequate working knowledge thereof. They must have the level of education or training corresponding to their scope of duties and should acquire the necessary know-how by instruction and training before starting work. Instruction serves to impart essential safety-related knowledge in the fields of work safety, fire prevention and radiation protection as well as plant-related knowledge. Training is held at the employee’s workplace and takes place prior to commencing work.

Prior to the deployment of personnel stated in guideline [3-2] relating to the proof of the technical qualification of nuclear power plant personnel (management personnel), the supervisory authority requires the submission of documents which verify the necessary technical qualification and practical experience. It reviews these documents for compliance with the requirements of the guideline.

The plant operator submits the verifications on advanced training of his personnel and his three years programme on the maintenance of technical qualification to the supervisory authority. The supervisory authority reviews the appropriateness of the measures on the basis of the requirements of the guidelines on technical qualification [3-2] and [3-27] .

The technical personnel - during initial training and repeatedly during advanced training - is regularly made aware of the importance of safety-oriented actions. For personnel of facilities for spent fuel and radioactive waste management, e.g., measures of technical qualification and further education account for 5 % of their working time.

The economic system in Germany precludes the compulsory allocation of employees, and ensures that working life is regulated by the principles of supply and demand. The same applies to the qualified personnel required in nuclear facilities. The state, in the form of the Federal Government and the *Länder*, provides educational facilities at which qualified vocational training is given. In addition to public education, in 1957 power plant operating companies founded a power plant training facility to account for the requirements for power plant personnel. As a result of the freedom of movement within the EU, however, there has been an additional increase in the potential of appropriately trained applicants. The operators of nuclear facilities, both state-owned and privately owned, for their part advertise for qualified staff.

In addition to vocational training, there are appropriate training opportunities available in Germany at 14 universities and six technical colleges, for example in the field of nuclear and reactor technology at Aachen, Berlin, Clausthal, Dresden, Essen, Karlsruhe, Munich and Zittau universities. Recognised radiation protection courses are held e.g. at FZK in Karlsruhe, at the Helmholtz Zentrum München and at Ilmenau Technical University. 2005 and 2006, a total of nine vacant or new professorships were offered by the Universities Aachen, Dresden, Karlsruhe, Munich, Stuttgart, Clausthal, partly with substantial financial support of the industry, in the fields of reactor safety, reactor technology, radiochemistry, repository systems and radiobiology. In spring 2005, after comprehensive upgrade measures, the AKR-2 training reactor obtained the approval to start operation as specified. Thus, the Technical University Dresden has the most modern training reactor in Germany. The training courses started summer semester 2005.

There are also recognised courses available in the non-governmental sector, e.g. at the various Chambers of Industry and Commerce and at *Haus der Technik* in Essen.

In order to ensure a sufficient number of qualified and well-educated staff for safety related work, existing knowledge must also be revised and updated.

- In relation to individuals, this is ensured by the regulations on recurring training in the field of radiation protection. Instruction courses are held every year according to the “Guideline Relating to the Assurance of the Necessary Knowledge of Other Persons Engaged in the Operation

of Nuclear Power Plants” [3-27]. For the other groups, instructions should be given at least every two or three years, respectively.

- Moreover, research institutions in the field of reactor safety joined to found the *Kompetenzverbund Kerntechnik* (Alliance for Competence in Nuclear Technology) of German research institutes in March 2000 within the framework of the HGF Nuclear Technology Research Pool in order to maintain an adequate level of know-how in the nuclear and radiation protection sector. It consists of the research centre FZK together with the universities of Karlsruhe and Stuttgart, the Jülich Research Centre together with the RWTH Aachen and the FH Aachen/Jülich, the Dresden-Rossendorf Research Centre together with TU Dresden and Zittau/Görlitz University of Applied Sciences, the Gesellschaft für Anlagen- und Reaktorsicherheit together with TU München and the Federal Institute for Geosciences and Natural Resources (BGR). This competence pool analyses the education and training situation and provides forecasts for the future, aimed at clarifying the current training situation.

Figure F-1: Alliance for Competence in Nuclear Technology (Copyright: FZK)



- Further, maintenance of competence in the field of nuclear safety also takes place in the field of radiation research. In February 2007, the *Kompetenzverbund Strahlenforschung* (Alliance for Competence in Radiation Research) has been founded. The aim of this alliance is to initiate and support research activities in close co-operation with the research centres involved and the surrounding universities to further develop scientific competence and to enable intensive junior staff development. Existing professorships shall be maintained and the establishment of new professorships as well as the establishment and development of working groups shall be promoted. Members of the Alliance for Competence in Radiation Research are six Helmholtz research centres, i.e. the Helmholtz Zentrum München, the Gesellschaft für Schwerionenforschung (GSI), the Forschungszentrum Jülich (FZJ), the Forschungszentrum Karlsruhe (FZK), the German Cancer Research Center (DKFZ) and the Helmholtz Centre for Environmental Research (UFZ), as well as the Forschungszentrum Dresden-Rossendorf (FZD) and the Federal Office for Radiation Protection (BfS).

- The power plant operators also have committed themselves to the co-ordinate promotion of German training and research institutions to contribute to the maintenance of competence and junior staff recruitment in the field of nuclear technology. This comprises the creation of a register on nuclear training offers and research activities to identify main fields of competence as well as on decision making within the framework of support of universities. Further, structured support of universities is given by sponsorships in form of support in the development of study courses, specific support of professorships, establishment of endowed professorships, appointment of visiting professors, awarding of postgraduate scholarships, and others. The sponsorships refers to the Universities of Heidelberg, Karlsruhe, Stuttgart, RWTH Aachen, FH Aachen/Jülich of Applied Sciences, TU Dresden, Zittau/Görlitz University of Applied Sciences, TU München and the Clausthal University of Technology. On 1 August 2007, an institute for disposal research has been founded at the Clausthal University of Technology. It comprises all disciplines relevant for final disposal (repository systems, geochemistry-mineralogy-salt deposits, geomechanics, hydrogeology and geochemistry as well as mineral resources). This institute conducts teaching and research in these disciplines.

F.2.2. Financial Resources during Operation and Decommissioning

Publicly-operated nuclear facilities are supplied with the necessary funding by the competent body, which also extends to any safety-related issues associated with these plants. Private operators must supply the necessary financial resources themselves. In order to ensure that this occurs, they are subject to governmental supervision as defined in § 19 of the Atomic Energy Act (AtG). Governmental supervision takes into account the requirements as set out in § 7 AtG.

Under § 249 ff of the Commercial Code (HGB) [HGB 02], private operators are required to make provisions for nuclear asset retirement for the costs arising after final shut-down of the plants, i.e. for disposing of spent fuel assemblies or radioactive waste and for decommissioning and dismantling. In the case of publicly funded facilities, funds for decommissioning and dismantling are set aside in the current budget (cf. also the remarks on Article 26 relating to the decommissioning and dismantling of nuclear installations).

F.2.3. Financial Means after Sealing of a Repository

Once a repository has been closed, its surveillance is a governmental task. Control measures performed by the authorities will essentially be confined to passive measures. Active measures will not be necessary, given the selection of the repository site and the design of the repository. In consequence, the anticipated costs are low. As these are government measures, their financing is guaranteed.

F.3. Article 23. Quality Assurance

Article 23. Quality assurance

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

F.3.1. Quality Assurance

The concept and design of facilities for the conditioning, interim storage and disposal of spent fuel assemblies and radioactive waste include constructive and administrative measures designed to protect the general public and workers against hazards arising from the release of radioactive substances and ionising radiation. The effectiveness of these measures is ensured within the framework of a quality assurance programme which also considers ageing phenomena and preventive maintenance. The KTA Nuclear Safety Standard 1401 of the KTA specifies general requirements for quality assurance regarding nuclear power plants; this standard is currently being revised by

the KTA. These requirements of this safety standard are applied wherever relevant. These include the principles of operational organisation, planning and design, production and construction including quality control, specified normal operation and incidents, documentation and archiving, as well as auditing of the quality assurance system itself. One essential element of quality assurance is the operating manual. The nature and scope of measures to safeguard quality characteristics are oriented towards their significance for preventing damages caused by radiation exposure. The applicant or licensee is responsible for the planning, performance and control of the effectiveness of quality assurance. In this respect, an essential requirement of KTA Nuclear Safety Standard 1401 is the technical knowledge and qualification of the personnel.

The quality assurance programme is addressed by the nuclear licensing procedure, which specifies the nature and scope of initial inspections and, where necessary, recurrent inspections by the supervisory authority. The supervisory authority monitors compliance with the quality assurance programme and related measures. In this role, it may consult experts. Moreover, it has access to the facility at all times in order to carry out the necessary inspections.

Some quality assurance requirements in international standards, e. g. in DIN ISO EN 9001 and DIN EN 45004, are not addressed by KTA 1401. However, AtG and StrlSchV [1A-8] generally require compliance with the state of the art in science and technology. It is thus ensured that quality assurance requirements that apply internationally are considered, too.

F.3.2. Waste Package Quality Control

Radioactive waste package quality control exists as a part of general quality assurance. Its task is to ensure compliance with waste acceptance requirements. These are the result of a site-specific safety analysis for the installation being licensed. The proof required in this respect pre-supposes a number of organisational and administrative regulations setting out the spheres of responsibility, tasks and activities of the parties involved. Within the scope of its responsibility for the operation of a repository, the BfS ensures that the waste acceptance requirements are met by examining waste packages and by qualification and accompanying control of conditioning measures.

Waste package quality control comprises regulations on quality assurance in the registration and conditioning of radioactive waste and in the production of waste containers, including the registration and documentation of the repository-relevant characteristics of the waste packages. Organisational and administrative regulations governing the spheres of responsibility, tasks and activities of the parties involved are laid down in a decision by the main committee of the LAA of 1/2 December 1994 (cf. Figure F-2) and through the agreements between the BfS and the waste producers. The supervisory authorities, the BfS, the appointed experts, the waste producers and the service companies acting on their behalf, as well as the operators of the interim storage facilities and *Land* collecting facilities, are all involved in waste package quality control. The nature and extent of waste package quality control measures are determined depending on the conditioning technique, waste characteristics and repository requirements. The measures required in order to guarantee the safety of a repository for radioactive waste are laid down in the respective plant licence (plan approval notice).

Figure F-2: Quality control procedure for radioactive waste packages from nuclear facilities with respect to their conditioning, interim storage and disposal

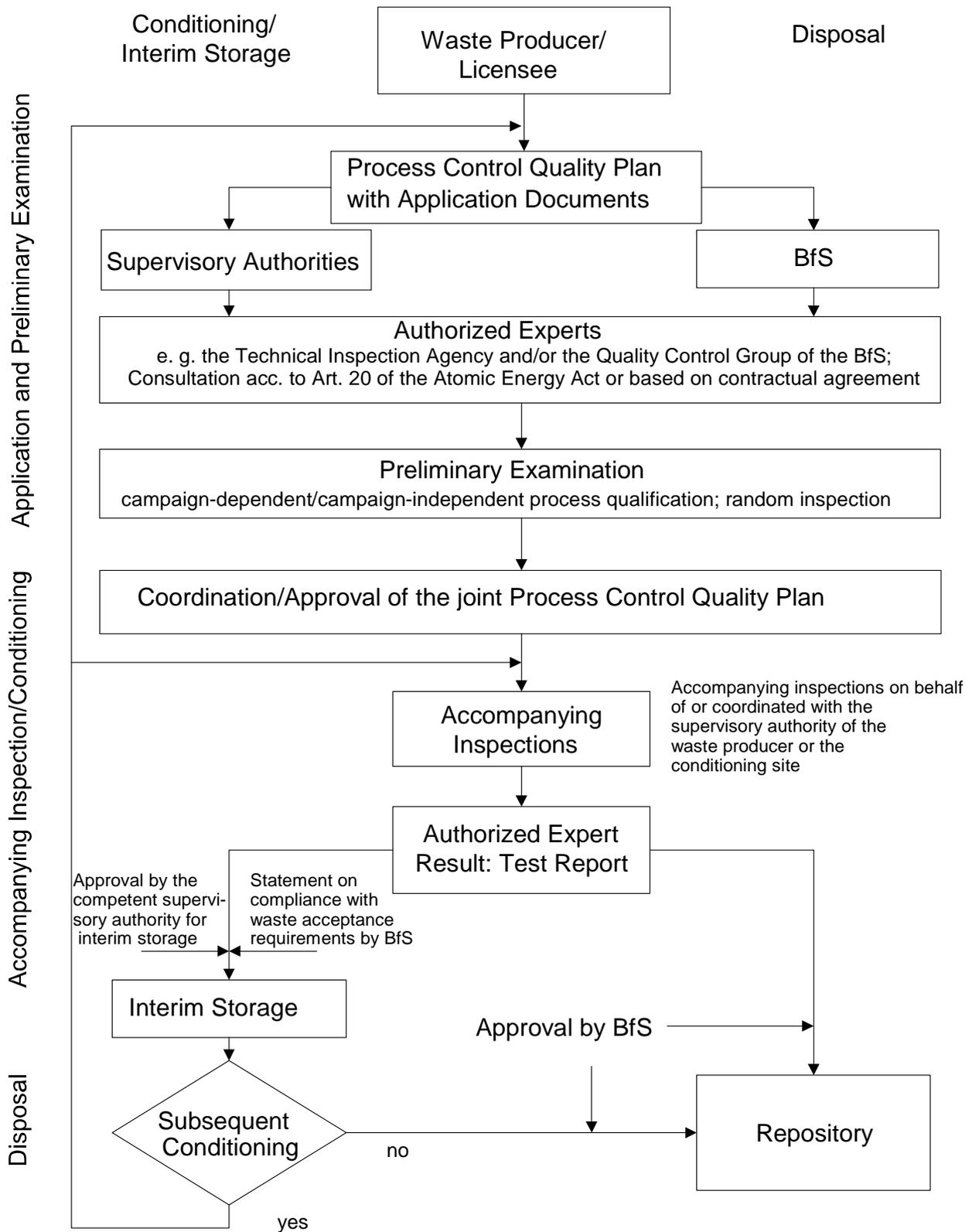


Figure F-3: Measurement for product control on a 200-l-drum (Copyright: GNS)



F.3.3. Regulations on Waste Package Quality Control

Generally speaking, the BfS regulations on waste package quality control of radioactive waste with negligible heat generation admit two methods of proving that the waste acceptance requirements are met:

- Random sample testing of waste packages already produced, or
- Qualification of conditioning techniques and determination of accompanying control measures to be carried out.

Both alternatives were examined in detail and confirmed by the Environment Ministry of Lower Saxony as the competent licensing authority for the Konrad repository within the scope of the licensing procedure.

According to § 74, para. 2 StrlSchV, methods that have been approved by the Federal Office for Radiation Protection have to be applied for the treatment and packaging of radioactive waste to produce waste packages that are suitable for final disposal. According to the Guideline on the Control of Radioactive Waste with Negligible Heat Generation that is Not Delivered to a *Land* Collecting Facility (Waste Control Guideline) [3-59], qualified techniques are to be applied where possible for pre-treatment and conditioning.

The application of waste package quality control specific measures prior to emplacement of the waste packages in a repository has proven successful in practice during emplacement operations in the Morsleben repository for radioactive waste. Co-operation between all the institutions involved has likewise worked well. The experience thereby acquired does not suggest any reason for diverging from these techniques.

Only those radioactive wastes may be disposed of in the Konrad repository which demonstrably meet the waste acceptance requirements for final disposal including the relevant ancillary provisions of the plan approval. Compliance demonstration is performed within the framework of product control by qualified conditioning methods or sample testing (see Article 23, quality assurance/product control). Already conditioned radioactive wastes shall be subjected to post-qualification. Only the difference to the already verified requirements is to be checked because

since 1989 (*Abfallkontrollrichtlinie* – Waste Control Guideline), the treatment of radioactive wastes destined for final disposal is exclusively performed according to qualified procedures.

Until today, there are no quantitative requirements or limit values for final disposal of heat-generating radioactive wastes in Germany. For later disposal in a federal repository, the compliance with waste acceptance requirements for final disposal within the framework of product control shall be demonstrated also for these radioactive wastes. Since, however, already today procedure qualifications for the conditioning of these waste streams have to be performed, the procedure here is analogous to that of product control for radioactive wastes with negligible heat generation. The objective of procedure qualification is to record the repository-relevant characteristics and data already during conditioning of the wastes under participation of independent experts such that later non-destructive or destructive tests on the waste products for demonstrating compliance with the waste acceptance requirements for final disposal can be avoided.

F.4. Article 24. Operational Radiation Protection

Article 24. Operational radiation protection

- 1) *Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:*
 - (i) *the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;*
 - (ii) *no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection;*
 - (iii) *measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.*
2. *Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:*
 - (i) *to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and*
 - (ii) *so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.*
3. *Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.*

F.4.1. Basis

The legal basis for radiation protection in the nuclear facilities listed above is the Radiation Protection Ordinance (StrlSchV) [1A-8]. The 2001 amendment of the Radiation Protection Ordinance has translated EURATOM Directives 96/29/EURATOM [1F-18] and 97/43/EURATOM [EUR 97a] into German law. Essential aspects of the “Guideline on the Control of Radioactive Waste with Negligible Heat Generation that is Not Delivered to a Land Collecting Facility” (*Richtlinie zur Kontrolle radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung, die nicht an eine Landessammelstelle abgeliefert werden*) [3-59] were likewise integrated into the new ordinance. Furthermore, rules on the release from control of radioactive materials (§ 29 StrlSchV) were also incorporated.

The Radiation Protection Ordinance is subordinate to the Atomic Energy Act (AtG) [1A-3], which outlines all the fundamental requirements to be observed in the construction and operation of nuclear facilities and the handling of radioactive materials.

The basic radiation protection standards of the IAEA [IAEA 96] and the recommendations of the ICRP are taken into account.

F.4.2. Radiation Exposure of Occupationally Exposed Individuals

Individuals exposed to radiation by virtue of their occupation are monitored for their radiation exposure by means of official and company dosimeters. According to § 55 StrlSchV, they must not receive an effective dose of more than 20 mSv in a calendar year. Limits are also specified for individual organ doses. Further details can be found in Table F-1.

Exceptions to these limits apply to minors under the age of 18, for whom the effective dose limit is only 1 mSv per year (instead of 20 mSv/a). In individual cases, the authority may permit effective doses of up to 6 mSv/a for individuals between the age of 16 and 18 if this is necessary for them to achieve the objectives of their professional training.

Furthermore, women of child-bearing age must not receive a cumulative dose of more than 2 mSv per month to the womb. For a foetus whose mother may continue working as occupationally exposed person after her pregnancy has become known, the limit is 1 mSv if an incorporation of radioactive materials can be excluded.

According to § 56 StrlSchV, the maximum effective dose permitted over an individual's entire working life is 400 mSv.

According to § 59 StrlSchV, the aforementioned dose limits may only be exceeded in exceptional cases for which official authorisation must be obtained, e.g. in the case of rescue work or measures to avoid or remedy accidents. The rescue work and the ascertained body dose must be notified to the competent supervisory agency, since it is responsible for monitoring body doses.

For the limit values cited, Germany has adopted some of the specifications of the EURATOM Basic Safety Standards [1F-18], whilst others have been set at a more restrictive level.

As a record of their radiation exposure, documentation is kept for all occupationally exposed individuals listing both the results of the official dosimeters and those of any other dosimeters kept for operational reasons, or of dose calculations. The results of the official dosimetry are additionally registered centrally at the radiation protection registry of the Federal Office for Radiation Protection (BfS). Specifications are regulated in § 12c AtG and § 112 StrlSchV. Before commencing work in a controlled area, Category A persons exposed to radiation by virtue of their occupation must undergo a medical examination according to § 60 StrlSchV; this must be repeated every year.

In keeping with the requirements of the Radiation Protection Ordinance, the protection of persons subject to on-site and off-site radiation exposure by virtue of their occupation has already been taken into account in the conceptual design of the nuclear facility, and must be ensured during its operation by appropriate protective measures and protective clothing, especially when handling open radioactive materials. For work to be carried out in the restricted-access areas, radiation protection instructions are specified as part of the preparation of the work so that the time of the employee staying within the restricted-access area is kept as short as possible and radiation protection is thus optimised. §§ 36 to 45 StrlSchV deal primarily with the radiation protection of the personnel. According to § 43, para. 1 StrlSchV, the protection of occupationally exposed persons from external and internal radiation exposure shall be effected as a matter of priority by means of structural and technical devices or by means of suitable. According to § 43, para. 2 StrlSchV, the working conditions for pregnant women must be designed in such a way as to preclude internal occupational radiation exposure.

According to § 6 StrlSchV, the operators of nuclear facilities are legally obligated to avoid any unnecessary radiation exposure and contamination of individuals and the environment. Any unavoidable radiation exposure and contamination, even if it lies below the legal limits, has to be kept as low as possible in line with the state of the art in science and technology, considering all circumstances of each individual case. Within the nuclear facilities themselves, the radiation protection

supervisor and the radiation protection officers (for terms and definitions see Chapter F.1.1) are responsible for ensuring that radiation exposure is limited in line with the state of the art in science and technology to protect the population at large, the environment, and the personnel. In connection with the granting of licences and the performance of their supervisory duties, the competent authorities check the provision of radiation protection measures and exposure limits and whether these are adhered to.

According to § 32, para. 5 StrlSchV, the radiation protection officer must not be hindered from fulfilling his duties or be disadvantaged as a result. The radiation protection officer ensures as part of the preparation of his work that the time of the employees staying within the restricted-access area is kept as short as possible. If necessary, he checks the measures taken for this purpose himself. He defines the necessary measures of radiation protection and its verification and supervises and documents these. He ensures that all systems and pieces of equipment relevant in connection with radiation protection are regularly maintained and inspected. He instructs the personnel and makes sure that alarm exercises are carried out at regular intervals. Furthermore, he is concerned with the necessary plant-internal emergency measures. To ensure that the radiation protection officer has the competence necessary for his task in accordance with § 30 StrlSchV, he has to acquire the necessary technical qualification (in line with the "Guideline relating to Technical Qualification in Radiation Protection", Appendix A, Technical Qualification Groups [3-40]) and take part in refresher courses at intervals of no more than five years.

F.4.3. Radiation Exposure of the General Public

According to § 46 StrlSchV, it is a general rule for all nuclear facilities that an effective dose of no more than 1 mSv per calendar year may result for individual members of the general public due to their operation. Adherence to this limit is taken into account at the planning stage of nuclear facilities. A summary of the limits for radiation exposure of the general public and of persons exposed to radiation by virtue of their profession is given in Table F-1.

Table F-1: Dose limits from the Radiation Protection Ordinance [1A-8]

§	Scope of application	Period	Limit [mSv]
Design and operation of nuclear facilities			
46	Limitation of the radiation exposure of the general public		
	Effective dose: direct radiation from facilities, including discharges	Calendar year	1
	Organ dose for the lens of the eye	Calendar year	15
	Organ dose for the skin	Calendar year	50
47	Limitation of discharges during specified normal operation		
	Effective dose	Calendar year	0.3
	Organ dose for bone surfaces and skin	Calendar year	1.8
	Organ dose for gonads, womb, red bone marrow	Calendar year	0.3
	Organ dose for large intestine, lung, stomach, bladder, chest, liver, oesophagus, thyroid gland, and other organs or tissue not named above	Calendar year	0.9
49	Accident planning reference levels for the operation of nuclear power plants, for the near-site storage of irradiated fuel assemblies, and for Federal facilities for the securing and disposal of radioactive wastes		
	Effective dose	Event	50
	Organ dose for thyroid gland and lens of the eye	Event	150
	Organ dose for skin, hands, forearms, feet, and ankles	Event	500
	Organ dose for gonads, womb, red bone marrow	Event	50
	Organ dose for bone surface	Event	300
	Organ dose for large intestine, lung, stomach, bladder, chest, liver, oesophagus, thyroid gland, and other organs or tissue not named above	Event	150

§	Scope of application	Period	Limit [mSv]
Dose limits for persons exposed by virtue of their occupation			
55	Persons exposed by virtue of their occupation		
	Effective dose	Calendar year	20
	Organ dose for the lens of the eye	Calendar year	150
	Organ dose for skin, hands, forearms, feet, and ankles	Calendar year	500
	Organ dose for gonads, womb, and red bone marrow	Calendar year	50
	Organ dose for thyroid gland and bone surfaces	Calendar year	300
	Organ dose for large intestine, lung, stomach, bladder, chest, liver, oesophagus, thyroid gland, and other organs or tissue not named above	Calendar year	150
	Body dose for persons under the age of 18	Calendar year	1
	Apprentices aged 16-18, with the permission of the government agency	Calendar year	6
	Partial body dose for womb for women of child-bearing age	Month	2
Unborn child	Pregnancy	1	
56	Occupational lifetime dose, effective dose	Whole lifetime	400
58	Elimination of the consequences of hazardous incidents (only volunteers of Category A only, after authorisation by the authority, no pregnant women)	Whole lifetime	100
	Effective dose	Whole lifetime	300
	Organ dose for the lens of the eye	Whole lifetime	1 000
	Organ dose for skin, hands, forearms, feet and ankles		
59	Averting dangers to people	Calendar year	100
	(only volunteers over 18 years of age)	Once a lifetime	250

If the nuclear facilities concerned are subject to licensing under §§ 6, 7 or 9 of the Atomic Energy Act, or authorised by means of the plan approval process under § 9b AtG (such as the Pilot Conditioning Facility for spent fuel assemblies (PKA), the Karlsruhe Vitrification Plant (VEK) for fission products, the interim storage facilities for spent fuel assemblies and repositories), the radiation exposure for a reference person under worst-case assumptions must be determined at the planning stage, so as to verify compliance with the limits.

During operation of the nuclear facility, admissible discharges into air and water are specified by the competent government authority by limiting the concentrations and quantities of radioactivity, taking into account the pre-existing burden from other nuclear facilities and from earlier activities.

On-site interim storage facilities and temporary storage facilities for spent fuel assemblies do not generate any discharges of radioactive waste water, since any contaminated waste water e.g. from maintenance work on the casks which exceeds the exemption limits specified in Appendix VII, Part D of the Radiation Protection Ordinance is transferred to sewage treatment facilities for disposal. Discharges into the air by releases from the storage casks are not anticipated, although release values have been applied for in order to allow for possible contamination of the cask surfaces, for example. In practice, however, discharges to the air are negligible, due to the leak-tightness criteria for storage casks and the existing rules for surface contamination on the outside of the casks. Radiation exposure due to direct irradiation by gamma and neutron radiation occurs in the immediate vicinity of the interim storage facilities. In such cases, the aforementioned radiation-exposure limits for personnel and the general public must be taken into account.

Nuclear facilities not subject to licensing under §§ 6, 7 or 9 of the Atomic Energy Act, or to authorisation by means of the plan approval process under § 9b AtG, but which instead require a licence under § 7 StrlSchV, such as conditioning facilities or interim storage facilities for radioactive wastes, do not require explicit specification of discharge values, provided the activity concentration levels listed in Appendix VII, Part D StrlSchV are not exceeded on an annual average. Adherence

to the requirements is regularly checked by the supervisory agency or appointed independent experts.

F.4.4. Measures to Prevent Unplanned and Uncontrolled Releases

In order to prevent incidents involving uncontrolled releases of radioactive materials, nuclear facilities must be planned and designed in such a way that the effects of such incidents remain limited.

Under § 49 of the Radiation Protection Ordinance, the following requirements apply to the design of near-site interim storage facilities for spent fuel assemblies, and to repositories for radioactive wastes:

- a maximum effective dose of 50 mSv due to the release of radioactive substances into the environment (calculated across all exposure paths, as a 53-year consequential dose for adults and up to a 69-year consequential dose for infants) must not be exceeded in a worst-case accident, and
- maximum organ doses for various organs must be taken into account, such as 150 mSv each for the eyes and the thyroid gland, and 300 mSv for bone surfaces.

For the aforementioned types of nuclear facilities, it is necessary to demonstrate during the licensing procedure that they are designed to avert certain accidents, the so-called design basis accidents, in accordance with these specifications.

For all other nuclear facilities and facilities as defined in § 3, para. 2, subpara. 10 StrlSchV, § 50 StrlSchV applies if certain amounts of radioactive materials handled are exceeded (cf. § 50, para. 3 StrlSchV). For such facilities, structural or engineering safeguards are specified by the licensing agency according to the hazard potential and the probability of accidents at a given plant. Over the next few years, the Federal Government intends to issue general administrative rules on accident prevention for the design of such facilities. Until entry into force of these provision, an effective dose of 50 mSv has been set for the worst-case accident according to § 117, para. 18 StrlSchV.

F.4.5. Limitation and Minimisation of Operational Discharges of Radioactive Substances

Discharges

According to § 47 StrlSchV, radioactive substances may not be released into the surrounding environment of a nuclear facility in an uncontrolled fashion. As defined in § 48 StrlSchV, their operational discharge into water or air must be monitored, and registered according to specific type and activity. The discharge values specified by the competent authority in the plant's licence shall be observed with regard to concentration and quantity of radioactivity. As a rule, the actual values fall well below these limits.

The worst-case radiation exposure of an individual at the site is already used as the basis for determining the permissible discharge values at the planning stage of nuclear facilities. According to § 47, para. 1 StrlSchV, this may not exceed an effective dose of 0.3 mSv per calendar year for discharges in vent air and waste water. The calculation method for the determination of the radiation exposure is set out in a General Administrative Provision [2-1]. There is also a detailed guideline on the performance of emission and immission monitoring [3-23]. According to § 47, para. 3 StrlSchV, the permitted discharge of radioactive substances in air and water is fixed by the competent authority by limiting the activity concentration or quantity.

With respect to minimisation of dose levels, reference is made to the remarks on Article 24 1.

Clearance of Material

Whilst reporting within the context of Article 24 2. (i) and (ii) is confined to discharges from the normal operation of nuclear facilities, at this point the release from control of materials from nuclear

facilities or other authorised handling of radioactive material (clearance) shall also be mentioned because of its particular significance for waste and residual-materials management. However, clearance of solid or liquid materials in accordance with § 29 StrlSchV is not a discharge within the meaning of the definitions given in § 3, para. 2, subpara. 2 StrlSchV, or within the meaning of §§ 47 and 48 StrlSchV.

Residual materials whose activities per unit mass or area – after decontamination, where applicable – are so low that they could at most lead to insignificant (trivial) doses in the general population are produced by nuclear facilities, especially during the decommissioning and demolition phases, and in particular from the operation of facilities for the treatment of radioactive substances and spent fuel assemblies. The criterion for triviality for each clearance option is defined in § 29, para. 2 StrlSchV as an effective dose of 10 µSv per year for individual members of the general public, in conformity with the regulations according to Guideline 96/29 Euratom [1-F18]. Released materials are mainly building rubble, excavated earth, scrap and other operational waste from the dismantling or repair of nuclear facilities. Following the dismantling of facilities, clearance procedures are also applied to site areas.

Various clearance options are available for the release of materials from control. These are listed in § 29, para. 2, subparas. 1 and 2 StrlSchV, in conjunction with the requirements outlined in Appendix IV StrlSchV. Important clearance options include the unrestricted clearance of all types of solid or liquid material, clearance for disposal (on a conventional landfill site or in a thermal waste-treatment plant), the clearance of rubble or soil for recycling (e.g. in road-building), the clearance of buildings for demolition or subsequent use, etc.

The definition of the clearance levels listed in Appendix III, Table 1, columns 5 to 10a StrlSchV, related to the unrestricted release of solid materials, the release of solid materials for disposal and the release of scrap metal for recycling, is based on the recommendation of the Commission on Radiological Protection on the "Clearance of Materials, Buildings and Land Areas with Slight Radioactivity from Notifiable or Licensable Activities" [SSK 98], adopted at its 151st meeting in February 1998. The requirements for the unrestricted release and its bases are continuously adapted to the changing boundary conditions in the closed substance cycle and waste management law.

As far as there are no specific definitions of the Radiation Protection Ordinance on the clearance or no clearance values are specified in the Radiation Protection Ordinance, a so-called "case-by-case decision" (*Einzelnachweis*) of adherence to the effective dose of 10 µSv/a for individual members of the general public is to be submitted. In such cases, the dose is determined on the basis of the specific peripheral conditions at the intended site of use, recycling or disposal.

Deliberate mixing or dilution of the materials in order to achieve clearance is not permitted.

F.4.6. Measures for the Control of Releases Following Incidents and Mitigation of their Effects

Basis

According to § 51 of the Radiation Protection Ordinance, in the event of a radiological incident that is significant for safety, all necessary measures to minimise the dangers to people and the environment must be initiated at once. Furthermore, in accordance with § 6 of the "Nuclear Safety Officer and Reporting Ordinance – AtSMV" [1A-17], such an event must be notified immediately to the supervisory authority under the Atomic Energy Act and, if necessary, to the authority responsible for public safety and order, as well as to the authorities responsible for disaster control.

The function of the Incident Registration Centre at the Federal Office for Radiation Protection (BfS) is to record, document and evaluate for the BMU all events that occur in nuclear facilities and are reported by the competent supervisory authorities. This way, the BfS supports the BMU in its task of having to inform the general public about such events and contributes by its systematic evaluation to the prevention of accidents in the operation of nuclear facilities. Independent of the reporting

process according to AtSMV, events that must be reported are classified by the nuclear facility operators according to the International Nuclear Event Scale (INES) of the IAEA.

In radiological emergency situations, the competent authorities will notify potentially affected segments of the population without delay, and issue instructions on appropriate conduct. The remarks on Article 25 give an overview of the emergency measures to be taken depending on the hazard potential of the nuclear facility.

For nuclear facilities where radioactive substances are handled whose activity exceeds the exemption limits according to Appendix III, Table 1 StrlSchV by 10^7 times (in the case of open radioactive materials) or by 10^{10} times (in the case of enclosed radioactive materials), under § 53 StrlSchV the operator must also take on-site measures in preparation for damage limitation in case of safety-relevant events. These include in particular the provision of

- the necessary trained personnel for limiting and eliminating the dangers created on the plant site by accidents or incidents, and
- the necessary tools and equipment.

The readiness for action of the personnel and equipment must be proven to the competent authority.

The in-house procedure in case of an unplanned and uncontrolled release of radioactive substances into the environment must be specified in an operating manual (cf. the remarks on Article 9). The latter must include a fire protection code and an alarm code (KTA 1201; cf. list of KTA rules in the appendix, to be applied analogously here). The fire protection code must specify preventive and aversive fire-protection measures. The alarm code should outline measures and rules of conduct for events posing a potential threat to staff and the surrounding area of the facility, as well as information on alarm drills and escape routes. Furthermore, the operating manual must outline the measures initiated automatically and those which must be initiated manually by the staff on shift in the case of an accident. It should also stipulate the criteria under which it is to be assumed that important safety functions are not being performed by the systems as designed, and on-site emergency protection measures must be invoked. The incidents defined in the licensing procedure must be addressed here.

Monitoring of Emissions and Immissions during Normal Operation and in Case of Accidents

According to § 48 StrlSchV, discharges from nuclear facilities must be monitored, specified by activity and type, and this data reported to the competent authority at least once a year.

The supervisory authority responsible for the nuclear facility may order measures supplementary to monitoring, or in individual cases may exempt the facility operator from this reporting obligation, provided he can prove by demonstrating the safe enclosure of the radioactive materials or by the small radioactive inventory and the kind of work to be carried out within the facility that the limits to be kept will be safely adhered to. This applies in particular to nuclear facilities licensed under § 7 of the Radiation Protection Ordinance, such as some of the conditioning facilities and interim storage facilities for radioactive wastes in which no repairs are carried out. Other than nuclear power plants, these facilities release only little or – in individual cases - no radioactivity.

For nuclear facilities requiring licensing or planning approval under §§ 6, 7, or 9b of the Atomic Energy Act, such as the Pilot Conditioning Facility for spent fuel assemblies (PKA), the Karlsruhe Vitrification Plant (VEK) for fission products, the interim storage facilities for spent fuel assemblies, several conditioning facilities for the treatment of nuclear fuels, and repository sites, the determination of meteorological and hydrological dispersion conditions may additionally be required.

It should be noted that the Pilot Conditioning Facility PKA, in which the spent fuel assemblies are dismantled and conditioned ready for emplacement, will only be used for the time being to repair

damaged fuel-assembly casks until selection of a repository site. There is no need to consider radiation exposure here at present.

The "Guideline on Emission and Immissions Monitoring of Nuclear Facilities" (*Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen = REI*) [3-23] contains specifications on the harmonisation of monitoring and the performance thereof. The holder of the licence is responsible for monitoring and internal auditing. Independent institutions perform reference measurements on behalf of the competent supervisory authority.

Appendix C of this Guideline [3-23-2] contains supplementary specific regulations applicable to interim storage facilities for spent fuel assemblies and repository sites for radioactive wastes. It stipulates the following provisions:

Interim Storage Facilities for Spent Fuel Assemblies

Monitoring of emissions is not necessary if the leak-tightness and integrity of the fuel-assembly casks has been demonstrated and is monitored continuously. Monitoring of environmental immissions from dry-storage facilities must be regulated in such a way that the monitoring of contributions to total dosage from direct radiation of the nuclear facility is ensured.

Asse Mine

Monitoring of discharges from the Asse mine is performed via measurements of the exhaust air by means of discontinuous or continuous sampling and measurements from the exhaust air as well as continuous measurements in the bypass flow. In addition, the air flow is continuously measured. From the mine, no operational waste water is discharged. Thus, there are no corresponding discharge values for waste water.

The dominating substances in the exhaust air are radon and its decay products. However, the increase of the activity concentration in the environment is so low that it cannot be identified by measurements.

The results of emission monitoring are published annually. Table F-2 shows the discharges of radioactive materials for 2006. For exhaust air, all nuclides identified are shown in higher concentrations as in the ambient air.

Table F-2: Release of radioactive materials with exhaust air from the Asse mine in 2006

	Exhaust air/Bq
H-3	$4.9 \cdot 10^{10}$
C-14	$7 \cdot 10^8$
Rn-222	$9.2 \cdot 10^{10}$
Short-lived decay products of Rn-222 at equilibrium	$4.6 \cdot 10^{10}$
Pb-210	$9 \cdot 10^5$

Repository Site for Radioactive Wastes (Morsleben)

The principal considerations for emissions monitoring are substances such as Rn-222 and its decay products tritium and carbon-14, radioisotopes of thorium, uranium, and the transuranium isotopes, and fission and activation products (cf. Table F-3). Specifically, the discharges in the exhaust air are monitored by means of continuous measurements, discontinuous or continuous sampling, and measurement in the bypass flow or from the exhaust air/waste air. The volumetric flow of the exhaust air/waste air must also be registered. Furthermore, the discharges in waste water during specified normal operation are also monitored.

Table F-3: Release of radioactive materials with exhaust air and waste water from the Morsleben repository in 2005

	Exhaust air/Bq	Waste water/Bq
H-3	$1.4 \cdot 10^{10}$	$1.6 \cdot 10^5$
C-14	$6.4 \cdot 10^8$	-*
Long-lived aerosols	$1.1 \cdot 10^6$	-*
Radon decay products	$5.1 \cdot 10^9$	-*
Nuclide mix except H-3	-*	$2.9 \cdot 10^3$

* monitoring not required

Integrated Measurement and Information System

Besides the monitoring of emissions and immissions at the site of a nuclear facility, the Precautionary Radiation Protection Act (*Strahlenschutzvorsorgegesetz = StrVG*) [1A-5] also stipulates the Integrated Measurement and Information System for Monitoring Environmental Radioactivity (*IMIS*), which ensures comprehensive monitoring of environmental radioactivity throughout the territory of the Federal Republic of Germany. The respective responsibilities of the Federal Government and the *Länder* are specified under §§ 2 to 5 of this Act, together with the corresponding information system. The general administrative provision [2-4] for § 10 of the Precautionary Radiation Protection Act governs the acquisition and transmission of data. The two parts of the appendices of this general administrative provision regulate its precise implementation; they distinguish between a routine measurement schedule during normal operation, and an intensive measurement schedule in the event of an incident.

According to § 48 StrlSchV, the federal authorities responsible according to Appendix XIV StrlSchV, namely

- *Deutscher Wetterdienst* (German National Meteorological Service),
- *Bundesanstalt für Gewässerkunde* (Federal Institute for Hydrology),
- *Bundesamt für Seeschifffahrt und Hydrographie* (Federal Board of Shipping and Hydrography),
- *Bundesforschungsanstalt für Ernährung und Lebensmittel* (Federal Research Institute of Nutrition and Food),
- *Bundesforschungsanstalt für Fischerei* (Federal Research Centre for Fisheries), and
- *Bundesamt für Strahlenschutz* (Federal Office for Radiation Protection)

perform comparative measurements and analyses uniformly throughout the country and develop sampling, analysis, and measurement techniques. The data from emissions and immissions monitoring are grouped and documented. The German national metrology institute providing scientific and technical services (Physikalisch-Technische Bundesanstalt - PTB) provides radioactivity standards for reference measurements. Upon determining the nuclide measurements to be performed, the authorities consult the provisions of the guideline on the monitoring of emissions and environmental concentrations for nuclear facilities as an orientation guide.

The IMIS comprises an automatic measurement network consisting of more than 2000 stationary measurement stations for monitoring the local gamma dose rate and measurement networks for determining the activity concentration in the air, precipitation, and the aqueous environment. In addition, the radioactivity in food, fodder, drinking water, as well as in residual substances and waste waters, is determined. Centralised data logging is performed at the Federal Central Station for Monitoring Environmental Radioactivity (*Zentralstelle des Bundes zur Überwachung der Umweltra-*

dioaktivität) at the Federal Office for Radiation Protection in Neuherberg. The BMU evaluates the data. If threshold values are exceeded, the BMU decides on activation of intensive operation in IMIS. In the case of an event, the *Länder* are alerted by the BMU.

F.5. **Article 25. Emergency Preparedness**

Article 25. Emergency preparedness

1. *Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.*
2. *Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.*

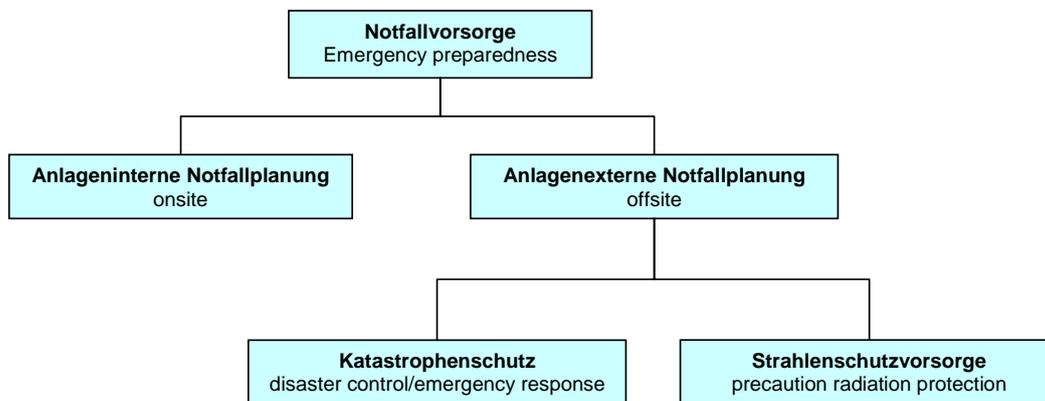
F.5.1. **Internal and External Emergency Plans for Nuclear Facilities**

Basis

In Germany, a concept of nuclear emergency preparedness has been established which is naturally geared primarily around nuclear power plants. In principle, these rules are applicable to any nuclear facility; however, the effort required may be reduced for the nuclear facilities under consideration here, because their hazard potential is substantially lower in some cases.

Nuclear emergency preparedness comprises on-site and off-site planning and preparedness for emergencies (cf. Figure F-4).

Figure F-4: Structure of emergency preparedness



On-site emergency preparedness is realised by technical and organisational measures taken at nuclear power plants to control an event or to mitigate its consequences.

Off-site emergency preparedness comprises disaster control and precautionary radiation protection. Disaster control serves for averting imminent danger. Precautionary radiation protection aims at coping with consequences of unplanned radiological releases below reference levels for short-term measures by means of precautionary protection of the population and serves for preventive health protection.

Regulatory Basis

Based on the regulations of the Atomic Energy Act [1A-3] and § 51 StrlSchV [1A-8], the operator is responsible - within the framework of on-site emergency preparedness - to keep the risk of potential hazards for man and the environment as low as possible in case of incidents and accidents.

Under § 12 of the Atomic Energy Act [1A-3] and § 51 of the Radiation Protection Ordinance, the operator of any nuclear facility must inform its competent supervisory agency without delay of any safety-relevant deviations from specified normal operation, particularly accidents, hazardous incidents, or radiological emergency situations. He should also notify the authority responsible for public safety and the agency responsible for disaster control in the *Land* concerned, if necessary.

The alarm criteria which, when reached, require alerting the disaster control authorities, are based on a joint recommendation of RSK and SSK on criteria for alerting the disaster control authority by the operator of a nuclear installation (*Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer Einrichtungen*) [SSK 04c].

According to § 53 StrlSchV [1A-8], no special emergency preparedness measures are required for a nuclear facility if the activity of the radioactive substances handled there does not exceed certain limits. These limits are:

1. 10^7 times the exemption limits for activity according to Appendix III, Table 1, column 2 StrlSchV in the case of open radioactive materials,
2. 10^{10} times these exemption limits in the case of enclosed radioactive materials.

In principle, therefore, some of the nuclear facilities for the management of radioactive waste do not require emergency preparedness planning at all, since the possibility of safety-relevant events can be excluded. These are usually facilities subject to licensing under § 7 of the Radiation Protection Ordinance.

Within the German Federal Government, the BMU is responsible for the provision of general criteria for the preparation of emergency plans for the surroundings of nuclear facilities.

For disaster control measures and actions under the Precautionary Radiation Protection Act (StrVG) [1A-5] in case of accidents in installations in Germany and abroad, there is a catalogue of measures of the BMU entitled "Overview of measures for the mitigation of radiological exposure following incidents or accidents with non-negligible radiological consequences" [BMU 99] and [SSK 05].

In accordance with the provisions of EU Directive 89/618 EURATOM [1F-29], § 51, para. 2 StrlSchV specifies that the affected population must be informed without delay of a radiological emergency situation and any special conduct which may be required on their part. The individual disaster control agencies will jointly agree and coordinate the process of notifying the general public.

As part of emergency preparedness, disaster-control and radiation prevention measures may be initiated if necessary when the alarm is raised. Correspondingly, guideline [3-15]

1. provides framework recommendations for disaster control in the vicinity of nuclear facilities, and
2. specifies radiological foundations for decision-making to determine which measures should be taken to protect the population.

When specifying the radiological foundations for the recommendation of radiation prevention measures in [3-15], fixed numerical values for recommended intervention reference levels have been adopted, based on the recommendations in publications no. 63 and no. 40 of the ICRP ([ICRP 93] and [ICRP 84]) and the International Basic Safety Standards [IAEA 96], which are designed to facilitate decision-making at the start of measures and which can be adjusted later on if

necessary (cf. Table F-4). This is consistent with the approach adopted by the European Commission.

Table F-4: Intervention reference levels for the measures of sheltering, taking iodine tablets, evacuation as well as temporary and long-term resettlement from [SSK 99]. The application of the intervention reference level of 50 mSv to children and adolescents under the age of 18 corresponds to a later SSK recommendation of 2001 [SSK 01].

Measure	Intervention reference levels		
	Organ dose (thyroid)	Effective dose	Integration and exposure paths
Sheltering		10 mSv	External exposure over 7 days and effective consequential dose due to radionuclides inhaled during this period
Taking iodine tablets	<p>50 mSv Children and adolescents up to the age of 18 as well as pregnant women</p> <p>250 mSv Individuals from 18 to 45 years</p>		Radioactive iodine inhaled during a period of 7 days, including consequential equivalent dose
Evacuation		100 mSv	External exposure over 7 days and effective consequential dose due to radionuclides inhaled during this period
Temporary resettlement		30 mSv	External exposure over 1 month
Long-term resettlement		100 mSv	External exposure over 1 year due to deposited radionuclides

For immediate decision-making, dose intervention reference levels are supplemented by measurable parameters, the so-called "derived reference levels".

Suitable parameters are:

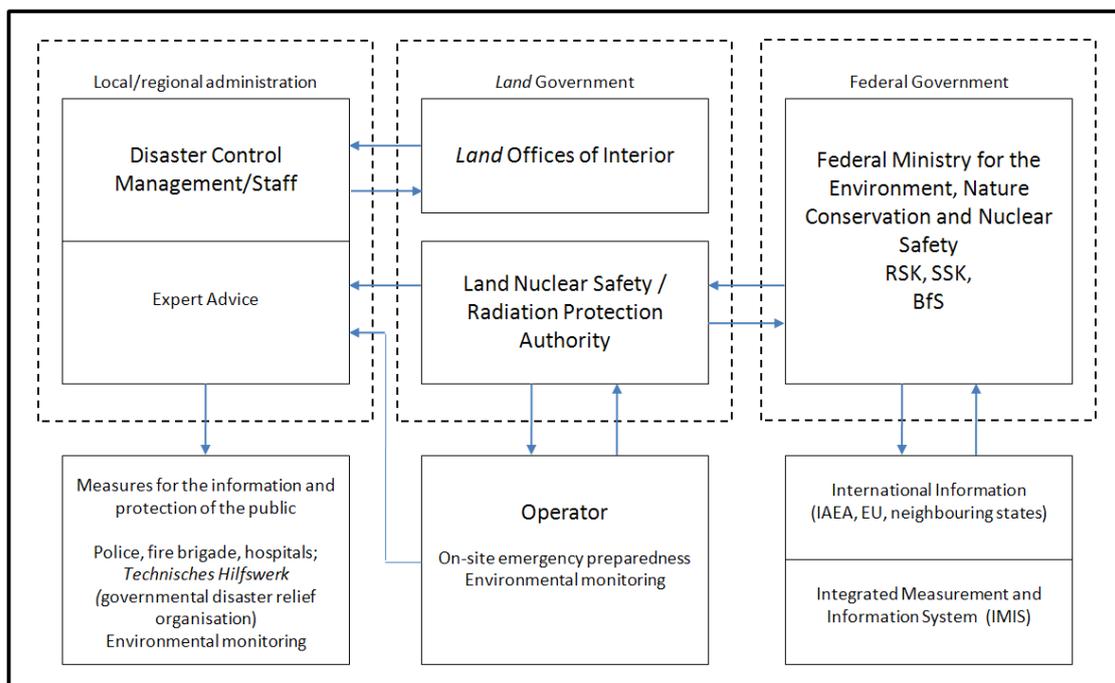
- local dose rate,
- (time-integrated) activity concentrations in the air,
- surface contamination (ground, objects, skin).

Extensive measures of external emergency preparedness, e.g. preparation of an off-site emergency plan, may not be required if the calculated effective doses for design basis accidents and events with low occurrence probability in the vicinity of a facility are significantly below the limit values of radiation exposure after design basis accidents as defined in §§ 49 and 50 StrlSchV. The decisions are taken by the competent licensing and supervisory authorities for the nuclear facilities in the *Land* concerned.

Organisation

The overall organisation of emergency preparedness is governed by co-operation between the Federal Government and the governments of the *Länder*, regional government agencies, the police, *Technisches Hilfswerk* (the governmental disaster relief organisation), fire fighters, hospitals, and the operator of the nuclear facility. While the operator is responsible for on-site emergency preparedness, off-site emergency preparedness outside the facility is the responsibility of the *Länder* authorities (as part of disaster control). Temporally and geographically limited disaster control measures are co-ordinated and performed by the *Länder* authorities, the regional government agencies, and in particular the management of the disaster control services. This requires a precise knowledge of the state of the facility and an evaluation of the radiological situation and the situation in the areas affected.

Figure F-5: Organisation of emergency preparedness



Responsibilities of the Federal Government and the *Länder*

In case of need, the BMU makes its resources, including those of the BfS or its advisory committees RSK and SSK, available for providing support and advice to the *Länder*.

The basic recommendations for disaster control are prepared under the leadership of the BMU and involvement of the *Länder*.

Within the framework of precautionary radiation protection, the Federal Government is authorised to specify limits and measures. However, as far as events with exclusively regional impact are concerned, the *Land* authority competent for precautionary radiation protection may determine measures to be taken for preventive health protection. By means of the Integrated Measurement and Information System for the Monitoring of Environmental Radiation (IMIS), the Federal Government monitors and assesses the radiological situation in Germany both during routine operation and under incident and accident conditions (cf. the remarks on Article 24). In case of need, the data are transmitted to the corresponding federal and regional civil protection authorities and the measuring frequency of the IMIS is increased.

If a radioactive release from abroad reaches German territory, alerting of the *Länder* is ensured on the one hand by the Federal Government which is informed on the basis of bilateral and international agreements if an event occurs, and on the other hand in parallel by the Integrated Measuring and Information System (IMIS-IT System).

It is the task of the competent government agency in a given *Land* to specify the nature and scope of emergency preparedness, taking into account the specific requirements of the respective nuclear facility. The criteria for the nature and scope of emergency planning are determined in particular by the radioactive inventory of the nuclear facility and the likelihood of an accident or hazardous incident occurring.

In the individual *Länder*, either a medium-level or a lower-level agency is responsible for disaster control. In accordance with the Disaster Control Act (*Katastrophenschutzgesetz*) of that particular *Land*, alarm and action plans must be drafted and updated, if required, by the agency responsible to serve as off-site emergency plans for the nuclear facilities within its jurisdiction. The off-site emergency plans should specify all measures scheduled by the competent disaster-control authority in the case of accidents or hazardous incidents in the corresponding facility.

The competent authority for the emergency preparedness of a nuclear facility has to nominate an "expert radiation protection consultant to the disaster response management". This person collects, verifies and assesses all information relevant in connection with an accident and consults the disaster response management with regard to the radiological situation. The work of this person is based on the guideline for the expert radiation protection consultant [SSK 04a], [SSK 04b], which is modified in line with the special requirements of the respective nuclear waste management facility.

Upon drawing up off-site emergency plans, the competent civil protection authorities consult the general recommendations, the corresponding civil-protection legislation of the respective *Land*, and the responsibility assignment plans regulating the co-operation among the different *Land* authorities. The off-site emergency plans show the competences and responsibilities for management on location, for crisis team management, for the alerting criteria as well as for the definition of the necessary civil-protection measures.

To limit the extent of preparatory measures, the surrounding area of the plant is divided into three zones:

- According to the basic recommendations for disaster control, the central zone should not exceed a radius of 2 km around the plant. This, however, depends on the local conditions.
- Adjacent to this central zone there is the intermediate zone with a radius of 10 km around the plant and
- the outer zone with a radius of 25 km.

In a radius of 25 to 100 km around nuclear power plants, iodine tablets are held in stock in seven central stores and made available, if required, for iodine blockage.

In an emergency case, a "risk zone" is defined on the basis of the results of an assessment of the situation, taking into account the constantly updated information and data on the conditions inside the plant, meteorological conditions, and the status of emissions and immissions.

Taking into consideration the safety report of the plant, the on-site emergency plan, and other information from the operator, as well as the exchange of views with the competent supervisory authority for the nuclear facility, the disaster-control agency may decide that it is not necessary to draw up an off-site emergency plan. This waiving of off-site emergency planning must be justified in detail by the agency. In such cases, potential accidents are covered by the measures for general disaster control which must be planned regardless of the hazard potential of specific facilities.

If an off-site nuclear emergency preparedness plan is drawn up for a nuclear facility, this has to be continuously updated and reviewed at regular intervals. At intervals of several years, the authori-

ties carry out civil protection exercises at the sites of the nuclear facilities in order to verify the efficiency of the emergency preparedness plans and identify weak points (cf. Figure F-6). The operators also take part in these exercises. Appendix XIII Part B StrlSchV stipulates that the population has to be informed periodically every five years about the emergency preparedness plans.

Figure F-6: Decontamination of fire brigade staff during emergency exercises (Copyright: Freiwillige Feuerwehr Wennigsen (Deister, Lower Saxony))



Responsibilities of the Operator

The operator develops the on-site emergency plan in the emergency manual and the alarm code as part of the operating manual of the nuclear facility and must keep them up to date. In detail, emergency planning has to regulate: duties and responsibilities, criteria for triggering alarms and for taking plant-internal measures, the information flow to the crisis team and to the civil protection authority, and special stipulations for the plant's emergency staff.

Further, in accordance with § 53 StrlSchV, the operator must have trained personnel and any tools which may be required on hand for controlling emergency situations, and must provide the authorities responsible for emergency preparedness with the information necessary to deal with an incident. He must assist the competent authorities in planning emergency measures, and inform them of possible risks when deploying helpers, and of protective measures required.

The plant operator alerts the civil protection service of the competent *Land* authority after an emergency situation occurred or if there are concerns that such a situation may happen. He recommends to the civil protection service which level of alarm should be raised, either an early warning or an emergency alert.

Various different on-site emergency exercises are carried out at regular intervals, with an increasing use of simulations. Depending on the type of exercise, authority representatives are also involved.

Specifically for the case of fire-fighting, the operator must agree necessary measures in advance in co-operation with the competent *Länder* authorities, the fire service, or the mine rescue service (in the case of repositories). In this respect, it is particularly important to clarify the special equipment required for fighting fires in the individual areas of the facility.

Plant-Related Implementation

The central interim storage facilities for spent fuel assemblies in Ahaus and Gorleben, the North Interim Storage Facility (*Zwischenlager Nord*), and the interim storage facility in Jülich are not subject

to any special nuclear emergency preparedness planning, despite the fact that their radioactivity inventories exceed the limits given in § 53 of the Radiation Protection Ordinance. On-site emergency plans exist for all central interim storage facilities. Since the individual fuel-assembly casks are already designed to withstand external impacts, a safety-related event involving releases that would necessitate emergency protection measures need not be postulated, neither for the case of a design basis accident nor for very rare events such as an aircraft crash or a blast wave caused by an explosion. Studies have shown that the values obtained lie well below the accident planning levels according to § 49 StrlSchV. Disaster control falls under the general disaster-control planning of the *Länder* agencies.

In principle, the same applies to on-site interim storage facilities at nuclear power plants as to the central interim storage facilities for spent fuel assemblies. However, these facilities are already covered by the extensive emergency preparedness plans of the nuclear power plants.

The Pilot Conditioning Plant for spent fuel assemblies in Gorleben will not require special measures of off-site emergency preparedness if it becomes operational. The cell wing of the facility is in a bunker and safeguarded against external impacts, in particular against an aircraft crash. In the wing housing the container storage area, protection is safeguarded by the design of the type-B packages. Other accidents involving a release of a relevant scope have been studied. They do not lead to any consequences requiring special emergency preparedness planning.

Nor are there any specific emergency plans available for the Morsleben repository site, in view of the safety-relevant events conceivable there.

The nuclear facilities for the management of highly active fission product solutions within the grounds of the Karlsruhe reprocessing plant (WAK) that are to be turned into vitrified HAW in the Karlsruhe Vitrification Plant (the VEK, which is not yet operational) have – together with the European Institute for Transuranic Elements (ITU) – off-site emergency preparedness plans drawn up in accordance with the regulatory specifications. The VEK building is designed and laid out against external and internal impacts in such a way that the safety-related requirements are fulfilled during normal specified operation and under accident conditions. For the transport and interim storage of the vitrification products produced in the VEK, casks are available which comply with the protection objectives for type-B packages and thus ensure adherence to the most relevant regulations for safe transport and interim storage.

F.5.2. Emergency Plans for the Case of Incidents in Nuclear Facilities of Neighbouring States

The basic recommendations for disaster control in the vicinity of nuclear facilities (*Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen*) [3-15] also apply to foreign nuclear facilities requiring planning measures on German territory because of their proximity to national borders. Admissible releases during normal specified operation and under accident conditions are a matter at discretion of the respective country's own legislation. In Germany, international regulations were considered from the start when the limits in the StrlSchV were defined.

The precautions in case of accidents in waste-disposal facilities on neighbouring foreign territory correspond to those applicable to other nuclear facilities, such as nuclear power plants remote from the frontiers. In order to determine the measures necessary under the Precautionary Radiation Protection Act [1A-5], a list of measures [BMU 99], [SSK 05] is applied which includes the necessary instructions on estimating the consequences and on planning measures to be taken.

On the basis of bilateral agreements, the authorities of neighbouring countries are involved in exercises in plants near the border, at least as observers, but usually as active participants. In addition, BMU officials are involved in EU and OECD/NEA (INEX exercises) exercises in order to gather relevant international experiences with a view to updating emergency preparedness planning in Germany.

Since the early 1980s, the Federal Republic of Germany has entered into bilateral agreements with all adjoining states, and some countries further away, regarding mutual assistance in case of disasters or major accidents ([1D-1], [1D-2], [1D-3], [1D-4], [1D-5], [1D-8], [1D-9]). These agreements specify the responsibilities and points of contact, guarantee cross-border traffic of personnel and resources deployed, and stipulate mutual exclusion of liability in case of personal injury or property damage, and agree a comprehensive exchange of information and experiences. In the years following German re-unification, agreements have also been signed with Poland [1D-10], Hungary [1D-6], Lithuania [1D-7] and Russia [1D-11], and a treaty agreed with the Czech Republic [1D-12].

Germany also has an agreement with France on the exchange of information in case of events or accidents with radiological effects dating from 1981, and an administrative agreement without binding effect under international law dating from 1976.

In addition, there are agreements with neighbouring states on the exchange of information and experience in connection with safety engineering or radiation protection, all of which were concluded prior to 1985 [BMU 99a]. There is also a superordinate European regime governing radiological emergencies.

F.6. Article 26. Decommissioning

Article 26. Decommissioning

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility.

Such steps shall ensure that:

- (i) qualified staff and adequate financial resources are available;*
- (ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;*
- (iii) the provisions of Article 25 with respect to emergency preparedness are applied;*
- (iv) records of information important to decommissioning are kept.*

F.6.1. Basis

Introduction

The following account collectively outlines the provisions which apply to safety during the decommissioning and dismantling of nuclear installations. The term “decommissioning” is hereafter understood in the meaning of this Convention (Article 2 (b)) in a broad sense and covers the final shut-down of the plant, the transition phase and the dismantling as well as all measures leading to the plant or the site being released from nuclear regulatory control.

Legal Basis

In Germany, the legal bases for licensing procedures for the decommissioning of nuclear facilities are the Atomic Energy Act (AtG) [1A-3], statutory ordinances promulgated on the basis AtG, as well as general administrative provisions. § 7, para. 3 AtG contains the basic requirement for the licensing of decommissioning. It stipulates that for any installation which has been licensed according to § 7, para. 1 AtG, the decommissioning, safe enclosure or dismantling of that installation or of parts thereof once operation has been permanently suspended shall require a licence. Here too, a consideration of the state of the art in science and technology is retained as a guiding principle.

The licensing procedure for the decommissioning of nuclear facilities is governed by the Ordinance Relating to the Procedure for the Licensing of Facilities in Accordance with § 7 of the Atomic Energy Act (*Atomrechtliche Verfahrensverordnung, AtVfV*) [1A-10]. It contains regulations pertaining

to decommissioning, particularly with regard to third party involvement and environmental impact assessment (EIA).

The pre-requisites which have to be fulfilled for issuing a decommissioning licence are listed in § 7, para. 2 AtG. As stipulated in § 7, para. 3 AtG, they accordingly pertain to decommissioning as for erection and operation of such a plant. The legislator has put the issuance of a licence according to § 7, paras. 1 and 3 AtG under the reserve of § 7, para. 2 AtG (“A licence may only be granted if” the pre-requisites of § 7, para. 2 AtG have been fulfilled). This emphasises the particular weight that is given to erection and operation as well as to decommissioning, safe enclosure and dismantling of a nuclear installation by the legislator. Other licences regulated by the Atomic Energy Act (e.g. §§ 5 and 6 AtG) or by the Radiation Protection Ordinance (StrlSchV) (§§ 7 and 9 StrlSchV [1A-8]) are not furnished with such a reserve (“A licence shall be granted if” the pre-requisites are fulfilled).

Dismantling of any buildings or rooms at the site of a nuclear installation where handling or storage of fissile material or other radioactive substances took place and which are covered by the operating licence is carried out within the scope of § 7, para. 3 AtG.

Apart from the AtG, the Radiation Protection Ordinance (StrlSchV) is also relevant for the decommissioning of other nuclear installations, as it specifies technical and operational measures, procedures and precautions to prevent damage caused by ionising radiation. This includes the definition of the principles of radiation protection, the regulations concerning transport and transboundary shipment of radioactive materials, for clearance, for knowledge in radiation protection, for in-plant organisation of radiation protection, for protection of individuals in radiation protection areas, including physical supervision of radiation protection, for the protection of the general public and the environment, for the protection against significant safety-related events as well as for radioactive wastes.

The implementation of licensed decommissioning activities of nuclear installations is monitored by the supervising authority.

Hazard Potential of Nuclear Installations during the Decommissioning Phase

The decommissioning of a nuclear installation is characterised by a continuous decrease in the plant’s radionuclide inventory, mainly by means of removal of the fuel assemblies, final removal of any residual radionuclides above clearance levels and the release from nuclear regulatory control. Moreover, there are largely no energy potentials for the dispersion of the radioactive inventory since, contrary to the operational phase, the installation is cold and pressureless. Generally speaking, this coincides with a continuous decrease in the hazard potential as dismantling progresses. Allowance is made for this fact by including specific decommissioning regulations and recommendations in the sub-statutory regulatory framework, as well as by application of the existing regulatory framework or by revoking supervisory regulations and requirements during the licensing and supervision procedure in line with the decreasing hazard potential.

Measures to Ensure Safety during Decommissioning of Nuclear Installations

The information contained in this report with respect to

- Article 18 (Implementing measures),
- Article 19 (Legislative and regulatory framework),
- Article 20 (Regulatory body),
- Article 21 (Responsibility of the licence holder),
- Article 22 (Human and financial resources),
- Article 23 (Quality assurance),

- Article 24 (Operational radiation protection) and
- Article 25 (Emergency preparedness)

also applies analogously to the decommissioning of nuclear installations. The accounts given in this report with respect to the aforementioned Articles also apply – either partially or in full – to the decommissioning of nuclear installations. Generally speaking, the same general safety standards apply during decommissioning of a nuclear facility as to its operational phase, although there are some significant differences in certain details. For example, the option of criticality no longer applies to nuclear reactors once all fuel assemblies have been removed from the plant, and the level of radioactivity which is discharged to the environment with authorised liquid and gaseous releases usually is considerably lower. Safety requirements and the implementation thereof are addressed in the remarks on Article 4.

Article 15 (Assessment of safety of facilities) of this Convention is also relevant with regard to the fact that during the decommissioning phase of a nuclear facility, it may become necessary to construct new radioactive waste management facilities. The requirements of Article 15 concerning assessment of the safety of such facilities and their environmental impact prior to construction and commission likewise apply to facilities for the treatment of radioactive waste which are constructed when decommissioning nuclear installations (cf. the remarks on Article 15). Likewise, the requirements of Article 16 (Operation of facilities) of this Convention concerning the operation of radioactive waste management facilities also apply analogously to the decommissioning phase (cf. the remarks on Article 16).

The Guide to Decommissioning of Facilities under § 7 of the Atomic Energy Act (AtG) [3-73] has been adopted as a consensus between the Federal Government and the authorities of the *Länder* to foster an effective and harmonised approach in licensing procedures for decommissioning. It pursues the following aims:

- to compile the aspects of licensing and supervision which are relevant in decommissioning procedures,
- to develop a common understanding between the Federal Government and the *Länder* how to carry out decommissioning procedures, and
- to harmonise the opinions and approaches as far as possible.

In particular, the Guide contains proposals for a practical approach concerning decommissioning as well as the safe enclosure and the dismantling of nuclear installations according to § 7 AtG with respect to the application of the sub-legal regulatory framework, the planning and preparation of decommissioning measures as well as licensing and supervision.

The nuclear rules and regulations deal with the two decommissioning options of direct dismantling and later dismantling after safe enclosure equally. The Federal Government and the *Länder* are in favour of the direct dismantling. The operators keep the two options equally open.

F.6.2. Availability of Qualified Staff and Adequate Financial Resources

Experience gleaned from various decommissioning projects of nuclear installations in Germany shows that the expert knowledge of the plant's operating staff is extremely valuable for the safe and efficient execution of decommissioning and dismantling. For this reason, the operator aims at involving the operating staff in the decommissioning phase as far as possible.

The manner in which the availability of financial resources is secured for the decommissioning phase differs between publicly-owned installations and installations belonging to the private power utilities:

- The decommissioning of publicly-owned facilities is financed from the current budget. For most projects (Table F-5), the Federal Government covers the bulk of the costs. Financing includes

all expenses incurred for the post-operational and transition phase, disposal of the fuel assemblies, execution of the licensing procedure, dismantling of the radioactive part of the facility, and disposal of the radioactive wastes, including all preparatory steps.

- The financial resources for facilities belonging to the privately owned power utilities, in particular nuclear power plants, are provided in the form of reserves built up during the operational phase. The formation of reserves according to commercial law is based on the obligation under public law to ultimately remove the radioactive part of the facility, which is derived from the Atomic Energy Act. The existence of reserves for decommissioning guarantees that financial provisions will be available for decommissioning and dismantling after electricity production has been terminated and there are no further revenues from electricity charges. At the same time, the formation of reserves serves to assign the costs for decommissioning and dismantling, which are ultimately caused by electricity production itself, to the operational phase. Further reserves are formed for the disposal of the fuel assemblies.

The power utilities manage decommissioning and dismantling (with the exception of the disposal of radioactive waste) at their own responsibility, under the supervision of the competent authorities. The allocation of reserves for the decommissioning of nuclear power plants covers all costs associated with dismantling of the plant itself. This includes the costs of the post-operational phase in which the facility is prepared for dismantling after its final shut-down (including removal of fuel assemblies and operational wastes), the costs for the licensing procedure and supervision, the costs of dismantling (dismantling and interim storage of all components and all buildings of the controlled area), and the cost of the interim and final storage of all radioactive wastes from decommissioning. The total amount of costs is estimated from cost studies which are updated regularly by the power utilities, with due regard for technical advancements and general price trends. These cost estimates are checked by the fiscal authorities with regard to the fiscal effects.

- The above remarks also apply analogously to commercially operated fuel cycle facilities and waste handling plants.

Table F-5: Research facilities in which nuclear installations are operated or decommissioned and which are financed from public funds

Research facilities	Short description	Normal funding
Research Centre Karlsruhe (FZK)	Founded in 1956 as " <i>Kernforschungszentrum Karlsruhe</i> "; initial research topics: development of heavy and light water reactors. Current research in numerous fields outside nuclear technology. The "Nuclear Facilities Decommissioning" department carries out the decommissioning and dismantling of research reactors: FR-2, MZFR, KNK II (At the FZK premises, there are also the Karlsruhe Reprocessing Plant (WAK) and the vitrification plant (VEK). Operator is the EWN GmbH; cf. Chapter D.5.)	Federal Republic of Germany, <i>Land</i> Baden-Württemberg

Research facilities	Short description	Normal funding
Research Centre Jülich (FZJ)	Founded in 1956 as “ <i>Kernforschungsanlage Jülich</i> ”; initial research topics: development of high temperature reactors. Current research in numerous fields outside nuclear technology. Decommissioning of the research reactors FRJ-2 and FRJ-1 (At the FZJ premises, there is the nuclear test reactor (AVR). Owner of the facility in the process of decommissioning is the AVR GmbH whose sole member is the EWN GmbH.)	Federal Republic of Germany, <i>Land</i> North Rhine-Westphalia
Research Centre Geesthacht (GKSS)	Founded in 1956 as “ <i>Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt</i> ” (Company for exploitation of nuclear energy in shipbuilding and navigation), operation of the nuclear ship “Otto Hahn”. Current research topics in the fields of traffic and energy technology, process and biomedical technology, water and climate in coastal regions. Operation of the research reactor FRG-1, decommissioning of the research reactor FRG-2, execution of the storage and disposal of radioactive wastes from the nuclear ship Otto Hahn	Federal Republic of Germany, <i>Länder</i> Schleswig-Holstein, Lower Saxony, Hamburg, Bremen
Helmholtz Zentrum München, Neuherberg	Founded in 1964 as “ <i>Gesellschaft für Strahlenforschung</i> ” (GSF) (Company for Radiation Research) for the construction and operation of radiation research facilities and carrying out research into the underground storage of radioactive waste; safe enclosure of the research reactor FRN; current research topics in environmental and health research. With effect from 1 January 2008, the GSF was renamed Helmholtz Zentrum München - German Research Center for Environmental Health.	Federal Republic of Germany, Free State of Bavaria
Hahn Meitner Institute Berlin (HMI)	Founded in 1959; current research topics in the areas structural research, material sciences etc.; operation of the research reactor BER II	Federal Republic of Germany, <i>Land</i> Berlin
Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V. (VKTA), Dresden	Founded in 1957 as the “ <i>Zentralinstitut für Kernforschung</i> ” (Central Institute for Nuclear Research) of the GDR; was restructured into the Research Centre Rossendorf (today Forschungszentrum Dresden-Rossendorf (FZD) e. V.) and the <i>Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V. (VKTA)</i> following reunification. VKTA carries out the decommissioning of the research reactor RFR and of the AMOR facilities; the zero-power research reactors RRR and RAKE have already been fully dismantled and removed	VKTA: Free State of Saxony
Various universities	Operation / decommissioning of smaller research reactors	Federal Republic of Germany, respective <i>Länder</i>

In all cases, the personnel expenditure is included in full in the calculated funds, whereby personnel costs may account for 50 % of the total costs, and in some decommissioning projects even more. In analogy to operation, the availability of the required numbers of qualified personnel for all tasks is thus guaranteed for the decommissioning phase as well. Education and training courses for achieving and maintaining the required expert knowledge, as well as research and education at universities and technical colleges, help to preserve the high standards of education and qualification in Germany. This will continue to apply in the light of the planned phase-out of nuclear power (cf. the remarks on Article 22 (i)).

In this field, considerable progress has been made in the last years which are summarised in Section F.7.

F.6.3. Radiation Protection during Decommissioning

The provisions applicable to radiation protection of a nuclear facility which is in the process of decommissioning are similar to those which apply during the operating period. Full details can be found in the remarks on Article 24 (Operational radiation protection) of this Convention.

With regard to discharges from a nuclear installation during decommissioning, the same requirements apply as during operation. § 47, para. 1 of the Radiation Protection Ordinance (StrlSchV) prescribes limits governing the maximum doses per calendar year caused by the release of radioactive substances with air or water from these facilities or installations applicable to individual members of the general public. According to § 47, para. 1 StrlSchV, provisions must be taken in order to prevent the uncontrolled discharge of radioactive substances. According to § 47, para. 3 StrlSchV, the permissible discharge of radioactive substances with air and water is determined by the competent authority by limiting the activity concentrations or quantities.

The requirements pertaining to the control of emissions and immissions are regulated in § 48 StrlSchV.

F.6.4. Emergency Preparedness

The extent of the measures for emergency preparedness during decommissioning of a nuclear facility is adapted in line with the hazard potential posed by the facility. Essentially, however, such measures do not differ from the measures for emergency preparedness during operation (cf. the remarks on Article 25 of this Convention).

F.6.5. Keeping of Records

The keeping of records of information important to decommissioning concerns, firstly, records pertaining to the construction and operation of the nuclear facility which will need to be accessed later in the decommissioning phase; and secondly, records generated during decommissioning and which are relevant to the long-term documentation of decommissioning itself. In the following account, those two issues are dealt with separately.

Keeping of Records of Information Pertaining to Construction and Operation

Records of information and documentation pertaining to the construction and operation of nuclear power plants are regulated in KTA rule 1404 "Documentation during the Construction and Operation of Nuclear Power Plants" (cf. the list of KTA rules in the Appendix). The need for all relevant documentations to be kept available is derived from criterion 2.1 of the Safety Criteria [3-1] which stipulates that all documentation necessary for quality assessment must be kept available. This requirement is specified in KTA rule 1404:

"The documentation arising during the construction and operation of nuclear power plants comprises all technical documents and other data carriers which will serve as proof in the licensing and supervisory procedure. As a general principle, the documents needed to assess the quality of design, manufacture, construction and testing as well as of the operation and maintenance of safety-relevant plant parts must be kept available throughout the plant's entire lifetime.

The purposes and functions of documentation are to

- a) indicate the existence of or compliance with statutory prerequisites (e.g. licensing prerequisites in accordance with § 7, para. 2 of the Atomic Energy Act (AtG))
- b) describe the desired state of the plant and essential processes during its construction,
- c) permit an assessment of the actual state of the plant,

- d) represent the facts required for the safe operation of the plant,
- e) permit feedback of experience.”

These records also include the documentation of operation. In addition, KTA 1404 stipulates the following with respect to the completeness of documentation and the updating thereof:

“The documents compiled shall be complete with respect to the safety-related information contained therein and shall describe both the desired values and the actual state of the plant and its parts.

The applicant or licensee shall be responsible for the preparation, maintenance and updating of the documentation.“

This means that not only the state of the plant at the start of operation must be fully documented but that this documentation must also be adapted to all changes and must reflect the actual state of the plant at all times. This ensures that all relevant information from the operating phase is available when required for the decommissioning phase. KTA 1404 further specifies that the documentation must be safely kept at a place and in a form suitable for long-term storage, and that a secondary set of documents must be retained at a place where it is not endangered by any impact that may originate from the plant. The period for which records have to be kept depends on the type of documents and ranges from 1 to 30 years.

These requirements also apply analogously to other types of nuclear installations in the scope of this Convention. Within the context of nuclear regulatory supervision, the competent authority satisfies itself that the records have been duly updated and correctly filed.

Keeping of Records of Information from the Decommissioning Phase

As for the operating phase, information from the decommissioning phase which have to be kept for longer periods of time cover a number of topics, such as operation, surveillance and radiation protection, in particular:

- protocols from the shifts,
- protocols of surveillance and measurements of activity releases,
- reports on accidents and incidents as well as the chosen countermeasures,
- record keeping of measurements of individual doses and body doses,
- record keeping on extraction, production, acquisition, transfer and other dispositions of radioactive substances,
- protocols of contamination measurements according to § 44 StrlSchV in cases where limits were exceeded.

Record keeping on extraction, production, acquisition, transfer and other dispositions of radioactive substances which is regulated in § 70 StrlSchV is of particular relevance for the decommissioning phase. § 70, para. 6 requires that such records must be kept for 30 years from the date when the material referred to is removed from the facility or when the clearance procedure has been completed. Records and documentation must be deposited with the competent authority at the request of the latter.

§ 70, para. 6 StrlSchV further requires that the records and documentation must be deposited at a place designated by the competent authority without delay if activity ceases prior to the end of the prescribed period. This ensures that the relevant documentation is still kept for the required period even if the operator of a nuclear facility no longer exists.

F.7. Progress and Major Changes since the Last Review Meeting

F.7.1. Human and Financial Resources

From 2005 to 2007, a total of nine vacant or new professorships were offered within the framework of endowed professorships by the Universities Aachen, Dresden, Karlsruhe, Munich, Stuttgart, Clausthal-Zellerfeld, partly with substantial financial support of the industry, in the fields of reactor safety, reactor technology, radiochemistry, repository systems and radiobiology. For the universities, endowed professorships are an approach to practice-oriented teaching and research. The sponsor benefits from his endowment from an economic and communicative point of view. The endowed professorships are appointed permanently via an appointment procedure. In general, the professorships are endowed for five years. After that, the endowed professorship continues to be financed from *Land* resources. The basic idea of this co-operation is to maintain and further develop the competence in the field of nuclear technology in Germany.

The number of students in the field of nuclear technology considerably increasing in recent years at different universities correlate with this, also as, for example, the commissioning of the nuclear training reactor AKR-2 of TU Dresden on 1 July 2005 which mainly serves the training of students in basic nuclear and reactor technology and is also used for research projects. The new facility replaces AKR-1 which was operated from 1978 to 2004. With the construction of the AKR-2, the most modern nuclear training reactor in Germany is available to the scientists and students at TU Dresden.

F.7.2. Clearance

In [SSK 06], the Commission on Radiological Protection (SSK) recommended new clearance levels for disposal considering the advanced state in waste disposal technology and the changed legal framework conditions. Four clearance levels were recommended for each radionuclide, for the disposal at a waste dump or an incineration plant and for masses up to 100 Mg and 1 000 Mg per calendar year. It is intended to incorporate these clearance levels in Appendix III, Table 1 StrlSchV [1A-8] as Columns 9 a to d to replace the current Column 9.

F.7.3. Decommissioning Guideline

The guideline for decommissioning, safe enclosure and dismantling of plants or plant components according to § 7 AtG was revised and is to replace the corresponding guideline of 1996 after its publication scheduled for 2008.

G. Safety of Spent Fuel Management

This section deals with the obligations according to Articles 4 to 10 of the Convention.

G.1. Article 4. General Safety Requirements

Article 4. General safety requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

- (i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;*
- (ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;*
- (iii) take into account interdependencies among the different steps in spent fuel management;*
- (iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;*
- (v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;*
- (vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*
- (vii) aim to avoid imposing undue burdens on future generations.*

G.1.1. Basis

The fundamental concepts of precaution regarding spent fuel management are laid down in the Atomic Energy Act (AtG) [1A-3] and the Radiation Protection Ordinance (StrlSchV) [1A-8]. According to these concepts, any unnecessary radiation exposure or contamination of persons and the environment is to be prevented, and, with due regard for the state of the art in science and technology and the particular circumstances of each individual case, is to be kept as low as practicable even where the values are below the authorised limits (§ 6 StrlSchV).

The planning of structural or technical measures to protect against design-basis accidents is based on the dose limits for the environment (§§ 49 and 50 StrlSchV) or is applied *mutatis mutandis*.

The following principles for spent fuel management are derived from the precautionary concept:

- fundamental protection objectives on radioactivity confinement, removal of decay heat, sub-criticality, avoidance of unnecessary radiation exposure,
- requirements regarding shielding, design and quality assurance, safe operation, storage and safe transport removal of radioactive substances.

In order to protect against the hazards emanating from radioactive substances and control their use, the Atomic Energy Act requires that the construction, operation and decommissioning of nuclear installations is subject to regulatory licensing. The licensing of nuclear installations is regulated by the Atomic Energy Act (cf. the remarks on Article 19).

Additional requirements regulate liability in case of damages [1A-11], protection against disruptive actions or other interference by third parties [3-62], [BMU 00] and the control of fissile material according to international conventions (cf. the remarks on Article 24).

G.1.2. Assurance of Subcriticality and Residual Heat Removal

Measures are taken to address the derived fundamental protection objectives of reliable maintenance of subcriticality and safe removal of residual heat. Particularly regarding the dry interim storage of spent fuel assemblies from LWR, HTR, prototype and research reactors, these measures are specified in greater detail by the RSK Guideline on safety technology [4-2]. With regard to criticality safety in connection with the wet interim storage of spent fuel assemblies, KTA 3602 is applied (see enclosed list of KTA nuclear safety standards), whilst KTA 3303 is applied with regard to the removal of residual heat.

At present, the nuclear regulations do not yet contain any formulated requirements as to how criticality is to be avoided in a repository and how residual heat is to be removed in a suitable manner. For assuring subcriticality, the burn-up credit is currently not being used. In this respect, the finalisation of a corresponding DIN standard is waited for.

According to the safety criteria for the emplacement of radioactive wastes in a mine (*Sicherheitskriterien für die Endlagerung radioaktiver Abfälle in einem Bergwerk*) [3-13], the thermal output and surface temperature of the packages for the disposal of heat-generating radioactive wastes should be determined in such a way that the specified properties of the packages are maintained and the integrity of the geological formations is not endangered.

G.1.3. Limitation of the Radioactive Waste Generation

§ 6, paras. 1 and 2 of the Radiation Protection Ordinance requires that any unnecessary radiation exposure or contamination of persons and the environment shall be prevented, and, taking due account of the state of the art in science and technology and the particular circumstances of each individual case, radiation exposure or contamination shall be kept as low as practicable, even where the values are below the authorised limits. Based on this, and analogous to § 22 of the Closed Substance Cycle and Waste Management Act [1B-13], the requirement to keep the generation of radioactive waste associated with spent fuel management to the minimum practicable is derived. Measures to reduce the amount of spent fuel assemblies arising are the increase of target burn-up and fuel assembly enrichment as well as the optimisation of fuel burn-up by fuel assembly shuffling.

Moreover, private operators of nuclear installations in the Federal Republic of Germany in any case have a vested interest in minimising waste volumes for economic reasons. These economic reasons result from state requirements in other areas, especially from the provisions of the Waste Disposal Advance Payments Ordinance (EndlagerVIV) [1A-13] according to which the advance payments for financing a repository are calculated on the basis of the volumes of waste arising.

G.1.4. Taking into Account Interdependencies between the Different Steps in Spent Fuel Management

Following the most recent revision of the Atomic Energy Act (AtG), according to § 9a AtG it is necessary to prove to the supervising authority that adequate provisions exist for the non-hazardous re-use or controlled disposal of spent fuel assemblies (*Entsorgungsvorsorgenachweis*). For this purpose, realistic plans are submitted annually showing that sufficient interim storage capacity remains available for those spent fuel assemblies already existing and those expected to arise in future, and that sufficient and adequate interim storage facilities are legally and technically available to meet concrete requirements for the next two years. Furthermore, similarly structured proof is also furnished to the supervising authorities regarding the interim storage of returned wastes from the reprocessing of spent fuel assemblies in foreign countries, as well as for the re-use of the

separated plutonium from the reprocessing of spent fuel assemblies in nuclear power plants, and for the whereabouts of the separated uranium from the reprocessing of spent fuel assemblies.

The type of conditioning and packaging depends on the specifications of the acceptance criteria laid down in the licence for the planned interim storage facility or repository.

Quantitative information showing the consideration of the reciprocal dependence can be found in the comments on Article 32 2.

G.1.5. Application of Suitable Protective Methods

The Atomic Energy Act and the Radiation Protection Ordinance require that precautions must be taken against potential damages in keeping with the state of the art in science and technology to guarantee effective protection. For compliance with the state of the art in science and technology on spent fuel management, internationally accepted criteria and standards of the IAEA [IAEA 94b] [IAEA 02], the ICRP and the EURATOM Basic Safety Standards [1F-18] are also referred to. This is ensured by the nuclear licensing applicable to the corresponding nuclear installation (cf. the remarks on Article 19).

Compliance with the provisions of nuclear licensing is ensured by the supervision of the competent authorities of the Federal Government and the *Länder* (cf. the remarks on Article 32 2.).

G.1.6. Taking into Account the Biological, Chemical and Other Hazards

The provisions of other legal fields take into account the precautions against damage from biological, chemical and other hazards (cf. the remarks on Article 19). This primarily concerns the reprocessing and disposal of spent fuel assemblies. There are no reprocessing plants in operation in Germany. Regarding disposal, biological, chemical and other hazards are considered within the framework of the plan approval procedure by corresponding safety analyses. These hazards need not be considered in connection with interim storage because the casks ensure leak-proof confinement, which precludes such hazards.

In addition, the Nuclear Licensing Procedures Ordinance stipulates the performance of an environmental impact assessment and compliance with other licensing requirements (e.g. for non-radioactive emissions and discharges into waters).

G.1.7. Avoidance of Impacts on Future Generations

There are no plans for the long-term interim storage of spent fuel assemblies in Germany. Interim storage is limited to a maximum of 40 years. The valid safety criteria [4-2] require that the permitted impacts of interim storage remain at a consistently low level throughout the entire period.

Safety criteria for the emplacement of radioactive wastes in a mine entered into force in Germany in 1983 [3-13]. They are being further developed with due regard for national and international developments, and consider the recommendations of the ICRP and OECD/NEA, the standards of the European Communities, and the safety principles of the IAEA on radioactive waste management [IAEA 06].

As things stand, the impacts of a release of radionuclides from repository operation in Germany must not exceed the dose limits applicable to nuclear power plants today. For the post-operational phase, the safety criteria (*Sicherheitskriterien*) [3-13] that still apply implicitly specify a dose limit of 0.3 mSv per calendar year.

G.1.8. Avoidance of Undue Burdens on Future Generations

The controlled phasing-out of the use of nuclear energy for the commercial generation of electricity is regulated by the amended Atomic Energy Act which entered into force on 27 April 2002. This also limits the generation of further nuclear waste.

The safety criteria for the emplacement of radioactive wastes in a mine [3-13] in Germany already make allowance for Principle 7 of the IAEA Safety Fundamentals [IAEA 06]. They ensure that no undue burdens are imposed on future generations. In this respect, financial resources have been set aside by the operators of the nuclear power plants, among others, for the direct disposal of spent fuel assemblies on the basis of commercial law.

Around 45 % of these reserves are intended for decommissioning and removal, whilst the remaining 55 % are intended for disposal. If required, the reserves will also cover the interim storage of spent fuel assemblies and radioactive waste in Germany until their final disposal.

Once a repository has been sealed, permanent monitoring is not necessary. For this reason, no further costs are incurred after sealing that would have to be borne by future generations.

Development of a concept for the direct disposal of spent fuel assemblies has reached technical maturity. There exist a prototype of a fully shielded POLLUX cask as well as the alternative concept of the unshielded fuel rod canister.

G.2. Article 5. Existing Facilities

Article 5. Existing facilities

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

G.2.1. Fulfilment of the Obligations under the Convention Regarding Existing Facilities

The fundamental requirements governing the preventive action to be taken are set forth in the Atomic Energy Act (AtG) [1A-3], the Radiation Protection Ordinance (StrlSchV) [1A-8] and other legal provisions, as well as in non-legally binding regulatory guidance instruments (cf. the remarks on Articles 18 to 20) which satisfy, and in some cases exceed, all the requirements of this Convention. An explicit review of the facilities to verify compliance with the requirements of this Convention is therefore not felt to be necessary.

Furthermore, existing facilities are also subject to continuous regulatory control throughout their entire operational life. Whenever there are any advancements in the state of the art in science and technology, the regulatory body may insist on a corresponding upgrade in safety in accordance with the provisions of § 17 AtG.

Independently from this, the regulatory framework governing the safe management of spent fuel [4-2] stipulates regular reviews intended to ensure the compliance with the protection objectives stipulated in the Act in line with the latest state of the art in science and technology. The protection objectives encompass the protection of the general public in the vicinity of the facility, the protection of the environment and the protection of operating personnel, as well as the protection of property against the effects of ionising radiation.

G.3. Article 6. Siting of Proposed Facilities

Article 6. Siting of proposed facilities

1. *Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:*
 - (i) *to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;*
 - (ii) *to evaluate the likely safety impact of such a facility on individuals, society and the environment;*

- (iii) *to make information on the safety of such a facility available to members of the public;*
 - (iv) *to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.*
2. *In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.*

G.3.1. Taking into Account Site-Related Factors Affecting Safety during the Operating Lifetime

§ 7, para. 1 of the Atomic Energy Act (AtG) [1A-3] regulates the licensing of stationary installations for the management of spent fuel assemblies, whilst the licensing of the mere storage of nuclear fuel outside Government custody is regulated in § 6, para. 1 AtG. The definition in the AtG encompasses storage of spent fuel assemblies. In order to obtain such a licence, the applicant must submit documentation containing all the relevant data required for the purposes of assessment. This data is summarised in the safety report (*Sicherheitsbericht*), a key document in the licensing procedure. The nature and scope of documentation and the data it contains are regulated in the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10].

§ 2 AtVfV prescribes that the licence application for the planned construction of a new facility must be submitted in writing to the licensing authority. This application must also contain data pertaining to all relevant site-related factors.

§ 3 AtVfV specifies the nature and scope of documentation referred to in greater detail in the remarks on Article 19 2. (ii). Usually, the required information pertaining to the site and the installation is compiled in the safety report and supporting documents.

An Environmental Impact Assessment (EIA) is required for installations which are listed in Appendix 1 of the Environmental Impact Assessment Act (UVPG) [1B-14]. According to nos. 11.1 and 11.3 of Appendix 1 of the UVPG, an environmental impact assessment is required for the construction and operation of facilities for the treatment of spent fuel assemblies, as follows:

- 11.1 Construction and operation of a stationary installation for the production, treatment, processing or fission of nuclear fuel or the reprocessing of irradiated nuclear fuel
- 11.3 Construction and operation of a facility or installation for the treatment or processing of irradiated nuclear fuel or highly radioactive waste or for the sole purpose of storage of irradiated fuel or radioactive waste which is scheduled to last for more than 10 years at a place different from the one where these materials have arisen.

The licence application must be accompanied by further documents as specified in § 3, para. 2 of the Nuclear Licensing Procedures Ordinance (AtVfV) (cf. the section on EIA under the remarks on Article 19 2. (ii)):

- 1. an overview of the most relevant alternatives for the technical procedures, including reasons for the choice, as far as these information may be relevant for the assessment of the admissibility of the intended work according to § 7 AtG,
- 2. indication of difficulties having become apparent during preparation of the data for the assessment of the requirements within the environmental impact assessment, especially insofar as these difficulties may relate to lack of knowledge and evaluation methods or to technological gaps.

Within the meaning of Article 6 1. (i) of the Convention, this detailed information will enable the authorities and any authorised experts consulted by them to assess all relevant site-related factors which might affect the safety of spent fuel management facilities during their operational life.

G.3.2. Impacts on the Safety of Individuals, Society and the Environment

In addition to the information outlined in the remarks on Article 6 1. (i), the safety report and the auxiliary documents must contain data on the following topics (cf. the remarks on Article 19 2. (ii)):

- Description of construction and operation, including an overview of the entire project; plant operating procedures, quality management concept, fire protection concept, documentation etc.,
- operational radiation protection: radiation protection areas in the plant, radiation and activity monitoring in rooms and in the plant, physical radiation protection monitoring of individuals, monitoring of releases of radioactive substances and environmental monitoring, surveillance of material which is released from the controlled area, measures to reduce exposure of personnel and in the environment,
- waste and residual material management: Release of cleared material from the operation, conditioning, storage and (if relevant) transfer of radioactive operational waste,
- exposure in the environment: Applicable limit values for discharges with air and water including substantiation, calculation of the exposure resulting from the discharge of radioactivity and from direct radiation,
- incident (design basis accident) analysis: Description of the protection objectives, possible incidents, incident analysis for operation, exposure as a result of incidents, and
- further effects of plant operation on the environment: Description, analysis and evaluation of the effects on man, animals, plants, soil, water, air, climate and landscape as well as cultural and other material assets.

In addition to this, other information relating to the site and the planned facility as outlined above are also relevant in this context. Within the meaning of Article 6 1. (ii) of this Convention, this will enable the competent authorities and any authorised experts consulted by them to assess the presumed effects of a spent fuel management facility on the safety of individuals, society and the environment.

G.3.3. Information of the Public on the Safety of a Facility

Projects to construct a spent fuel management facility are publicly announced and the documents are publicly displayed in accordance with the provisions of § 4 of the Nuclear Licensing Procedures Ordinance (AtVfV). The public hearing which may be necessary is regulated in §§ 8 to 13 AtVfV. The public hearing is the oral discussion of the previously filed objections against the planned work, carried out under participation of the authority, the objectors and the applicant. The public hearing is intended to provide those who have raised objections during the period determined by § 7 AtVfV with the opportunity to explain their objections. According to § 12, para. 1 AtVfV, the public hearing is not open to the general public.

Details concerning the related procedures are described in the section on involvement of the public under the remarks on Article 19 2. (ii).

This approach, particularly the involvement of the public as defined in the AtVfV and the Environmental Impact Assessment Act (UVP), ensures that the general public has access to all the necessary information regarding the safety of planned spent fuel management facilities as stipulated by Article 6 1. (iii) of this Convention.

G.3.4. Consultation of the Contracting Parties in the Vicinity

§ 7a AtVfV regulates the procedure for cases of transboundary environmental impacts; this procedure is also relevant to spent fuel management facilities. According to § 7a, para. 1 AtVfV, the competent authorities of the foreign state are notified of the project with respect to EIA at the same

time and to the same extent as the authorities which are to be involved under the terms of the German Atomic Energy Act, in cases where

- a project which is subject to EIA may have substantial impacts (as described in the safety report or in the information on other environmental impacts) on the protected entities cited in § 1a AtVfV (man, animals, plants, soil, water, climate, landscape, cultural or other material assets) in a foreign state, or
- upon request of another state, which might be considerably affected by the impacts,

the authorities designated by the other state shall be informed about the project, with a view to the EIA, at the same time and to the same extent as the authorities to be involved pursuant to the German Atomic Energy Act (AtG) [1A-3], allowing a reasonable period of time for a notice on whether participation in the procedure is requested.

The licensing authority in Germany should ensure that the project is publicly announced in a suitable way in the foreign state, that details are given of the authority to whom any objections may be submitted, and that mention is made of the fact that any objections not founded on titles under private law are excluded once the set period for objections has expired.

On the basis of §§ 2 and 3 AtVfV, the German licensing authority will give the involved authorities of the foreign state the opportunity to voice their opinions on the application on the basis of the submitted documents within an appropriate period before reaching its decision. Citizens of that state are accorded equal status with German citizens with respect to their further involvement in the licensing procedure.

§ 7a, para. 2 AtVfV specifies that upon request, the applicant must supply translations of the required summary, as well as any other information about the project which may concern transboundary involvement, in particular concerning transboundary environmental impacts.

According to § 7a, para. 3 AtVfV, consultations are to be held, where necessary, between the supreme German Federal and the authorities of the *Länder* and the competent authorities of the foreign state regarding the transboundary environmental impacts of the project and any measures for avoiding or ameliorating them.

Furthermore, § 8 of the Environmental Impact Assessment Act (UVP) shall also apply to the participation of the authorities in other countries, insofar a protected commodity in another state may be affected.

In addition, Article 37 of EURATOM [1F-1] requires each member state of the European Atomic Energy Community to provide the European Commission with general data relating to any plan for the disposal of radioactive waste in whatever form which will enable it to determine whether the implementation of such a plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State. This also satisfies the requirements of Article 6 2. of this Convention. Such data usually comprise details of the site, the plant, the release of radioactivity into the atmosphere or in liquid form during normal operation, the management of solid radioactive waste, any unplanned releases of radioactive substances, and environmental monitoring.

G.3.5. Measures to Avoid Unacceptable Effects on Other Contracting Parties

The effects of the operation of spent fuel management facilities on protected commodities, such as man, animals, plants, soil, water, air, etc., are described in the documents supplied by the applicant, as outlined in the remarks on Article 6 1.

Effects on other Contracting Parties of this Convention which are adjacent to the spent fuel management facility may result from the licensed liquid and gaseous releases from the plant during normal operation and from possible additional release of radioactivity into the environment during incidents:

- The release of radioactivity during normal operation is limited by § 47 of the Radiation Protection Ordinance (StrlSchV) [1A-8] in such a way that the doses resulting from discharges with water and air will not exceed the dose limits specified in Table F-1 for any individual member of the general public per calendar year.
- The release of radioactivity during incidents in spent fuel management facilities is regulated by the provisions of §§ 49 and 50 StrlSchV, respectively, depending on the type of facility. § 49 StrlSchV specifies that for local interim storage facilities for spent fuel assemblies, the doses caused by releases of radioactive substances into the environment in the case of the most severe design basis accident must not exceed the limits specified in Table F-1. In cases falling under the scope of § 50 StrlSchV, the nature and extent of protective measures are stipulated by the competent authority, with due consideration for the individual case, particularly with regard to the hazard potential of the plant and the likelihood of an incident occurring.

Concerning the effects on other Contracting Parties, it is important to consider that the AtVfV prescribes the involvement of the authorities of affected neighbouring states (see above). As such, those authorities will be informed about the possible radiological effects of normal operation of the plant as well as any potential incidents. Provided the specified dose limits, which correspond to the relevant EU regulations and to international standards, are also used as a basis by other Contracting Parties, then the effects will also be acceptable to them.

G.4. Article 7. Design and Construction of Facilities

Article 7. Design and construction of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

- the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;*
- at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;*
- the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.*

G.4.1. General Protection Objectives

For these facilities (cf. Table L-1 to Table L-4), the protection objectives according to § 1 subpara. 2 AtG [1A-3] apply, namely the

- protection of life, health and property against the hazards of nuclear energy and the detrimental effects of ionising radiation

or those of § 1 of the Radiation Protection Ordinance (StrlSchV) [1A-8], i. e. the

- protection of man and the environment against the harmful effects of ionising radiation.

Furthermore, § 6, para. 2 AtG contains the licensing conditions which – if adhered to – ensure that the protection objectives are fulfilled. Both cover the stipulations of the Joint Convention.

During the licensing procedure, the competent licensing authorities make sure that the corresponding requirements are fulfilled. This means that constant checks are performed during the design phase already that the protection objectives are fulfilled, both under normal operating conditions and in the event of an uncontrolled accidental release.

G.4.2. Provisions for Decommissioning

The decommissioning of a spent fuel management facility is governed by the same legal prerequisites and peripheral requirements as other nuclear installations. The operation of spent fuel man-

agement facilities is licensed for a specified purpose and the facilities must be removed once the licence has expired. There are also regulations governing decommissioning and dismantling. The BMU has decreed that the RSK safety guidelines on dry interim storage of irradiated fuel assemblies in storage casks [4-2] must be observed. This guideline contains the following provision concerning decommissioning (Section 2.16):

“The interim storage facility for spent fuel assemblies shall be designed and built in such a way that it can be decommissioned in compliance with the radiation protection regulations and can either be made available for alternative use or removed. Prior to any further use or the dismantling of the storage building, it must be demonstrated by measurements that the building is not contaminated or has been sufficiently decontaminated and is free of any inadmissible activation. The requirements under building and waste law shall be observed.”

This means that the radiation protection principles and requirements set forth in the StrlSchV must be observed during the decommissioning and dismantling of these types of facilities. However, additional regulations from the Closed Substance Cycle and Waste Management Act and the building regulations of the *Länder* must also be observed. Those statutory requirements combine to form the legal framework within which the technical execution of decommissioning is to be planned, which must furthermore be in line with generally accepted technical rules.

G.4.3. Technical Bases

The construction of installations in Germany is governed by the commonly accepted technical rules – e.g. the specifications laid down in the DIN/EAN standards. In the nuclear sector, the requirements specified in KTA rules additionally apply (cf. the remarks on Article 13 2. (i)) and the state of the art in science and technology must also be observed.

These standards, as well as the state of the art in science and technology, are derived from experience. Hence, in Germany, the experience gleaned from nuclear research installations as well as from industrial application have been incorporated into the regulatory framework. Technical rules are issued by the KTA, which is comprised of representatives from research, industry and administrative bodies who pool their experience from the various different areas of nuclear safety.

The development of transport and storage casks is based on many years of experience in the design and manufacturing of such casks, as well as on testing e.g. by drop tests and by numerical analysis based on experimental results. Both publicly and privately funded research programmes (e.g. long-term safety analyses) address specific issues, the results of which are incorporated into the revisions of existing KTA rules as well as in the specification of new rules.

G.5. Article 8. Assessment of Safety of Facilities

Article 8. Assessment of safety of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;*
- (ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph i).*

G.5.1. Assessment of Safety in the Licensing Procedure

The assessment of the safety of nuclear facilities for the treatment of spent fuel assemblies (central and local interim storage facilities and temporary storage facilities, and the Gorleben pilot conditioning plant PKA), and the assessment of environmental impacts conducted prior to the construc-

tion of such a facility, take place within the context of a licensing procedure (cf. remarks on Article 19 2. (ii)).

An assessment of the safety and environmental impacts conducted prior to commissioning takes place within the context of the accompanying supervision under the relevant nuclear laws.

Regulatory Basis

The construction and operation of nuclear facilities for spent fuel management is subject to licensing under the Atomic Energy Act (AtG) [1A-3]. For the building work, a building permit is also required under the Building Code of the respective *Land*.

Applications for licences under the Atomic Energy Act must be submitted to the competent licensing authority. The application must include a statement on the extent to which the nuclear facility ensures the necessary precautions against damage resulting from the treatment of spent fuel assemblies according to the state of the art in science and technology, and meets the requirements of the rules and regulations in force. The nature and content of the documents submitted with the application must meet the requirements of the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10], or in the case of facilities for the storage of spent fuel assemblies, must fulfil them *mutatis mutandis*. The documents required (see also KTA 1404, cf. the list of KTA rules in the Appendix) are listed in detail in the remarks on Article 19 2. (ii) and (iii).

In order to implement the corresponding European requirements for an environmental impact assessment under [1F-13], which have been implemented in national law by the revision of the Environmental Impact Assessment Act (UVPG) [1B-14], an environmental impact assessment is conducted as a subsidiary part of the licensing procedure for the construction of nuclear facilities for the storage of spent fuel assemblies for which applications have been submitted since 1999. In such cases, the following documents must be added to the application:

- a presentation of the possible effects of the project on humans, fauna, flora and their habitats, on water, air, and the climate, as well as on the landscape and cultural and material assets,
- an overview of the technical process alternatives examined by the applicant, and the reasons for selection, if significant, as well as
- notes on any difficulties experienced in compiling the information for the assessment of environmental impacts.

Regulatory Reviews

In the licensing and supervision procedure, the competent authorities are responsible for the review of the documents submitted and the licensing prerequisites. According to § 20 AtG, experts may be consulted for it. The basic requirements governing expert opinions are formulated in a directive [3-34]. The independent experts review in detail the documents and licensing prerequisites submitted by the applicant. On the basis of the evaluation standards, details of which must be included in the expert opinion, they perform their own tests and calculations – preferably using methods and programs other than those of the applicant – and give an expert assessment of these results. Unless there are specific provisions governing the safety assessment of nuclear facilities for the treatment of spent fuel assemblies, any relevant rules from the existing set of rules and regulations for the safety assessment of nuclear power plants are applied *mutatis mutandis* (e.g. [3-23], [3-33], [3-1] and KTA 2101). Specific requirements for nuclear facilities for the treatment of spent fuel assemblies may be derived from international recommendations, such as those of the IAEA ([IAEA 94] and [IAEA 94a]).

A licensing prerequisite is the result of the verification of the reliability of persons responsible for the handling of radioactive material. According to § 12b AtG, the reliability check is carried out by the competent authorities as a protection against unauthorised acts which may lead to a diversion or major release of radioactive material [1A-19].

Requirements for Design and Operation

The requirements for design and operation of facilities for spent fuel management are presented exemplarily by means of the requirements for dry interim storage facilities for spent fuel assemblies:

For the technical design and the operation of facilities for the dry interim storage of irradiated fuel assemblies in casks, guidelines apply that were recommended in 2001 [4-2] by the Reactor Safety Commission (*RSK*). These guidelines were prepared in the wake of the large number of license applications in 1999 and 2000 to build and operate on-site interim fuel assembly storage facilities. With the exception of one facility that was licensed in 2004, all the other ones had been granted their licences by the end of 2003.

According to these guidelines, the design and operation of an interim storage facility must meet the following radiological protection objectives in order to ensure that the precautions against damage reflect the state of the art in science and technology:

- **Safe enclosure of the radioactive inventory**
The barriers or fuel-assembly casks that ensure the containment must retain sufficient integrity (monitoring of sealing function, formulation of a repair concept) under all credible circumstances (hazardous incidents, accidents, ageing, impacts, etc.)
- **Avoidance of unnecessary radiation exposure, limitation and monitoring of the radiation exposure of operating personnel and the general population**
Adherence to the corresponding limit values of the Radiation Protection Ordinance (*StrlSchV*) [1A-8], even in the most unfavourable case (receiving and dispatching checks on the fuel-assembly casks, formulation of a radiation-protection concept, division of the interim storage facility into radiation protection zones, radiation monitoring in the interim storage facility and the vicinity).
- **Reliable maintenance of subcriticality**
Proof of the criticality safety of the fuel assemblies during storage shall be demonstrated for the least favourable conditions to be expected during specified normal operation (limitation of the enrichment of the fuel assemblies, exclusion or limitation of neutron moderation, use of neutron absorbers, maintenance of the appropriate spacing) [DIN 25403], [DIN 25474].
- **Sufficient removal of heat from radioactive decay**
Even in the case of combined impacts on the effectiveness of heat removal, the operators must guarantee that only admissible temperatures will occur. The mechanisms of heat removal must be independently operative as far as possible (passively by natural convection).

From these protection goals, further requirements can be derived which are essential for compliance with the above targets:

- Shielding of the ionising radiation,
- Design, execution, and quality assurance suitable for operation and maintenance (KTA 1401, cf. list of KTA rules in the Annex),
- Safety-oriented organisation and performance of operation,
- Safe shipment off-site of the radioactive materials (see also [IAEA 96a]),
- Design against accidents, and provision of measures to reduce the harmful effects of events that exceed the design parameters (incident analysis). Calculation of the effects of hazardous incidents and of pre-existing pollution prevailing at the site before the facility is erected is regulated by [2-1] and [3-33].

In the context of the incident analysis (extraordinary events), a distinction is made between external and internal events, the latter being caused by the spent fuel assembly treatment facilities themselves.

In connection with dry interim storage, the following internal events generally have to be considered:

- mechanical impacts, such as the crash of a fuel assembly cask, a cask toppling over upon handling, and the crash of a load onto the cask (cf. drop test examples of BAM in Figure G-1),
- fire, and
- abnormal operating conditions, such as a power cut, the failure of instrumentation and control system, hoisting gear and transport systems as well as of ventilation system or active components relevant to heat removal.

Figure G-1: Drop test of a transport and storage cask for vitrified waste at the test facility of the Federal Institute for Materials Research and Testing (BAM) within the framework of an approval procedure under traffic law (Copyright: BAM)



According to the guidelines, external natural impacts and man-made impacts from outside are taken into consideration (see also [BMU 00], [3-62]). The assessment of these impacts is performed within the framework of the licensing procedure by the competent licensing authority. Recommendations for disaster control are given in [3-15] (cf. the remarks on Article 25).

External impacts that have to be considered are:

- external natural impacts such as storm, rain, snow, frost, lightning, flooding, landslides and earthquakes,
- man-made impacts from outside such as the effects of harmful substances (e. g. poisonous or explosive gases), blast waves caused by chemical explosions, fires (e. g. forest fires) spreading to the facility, mines caving in, and aircraft crashes.

Effects from events affecting a neighbouring power plant are also considered, e. g. the collapse of a vent or other structures, a turbine failure, or the failure of vessels with high energy content, as far as debris from such events may affect the interim storage facility.

The aspects of operational lifetime are taken into account by the limitation of the operating licenses for on-site interim storage facilities and the storage time of a cask to 40 years as well as by the consideration of this period in the licensing procedure. By imposing further conditions at a later stage operating during the lifetime, the competent authority may demand adaptations of the facility to comply with the state of the art in science and technology as far as this is necessary to fulfil the safety requirements (cf. § 17, para. 1, subpara. 3 AtG).

G.5.2. Safety Assessment in the Supervisory Procedure before Operation

The review of the safety of nuclear facilities that accompanies their construction prior to commissioning is carried out by the competent supervisory authority under the Atomic Energy Act. The authority determines whether the statements contained in the documents submitted, and any supplementary requirements in the licence, are being observed and implemented. Independent experts are also consulted for these supervisory duties.

If there are any relevant deviations from the state of the art in science and technology as specified in the licensing documents, modifications become necessary according to § 7, para. 1 or 6 AtG for which a modification licence is required; in this connection, all documents also have to be adapted to the corresponding state of the art in science and technology. Here, it has to be checked whether the modified facility satisfies overall the imperative of damage precaution, with this check extending to all effects of the modification on the safety of the facility and its operation. A deviation from the licensed status or operation of the facility is considered as being substantial if it does not show merely irrelevant consequences for the safety level at the facility. Modification licences are applied for at the competent licensing authority by the operator of the respective nuclear facility, sometimes within the framework of an order issued by the nuclear supervisory authority.

Under the Atomic Energy Act, the supervisory authority for spent fuel management facilities is the competent supreme agency of the respective *Land*.

Figure G-2: Ahaus interim fuel assembly storage facility (Copyright: GNS)



According to the Reactor Safety Commission's guidelines [4-2], with regard to the operation of an interim storage facility (cf. Figure G-2 showing the transport cask storage building at Ahaus as an example of an interim fuel assembly storage facility), precautionary measures against damage must be taken in particular for all procedures leading to first-time achievement of the normal operating state of the nuclear facility (commissioning).

The precautionary measures specified therein include:

- commissioning tests of all equipment of the storage facility (commissioning program),
- preparation of instructions for operational procedures and procedures for the management of incidents and eliminating the consequences thereof (operating manual in accordance with KTA 1201; cf. list of KTA rules in the Annex),
- drafting of implementing provisions for adherence to the Technical Acceptance Conditions (*Technische Annahmebedingungen*) (the boundary conditions for vessel properties and fuel assemblies used in the safety studies),
- the keeping of an inspection manual on in-service inspections (inspection manual according to KTA 1202; cf. list of KTA rules in the Annex),
- centralised registration and documentation of fault signals,
- exchange of experience among the various operators of interim storage facilities,
- the regulation of maintenance work with regard to its performance and access to the facilities,
- adequate staffing levels of qualified personnel,
- drafting a plan for emergency plant protection measures,
- submission of a monitoring concept for controlling the long-term and ageing effects during the service life applied for.

G.6. Article 9. Operation of Facilities

Article 9. Operation of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;*
- (ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;*
- (iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;*
- (iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;*
- (v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;*
- (vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;*
- (vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.*

G.6.1. Licence to Operate the Facility

In Germany, only interim storage facilities are operated for spent fuel management, since the licence of the pilot conditioning plant in Gorleben (PKA) is currently only limited to the repair of defective casks and thus no repository is available yet. Therefore the following will only deal with interim storage facilities.

The interim storage facilities generally have a licence for an operating life of 40 years. Before a facility can commence operation, it is subjected to commissioning tests according to the Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks [4-2]. These tests are specified in a commissioning programme which ensures that the safety requirements specified in Article 8 are fulfilled. The commissioning programme is subject to the approval of the competent authority. The tests serve to demonstrate that the installations have been constructed in a suitable manner to comply with the planned operation and can be operated as specified. The results are documented.

The entire operation should be structured in a suitable manner so as to ensure the safe performance of the operational processes. In particular, the administrative prerequisites regarding personnel, organisation and safety must be fulfilled. The authority supervises compliance with these prerequisites. Clear instructions must be formulated in an operating manual for operational processes, accident management and elimination of the consequences of incidents and accidents. Competencies and responsibilities must be clearly defined. The competent authority supervises compliance.

At each facility, cold testing with one cask for each cask type licensed for storage is performed for the entire handling procedure, including radiation protection measures, before casks are stored there for the first time.

G.6.2. Definition and Revision of Operating Limits

All operational processes and the measures to be taken in case of incidents are described in form of clear service instructions, which are laid down in an operating manual in fulfilment of the Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks [4-2]. In particular, all aspects relating to safety must be addressed, and the procedure in the event of modifications or additions of system components and procedures must be specified. This is intended to ensure that the personnel is able to promptly and confidently initiate and perform the necessary measures in case of abnormal operation or incidents and that the limits defined in the Radiation Protection Ordinance (StrlSchV) [1A-8] as well as the limits specified, in particular, for thermal rating and inter-lid pressure in the licence are kept for casks for dry interim storage. This procedure is subject to regulatory supervision. Should it turn out during the facility's operating lifetime that there is a need to adjust these limits, this is initiated by the licensing authority upon application of the licensee.

G.6.3. Compliance with Specified Values

For interim storage facilities, the assumptions and boundary conditions for cask properties and fuel assemblies used in the safety inspections are compiled in the form of technical acceptance criteria. Performance criteria are drawn up for compliance with the technical acceptance criteria. This also includes operating instructions and test procedures which must be taken into account during the loading of the casks. Compliance is supervised by experts from the competent supervisory authority.

A monitoring system is used for operational monitoring of the sealing function of the casks. This sends a signal to a central monitoring point as soon as a malfunction occurs in one of the two cask sealing systems. The monitoring system allows the affected cask to be identified.

The above-mentioned RSK Guideline stipulates e. g. the following measures:

- On reception, fuel assembly casks are checked for compliance with the limits applicable to the interim storage facility and defined in the cask qualification document by the Federal Office for Radiation Protection (BfS) by means of gamma and neutron dose rate measurements. In addition, incoming casks are examined for surface contamination. Only casks whose surface contamination does not exceed the admissible limits according to Annex III, Table 1 of the Radiation Protection Ordinance (StrlSchV) [1A-8] are emplaced in the storage facility. Furthermore, only casks which were loaded in accordance with the technical acceptance criteria of the respective interim storage facility are accepted. If emplacement is taking place from a neighbouring nuclear power plant without shipment along public transport routes, provisions may be made whereby certain parts of the mandatory controls during loading in the nuclear power plant may be dispensed with on emplacement in the interim storage facility.
- The radiation protection concept of the storage facilities covers all operating sequences during specified normal operation, measures for preventive maintenance, monitoring, measuring, in-service inspection, repair and for the collection and disposal of operational radioactive waste, and also includes the precautions and measures against accidents and emergencies. The responsibilities, competencies and organisation of radiation protection are clearly and unambiguously defined. The registration and evaluation of operational processes and special events that are relevant to radiation protection is ensured.
- Within the storage areas, the local dose and the local dose rate are measured and documented continuously or following every change in the emplacement plan, but at least once a year. These measurements are performed at representative points, covering the gamma and neutron doses. Mobile measuring equipment must be provided to a sufficient extent and used, in particular, during the performance of maintenance measures.
- The atmosphere in working areas where contaminations may occur is monitored continuously for control purposes, e.g. by means of mobile air sample collectors. Transport areas within the storage area, persons, work places, transport routes and mobile objects are all checked for contamination by suitable means and the results documented. Suitable decontamination facilities must be provided and organisational specifications made.
- In order to ensure the radiological work safety of the operating personnel and the protection of the population, air samples are taken at regular intervals in the storage area near the emplaced casks and subsequently analysed, the local dose (gamma and neutron dose) is monitored at representative points, e. g. at the fence of the facility, and the correct functioning of the equipment provided and used for radiation monitoring is systematically and regularly checked.
- The facility has a sufficient number of qualified personnel available to ensure the fulfilment of safety requirements, who are trained on a regular basis. This may be ensured by deployment of personnel from neighbouring nuclear installations. The technical qualification required depending on the staff member's position is verified in accordance with the requirements of the Radiation Protection Ordinance (StrlSchV) or other special regulations. The requirement concerning responsibility for nuclear safety issues is regulated by the Atomic Energy Act (AtG) [1A-3] and the Radiation Protection Ordinance.

A monitoring concept is drawn up in order to control long-term and ageing effects during the interim storage facility's operational period as detailed in the licence application. Here, a general distinction is made between parts and components that are designed for the entire period of use of the facility, and those that may need to be replaced. The essential safety-related properties of the systems, parts and components are ensured for the entire operating period. In particular, the condition of the lifting trunnions must allow the casks to be moved within the facility at any time.

Regulatory supervision ensures compliance with the procedures on operation, maintenance, monitoring, inspection and testing established in the nuclear licensing procedure for spent fuel management facilities.

G.6.4. Availability of Technical Support

Report on the measures to ensure engineering and technical support during the operating lifetime of the facilities by providing adequate competent staff was already made in the remarks on Article 22 (i).

The technical systems and equipment used for outward shipment of the fuel assembly casks are kept available until all casks loaded with fuel assemblies have been removed.

All auxiliary systems, such as cranes and monitoring systems, are provided and maintained throughout the operating lifetime of the facility.

Periodic testing is performed on all essential systems and equipment of the facility. The respective tests are specified in a testing manual. The technical equipment required for this purpose is kept available throughout the facility's operating lifetime.

G.6.5. Reporting of Significant Incidents

The obligation incumbent upon operators of facilities licensed according to § 6 or § 7 of the Atomic Energy Act (AtG) [1A-3] to report accidents, incidents and other events significant to safety to the supervisory authority is regulated in the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17].

Operation of the facility is monitored to check that safety-relevant disruptions to operation and incidents are reliably detected and the corrective measures specified in the operating manual can be taken. Operational disturbances and incidents are recorded and documented centrally and reported to the authority in a timely manner. Here, there are reporting deadlines ranging from immediate reporting to a period of up to five days, depending on the severity of the event. For facilities that are licensed according to § 7, para. 1 AtG, the reporting procedure and the reporting obligation criteria are laid down in §§ 6 to 10 of the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17]. The reporting criteria apply mutatis mutandis to facilities licensed according to § 6 AtG. The AtSMV contains furthermore provisions for the reporting of cases of contamination and dose rates. The International Nuclear Event Scale (INES) developed jointly by the IAEA and the OECD/NEA is used for the classification of reportable events by their safety-related and radiological significance.

Other safety-relevant findings from initial start-up, specified normal operation (especially in the case of maintenance, inspections and repairs) and in-service inspections are also documented and submitted to the supervisory authority. Any consequences derived from the evaluation of the incidents are taken into account in the operating procedures.

For the purpose of an international exchange of experiences, Germany also participates in the Fuel Incident Notification and Analysis System (FINAS) that was set up by the OECD/NEA for nuclear fuel cycle facilities following the Incident Reporting System (IRS) for nuclear power plants. Within the context of FINAS, the participating countries exchange information on disturbances and incidents with general safety significance with a view to learning lessons for improving plant safety wherever possible.

G.6.6. Collection and Use of Operating Experience

In view of the obligation of the authorities to take precautionary action, incidents significant to safety must be reported by the operator in accordance with the Nuclear Safety Officer and Reporting Ordinance (AtSMV). The supervisory authority examines in the individual case whether the event sequence requires additional safety-related measures. The reportable events are recorded and evaluated at the incident registration centre of the Federal Office for Radiation Protection (BfS). The results are published by the BfS in annual reports. In case of events with special significance and applicability to the safety of other plants, information notices are prepared in which the event is described in detail and an expert assessment is given on its safety relevance. Information

notices shall serve to enable the operators of comparable to check the applicability of the event to their facilities and, if required, initiate appropriate improvement measures. In addition, events in foreign facilities are also recorded and evaluated by GRS on behalf of the BfS.

In addition, with regard to components and parts that might require replacement, care is taken to ensure that this work is performed without major impairment to the operating processes at the interim storage facility and preferably shielded off from the radiation field of the storage casks, and that sufficient accessibility is provided.

The monitoring concept ensures the monitoring of the overall status of the facility and as a minimum requirement ensures the following:

- The condition of the storage building and the components required for interim storage are controlled by means of walk-downs and suitable measurements.
- Recurrent subsidence measurements are performed for the storage building.
- The external condition of the storage casks is monitored by inspections.
- The findings from in-service inspections are evaluated.

Experiences from the operation of similar plants are incorporated into plant management. For this purpose, procedures are put in place to ensure an exchange of experiences (e.g. on the basis of operating reports) between plant operators.

Moreover, the RSK guideline provides reports regularly prepared at intervals of ten years. The necessary contents and scope of such reports is currently being determined.

G.6.7. Preparation of Decommissioning Plans

Spent fuel treatment facilities are designed and constructed in such a way that they can be decommissioned in compliance with the regulations on radiological protection and then either be re-used or disposed of. Proof to this effect is checked during the course of the nuclear licensing procedure. Applications for changes to the licensed condition of the facility must either be submitted to the supervising authority for approval or in case of significant modifications to the licensing authority. Before further use or demolition of the storage building, proof that the building is either not contaminated or has been decontaminated sufficiently and is free of inadmissible activation must be furnished in the form of measurements. The requirements under construction and waste law must also be observed. The supervisory authorities of the *Länder* ensure that a corresponding exchange of expertise takes place at the level of supervision and with the experts also consulted.

G.7. Article 10. Disposal of Spent Fuel

Article 10. Disposal of spent fuel

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

G.7.1. Procedures for Spent Fuel Management

In Germany, all spent fuel assemblies from nuclear power plants are intended to be put in direct final storage, with the exception of those delivered to a reprocessing plant up until 30 June 2005. Since 1 July 2005, the reprocessing of fuel assemblies from power reactors is prohibited.

Under the direct disposal concept, spent fuel assemblies are to be packed in casks suitable for disposal after having been held in storage for several decades (a period of 40 years has been applied for and approved), and these casks are then to be sealed and emplaced in galleries or bore holes in deep geological formations. The prototype of a facility for the packaging of the spent fuel assemblies in casks that are suitable for disposal has been erected.

Since no repository has yet been implemented which is capable of accommodating spent fuel assemblies, there are only conceptual considerations available on the design of such a repository (cf. the remarks on Articles 13, 16 (ix) and 17).

G.8. Progress and Major Changes since the Last Review Meeting

In the remarks on Article 4 i it was pointed out that, at present, the nuclear regulations do not yet contain requirements for assurance of subcriticality in a repository in deep geological formations. In this respect, it should be noted that the DIN Standards Committee for Materials Testing started work on nuclear criticality safety in the context of final disposal.

H. Safety of Radioactive Waste Management

This section deals with the obligations according to Articles 11 to 16 of the Convention.

H.1. Article 11. General Safety Requirements

Article 11. General safety requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

- (i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;*
- (ii) ensure that the generation of radioactive waste is kept to the minimum practicable;*
- (iii) take into account interdependencies among the different steps in radioactive waste management;*
- (iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;*
- (v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;*
- (vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*
- (vii) aim to avoid imposing undue burdens on future generations.*

H.1.1. Ensuring Subcriticality and Residual-Heat Removal

The nuclear regulations presently do not contain any requirements on how criticality is to be prevented in a repository and how residual heat is to be removed in a suitable form. Within the framework of the comprehensive site-specific safety analysis for the Konrad repository, studies have been carried out into criticality safety/maintenance of subcriticality and into the thermal influence on the host rock. The results were implemented in the waste acceptance requirements for final disposal for the Konrad repository [BfS 95] and stipulated with the plan approval decision for the Konrad repository of 22 May 2002. It is therefore ensured for the operational and post-operational phases of this facility that each criticality is avoided and that the residual heat arising is taken into account.

Furthermore, the remarks on Article 4 apply analogously to Articles 11 (i) to (vii).

H.1.2. Limitation of the Generation of Radioactive Waste

According to the "Guideline relating to the control of radioactive waste with negligible heat generation that is not delivered to a *Land* collecting facility" [3-59], the waste producer has to present to the competent Länder regulatory authority a waste concept, indicating how the arising of radioactive waste is avoided or reduced.

Furthermore, the remarks on Article 4 apply analogously to Articles 11 (i) to (vii).

H.2. Article 12. Existing Facilities and Past Practices

Article 12. Existing facilities and past practices

Each Contracting Party shall in due course take the appropriate steps to review:

- (i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;*
- (ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.*

H.2.1. Safety of Existing Facilities

In Germany, all facilities existing at the time when the Joint Convention entered into force have already demonstrated in principle their adequate safety within the licensing procedures and their operation. Construction and operation have to be such that the necessary precaution against damage has been taken in line with the state of the art in science and technology. The competent licensing authority has confirmed this through granting the licence. Following the commissioning of a facility, its safety is reviewed, which is yet again done by the authorities as part of their nuclear supervisory role.

The general requirements regarding the precautionary measures to be taken are stipulated in the Atomic Energy Act (AtG) [1A-3], in the Radiation Protection Ordinance (StrlSchV) [1A-8] and in other legal and subordinate regulations. The safety requirements of the IAEA, as included e.g. in [IAEA 00a] or [IAEA 95], are also observed.

The protection targets extend to the protection of the local population in the vicinity of the facility, protection of the environment, protection of the operating personnel, and the protection of property against the effects of ionising radiation (cf. the remarks on Article 11 and 4, respectively). Compliance with these protection targets also satisfies the requirements of the Convention. This is ensured by nuclear licensing and the corresponding supervision.

In the following account, a distinction is made between facilities for the treatment and storage of heat-generating waste and waste with negligible heat generation.

Safety of Facilities for the Treatment of Heat-Generating Waste

In Germany, there exists one facility for the vitrification of HAWC solutions (VEK). At the HDB as well as in the interim storage facility at Gorleben, heat-generating waste is stored. The storage of vitrified waste from the VEK in the Interim Storage Facility North (ZLN) and the storage of compacted waste from reprocessing in the interim storage facility at Ahaus has been planned and applied for.

The HAWC solutions generated during the operation of the Karlsruhe Reprocessing Plant (WAK) are currently being stored and are intended for vitrification. The Karlsruhe Vitrification Plant (VEK) was built for this purpose. This facility is now complete. The inactive trial operation of the VEK was successfully accomplished in 2007. In the course of this operation, 17 m³ of a simulated waste solution were vitrified. This solution had a similar composition as the radioactive HAWC with the exception of actinides and technetium, which only occurs as radioisotope. The resulting glass products were filled into 32 stainless steel canisters.

After granting of the licence for active trial operation, 2 m³ of strongly diluted HAWC solution will be vitrified. Routine vitrification operation will presumably start in 2009, where about 60 m³ of HAWC solution will be enclosed into approximately 50 Mg of borosilicate glass by melting during a con-

tinuous three-shift operation. The resulting glass product will be poured into approximately 130 canisters, that will be emplaced into presumably five transport and storage casks of type CASTOR[®] HAW 20/28 CG, which shall be transferred into the Interim Storage Facility North (ZLN).

The safe storage of the HAW solutions is ensured by

- the safe enclosure of the activity by two barriers,
- the removal of the decay heat, and
- the removal of the radiolysis gases via the exhaust system.

The cell block and the storage tanks are protected against external impacts, i.e. also against aircraft crashes and earthquakes.

Once vitrification is complete, the storage tanks will be purged and dismantled. This constitutes part of the decommissioning procedure of the reprocessing plant.

In terms of equipment technology, process control and handling techniques, the methods used for the vitrification of HAWC at the VEK plant is based on the comprehensive experience gleaned from the PAMELA vitrification plant in Mol and at the WAK, as well as from cold-test research facilities, and complies with the state of the art in science and technology.

Within the context of the licensing procedure, the extent of testing of the safety-relevant components and systems as well as the participation of independent experts is defined.

During construction, the supervisory authority performed checks within the framework of quality assurance to verify whether the specified requirements for systems and components were met. The results were recorded in inspection reports. Independent experts were involved in this task.

During operation, key safety-relevant systems and components are rechecked at regular intervals. During these checks, the inspectors verify whether these systems and components still meet the specified requirements. In addition, wearing parts (e.g. seals) are regularly replaced within the context of preventive maintenance.

Interim storage facilities for heat-generating radioactive waste exist at Gorleben as well as on the premises of the Karlsruhe Research Centre. At the Gorleben transport cask storage facility, not only spent fuel assemblies but also vitrified high-active waste from reprocessing are stored in transport and storage casks. Here, the same safety requirements apply as those described in the remarks on Article 5. At Karlsruhe, the LAVA facility houses the fission product solutions from former operations of the reprocessing plant. These are to be vitrified in the VEK in the coming years. In addition, there is heat-generating waste that is stored in a storage bunker with remote handling systems. The safety of this storage facility has been checked as part of the licensing procedure and is subject to authority supervision over its entire operating period.

In principle, the procedure described below applies to all heat-generating radioactive waste.

One key central precaution is the confinement of radioactive substances by several barriers connected in series. These may either be material barriers, such as the tank walls, the cell walls, the stainless steel canister and the vitreous matrix, as well as the outer building, or process engineering barriers, such as directed airflows of the waste air from the room and cells caused by pressure differences.

The number and technical design of the barriers are tailored to the nature (solid, liquid, gaseous) and activity inventory of the substances to be retained.

The efficiency of the barriers is monitored in the cells, work rooms and operating rooms by devices for the detection of leakages, pressure deviations and airborne radioactivity in the cells.

Safety of Facilities for the Treatment of Waste with Negligible Heat Generation

Radioactive waste with negligible heat generation is put in interim storage, either at the place where it arises or in a central facility, until it can be disposed of in a repository. As a repository in Germany will not be available before the year 2013, conditioning has to be such that safe interim storage is guaranteed even for longer periods of time. Corresponding requirements were issued by the RSK in 2002 [4-3] (cf. the remarks to Article 15 (i)).

Different facilities and methods are used for the conditioning of radioactive waste (cf. Table L-5). In the case of liquid waste, the radioactive components are separated through evaporation, ion exchange, filtration or chemical precipitation. Solid waste is burnt or compacted if necessary in order to reduce its volume. Afterwards, it is safely confined in containers. The conditioning plants are almost all assigned to specific nuclear facilities and, together with the other facilities and industrial premises, are subject to licensing, monitoring and supervision by the competent local authority. The safety of the conditioning plants was assessed in the licensing procedure. During operation, regulatory control ensures that safety-related requirements are fulfilled.

The confinement of radioactive substances during the storage of radioactive waste is ensured by a system of technical barriers and supplementary measures. This can be achieved with a variety of different approaches and may include, for example, integration into the matrix of the waste product, confinement in waste containers or, where applicable, the barrier function of buildings and ventilation systems with retention devices. Overall, safe enclosure can be achieved by one barrier or the combined effects of several barriers.

Facilities for the interim storage of radioactive waste with negligible heat generation and residual waste are generally designed for the handling and storage of sealed radioactive substances – in other words, the waste packages perform the function of safe activity confinement. In order to comply with the corresponding specifications, the waste packages are subjected to product control. This is ensured by means of monitoring and supervision.

Within the context of analysing hazardous incidents, external impacts are also taken into consideration. On this basis, the authority decides which precautionary measures are to be taken for the facility.

The different facilities take measures to ensure safety during long-term interim storage. These comprise e. g. updates of the documentation pertaining to the waste, technical inspections of the waste packages and – if necessary – their re-packaging or emplacement in additional enveloping containers. The requirements for longer-term interim storage are described in detail in the remarks on Article 15 (i).

As expressed in the remarks on Article 32 2. (iii), two different types of interim storage facilities in Germany accept radioactive waste, depending on its origin. These facilities differ from each other not so much in their technical design but in the associated responsibilities.

One group is formed by the interim storage facilities of the nuclear power plant operators who – according to the polluter-pays-principle – are responsible for the lawful and safe treatment of their radioactive waste. These interim storage facilities require a licence according to § 7 StrlSchV, to be issued by the respective competent *Land* authority.

In contrast, radioactive waste from research, industrial or medical application may be surrendered to *Land* collecting facilities (cf. Mitterteich *Land* collecting facility as an example in Figure H-1) unless it is stored at the originator's site. According to § 9a AtG [1A-3], these *Land* collecting facilities have to be provided by the *Länder* for the radioactive waste arising on their territory. The handling of the radioactive waste within the *Land* collecting facilities as well as any deviations of the handling procedures laid down in the licensing documents (Annex II Part A StrlSchV) also require licensing according to § 7 StrlSchV by the competent *Land* authority. Checks during the licensing

procedure ensure that relevant safety requirements are fulfilled (cf. the remarks on Article 15). If the radioactive waste is not only stored but also treated at the *Land* collecting facility, the regulations have to be applied accordingly (cf. the remarks on Article 15). Usually, the licence for storage is limited in time.

An application to the *Land* collecting facilities for the delivery of radioactive wastes must be submitted in writing by the delivering party and accompanied by a waybill. On the basis of these documents, checks are made to ascertain whether the preconditions for acceptance of the radioactive waste have been met. The acceptance criteria of the *Land* collecting facilities differ from one *Land* to another, and are laid down in the respective regulations for use. They depend on the respective licensing situation, and on the availability of conditioning equipment. Recommendations for the interim storage of low- and medium-active waste are contained in [4-3] (cf. the remarks on Article 15). These recommendations include visual inspection of the outer surfaces of certain waste packages, and separate storage and repeated checks with visual inspection for unconditioned wastes. Safety-related findings must be notified to the *Land* authority responsible for the interim storage.

If the radioactive wastes fail to meet the preconditions stipulated in the respective regulations for use of the *Land* collecting facility, the latter may refuse to accept them, and will report this to the supervisory authority responsible for the delivering party. In such cases, the wastes will remain in the hands of the delivering party until transformed into a condition conforming to the regulations for use, and the *Land* collecting facility is willing to accept it. Alternatively, the radioactive wastes may be delivered by special agreement, subject to the consent of the competent supervisory authority. After acceptance, a further incoming inspection is performed to verify once again that the acceptance criteria have been met.

Figure H-1: Mitterteich *Land* collecting facility (Copyright: GRB)



When the waste is surrendered to the *Land* collecting facility, it passes into the ownership of the latter. This also applies to raw waste. The waste originator's duties in connection with conditioning

are thus adopted for this waste by the operator of the *Land* collecting facility. This procedure ensures that waste packages that are stored over a longer period at a *Land* collecting facility have the same quality standard as those in an interim storage facility for waste from nuclear installations (§ 74 StrlSchV).

The acceptance criteria are laid down in the licence in line with the state of the art in science and technology. Each year, the individual operators of *Land* collecting facilities hold a meeting for the purpose of exchanging information.

H.2.2. Past Practices

In Germany, past practices as defined by this Convention, such as the use of radium in the production of luminous paint or of thorium in the manufacture of gas mantles etc. in the first half of the twentieth century resulted in a number of individual sites which were contaminated to a limited extent. These contaminated sites have been or are currently being cleaned up and redeveloped for radiological and other reasons. Cataloguing and categorisation of such legacy sites has largely been completed in Germany.

Past practices with respect to Uranium mining and milling have been carried out at a large number of sites especially in Saxony which have been discontinued prior to 21 December 1962 and therefore do not fall into the responsibility of the Wismut GmbH for carrying out remediation measures (cf. the separate report on remediation work of Wismut GmbH). According to the Federal Office for Radiation Protection, the residues present at those sites amount to about $46.5 \cdot 10^6$ m³ of heaps and about $4.7 \cdot 10^6$ m³ of mill tailings. A register of radiologically relevant sites contaminated from mining activities has been established.

According to § 11 para. 8 of the Precautionary Radiation Protection Act (*Strahlenschutzvorsorgegesetz* [1A-5]), the BfS was responsible for the determination of the environmental radioactivity originating from mining operation in the presence of natural radioactivity in the new Federal States. Therefore, the BfS carried out the project "Radiological Survey, Investigation and Assessment of Mining Residues (*Altlastenkataster*)". Radioactive legacy sites of uranium mining no longer belonging to the Wismut GmbH and radioactive legacy sites from historical mining activities were systematically catalogued, explored and radiologically assessed. This comprised the following objects:

- milling facilities (facilities for separation and processing of the usable material by mechanical, chemical or metallurgical processes, including the plant areas and associated premises),
- industrial settling ponds (basins for deposition of tailings and cleaning of liquid process media from mining facilities),
- heaps (stockpiles of excavation material from mining or mechanical ore processing or of residues of metallurgic processes (slags)),
- prospected sites (shallow outcrops on small areas for exploration of ores or raw materials),
- galleries (horizontal drifts),
- shafts (vertical drifts),
- unused open pits and cavities,
- plants (unvegetated areas of facilities and possibly undecontaminated mining sites like ore bunkers, uranium ore box storage, hydro-engineering plants etc.) and ore loading facilities (areas away from factory premises on which ore was reloaded).

Apart from these objects, the identification of sites influenced by mining operations in the vicinity of the objects listed above and for which measures for reduction or avoidance of exposure of the

general public was of special interest. This project identified those sites for which exposure above 1 mSv/a could not be excluded and for which therefore further investigations and – if necessary – remedial actions or restrictions for use could be considered. The aim, execution and results of this project are summarised in [BfS 02] .

In order to make efficient use of financial resources, the investigation was concentrated on potentially contaminated areas. The results of the investigations were stored in the A.LAS.KA database and in the technical information system on environmental radioactivity caused by mining („*Fachinformationssystem bergbaubedingte Umweltradioaktivität*“, FbU) and were also discussed extensively in area-specific reports. The data and information are available to the competent authorities of the *Länder* Saxony, Saxony-Anhalt and Thuringia.

In parallel to the “*Altlastenkataster*” project, the BfS carried out a measurement programme to investigate the outdoor exposure by radon. The results showed that the radon concentration is markedly increased in the direct vicinity of mining sites compared to the natural background, but that there is no large-scale influence.

Remediation of contaminated sites in Saxony commenced in 2003 on the basis of a administrative agreement between the Federal Government and the Free State of Saxony.

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety has prepared a concept for the evaluation of the requirements for remediation of radioactive legacy sites that may form the basis for a legal provision, if required.

H.3. Article 13. Siting of Proposed Facilities

Article 13. Siting of proposed facilities

1. *Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:*
 - (i) *to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure;*
 - (ii) *to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure;*
 - (iii) *to make information on the safety of such a facility available to members of the public;*
 - (iv) *to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.*
2. *In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.*

H.3.1. Preliminary Remark

The siting process outlined in Article 13 refers to proposed radioactive waste management facilities and repositories. These types of facilities are addressed separately in the following two subsections. As the information required under Article 13 1. numbers i to iv has already been given in other sections of this report (cf. the remarks on Article 6), the relevant information is merely summarised here and reference is made to the appropriate sections.

H.3.2. Siting of Proposed Radioactive Waste Management Facilities

For facilities for radioactive waste management which require a licence according to the Atomic Energy Act (AtG) [1A-3], the remarks provided for Article 6 apply accordingly.

For the other facilities for radioactive waste management, only the handling of radioactive substances requires a licence according to § 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8], depending on the nature of the facility. In contrast to the facilities mentioned above, this licensing procedure is in principle not regulated by the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10]. An exception is a case where the respective use requires an environmental impact assessment (EIA) according to the requirements in the Environmental Impact Assessment Act (UVPG) [1B-14]. Regulations of the Nuclear Licensing Procedures Ordinance are applied at least with respect to the EIA. Licensing is carried out by the competent licensing authority of each *Land* and follows the process described in the following.

The licensing requirements which must be met by such a facility are described in § 9, para. 1 StrlSchV. With respect to the siting of such facilities, the following licensing requirements are particularly relevant:

- the necessary protection must be ensured against disruptive action or other interference by third parties,
- the choice of the site must not conflict with overriding public interests, particularly in view of its environmental impacts.

The required documentation and information depends on the type of facility and in particular on whether or not an environmental impact assessment (EIA) is necessary. According to Appendix 1 of the Environmental Impact Assessment Act (UVPG) [1B-14], an EIA is required for:

- 11.3: Construction and operation of a facility or installation for the handling or management of irradiated fuel assemblies or highly radioactive waste.

By contrast, the following facilities or installations (see Appendix 1 of the UVPG) require a general preliminary assessment of each individual case according to § 3c, para. 1 of the UVPG:

- 11.4: Construction and operation of a facility or installation for the storage, handling or treatment of radioactive waste where the activities reach or exceed those limits laid down in an ordinance promulgated on the basis of the Atomic Energy Act (AtG) [1A-3] and compliance with such limits does not require any measures for mitigating the consequences of deviations from specified normal operation (according to § 50 of the Radiation Protection Ordinance, such activities are defined as 10^7 times the exemption levels as specified in Appendix III, Table 1, column 2 of the StrlSchV in the case of unsealed radioactive substances and 10^{10} times the exemption levels as specified in Appendix III, Table 1, column 2 of the StrlSchV in the case of sealed radioactive substances).

This general preliminary assessment includes a rough review of the individual case with respect to potential substantial negative environmental impacts, with due regard for the criteria listed in Appendix 2 of the UVPG (including characteristics of the project, site, possible effects). Based on the outcome of this preliminary assessment, the competent authority will determine whether or not an environmental impact assessment is required.

Where the cases listed above pertain to the planned radioactive waste management facility or installation and if an EIA is required for the facilities or installations listed in point 11.4, then the type of information outlined in the remarks on Article 6 1. (i) and (ii) must be provided. This also implies the involvement of the general public (cf. the remarks on Article 6 1. (iii)) as well as the participa-

tion of other authorities and, where applicable, the participation of authorities of other countries (cf. the remarks on Article 6 1. (iv)).

H.3.3. Site Planning for Disposal

As part of the governmental task to provide and to operate facilities for the disposal of radioactive waste, the Federal Office for Radiation Protection (BfS) is responsible for the construction and operation of repositories.

According to the Atomic Energy Act [1A-3], construction of a repository for radioactive waste in Germany requires a plan approval procedure, which includes an environmental impact assessment and the involvement of the general public. According to this legal framework, the Konrad mine has been licensed as a repository for non heat-generating radioactive waste, which has been affirmed in 2007 by the administrative court.

The Gorleben salt dome was chosen from over 140 salt domes in Germany as a repository especially for heat-generating waste in 1977 and has been explored from 1979 until 1 October 2000. According to the agreement between the Federal Government and the power utilities of 11 June 2001, a moratorium on further exploration for up to ten years was decided.

H.4. Article 14. Design and Construction of Facilities

Article 14. Design and construction of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;*
- (ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;*
- (iii) the design stage, technical provisions for the closure of a disposal facility are prepared;*
- (iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.*

H.4.1. Impacts on Individuals and the Environment

Regarding the design and construction of radioactive waste management facilities, both the requirements of relevant acts and ordinances (such as the Atomic Energy Act (AtG) [1A-3] and the Radiation Protection Ordinance (StrlSchV) [1A-8]), and the content and recommendations of sub-statutory rules and regulations are duly taken into account and applied with regard to radiological aspects (e.g. KTA 1301.1; see enclosed list of KTA nuclear safety standards).

The realisation of these requirements creates the prerequisites for compliance with the radiation exposure limits for persons in Categories A and B who are exposed to radiation by virtue of their occupation, as well as for the population in the surrounding area during operation of the facility, as stipulated in the Radiation Protection Ordinance.

Radiological Protection of Operating Personnel

The measures to ensure the radiological protection of operating personnel which must be taken into account during the design and construction of facilities for the treatment of radioactive waste refer, in particular, to structural measures regarding the arrangement and design of the rooms in the controlled area of the facility. In this respect, the emphasis is on the arrangement and accessi-

bility of the rooms, the arrangement and accessibility of the containers, the design of the wall and floor surfaces from the point of view of shielding, the decontaminability of the wall and floor surfaces, and the space requirement for tasks related to radiation protection, as well as the design of the entry and exit of the controlled area (including facilities for issuing work and protective clothing, washing facilities for the personnel, and facilities for contamination control before leaving the controlled area). The system design and the ventilation concept, the storage concept, the measurement methods for radiation protection monitoring within the controlled area of the facility (local dose rate, air activity concentration, surface contamination) and monitoring of the internal and external radiation exposure of personnel are additional aspects which must be taken into account during the design and construction of facilities for the treatment of radioactive waste and in the licensing procedure by the competent authority.

Radiological Protection of the Population during Specified Normal Operation

The radiological protection of the population during specified normal operation is ensured during the planning and construction of radioactive waste management facilities by their structural and technical design. In addition to shielding effect of the walls of the controlled area already mentioned above under the aspect of radiological protection of operating personnel, which also serves to limit direct radiation at the site and in the vicinity of the facility in accordance with § 46 of the Radiation Protection Ordinance (StrlSchV), appropriate technical equipment must also be provided to limit the release of radioactive substances with air or water, in order to comply with the limits specified in § 47, para. 1 StrlSchV for individual members of the local population in the vicinity of the facility. Such equipment comprises retention devices for airborne radioactive substances, as well as treatment facilities for contaminated waters and transfer tanks for waters from the controlled area. Moreover, the prerequisites for the measurement of releases and their nuclide-specific balancing are ensured by means of corresponding measurement, sampling and analysis methods.

Radiological Protection of the Population in Case of an Accident or Hazardous Incident

In accordance with § 50 of the Radiation Protection Ordinance (StrlSchV), the conceptual planning of a radioactive waste management facility (interim storage facility, conditioning facility) includes structural and technical protective measures, with due regard for the potential extent of any damages, to limit radiation exposure caused by the release of radioactive substances into the environment in case of an accident or hazardous incident. The licensing authority defines nature and scope of the protective measures with reference to each individual case, particularly with regard to the hazard potential of the facility and the likelihood of an incident or accident occurring.

According to § 49 StrlSchV, the design of structural or other technical measures to protect against incidents in or around a repository for radioactive waste must be based on a maximum effective dose of 50 mSv caused by the release of radioactive substances into the environment in the least favourable case. This requirement remains applicable until decommissioning. Individual dose limits are to be applied for specified organs. Further details can be found in Table F-1. The state of the art in science and technology is decisive for the adequacy of precautionary measures against accidents.

At the same time, the measures to protect the population against radiation also serve to ensure the protection of the environment.

H.4.2. Planning Concepts for Decommissioning

The decommissioning of radioactive waste management facilities is taken into account at the design stage and during their construction, thanks to the analogous application of the stipulations and recommendations contained in the statutory and substatutory rules and regulations on the decommissioning of nuclear installations (cf. [3-73]). With regard to facilities for the dry storage of HAW

canisters, Guidelines [4-2] must also be applied. These guidelines state that an interim storage facility must be designed and executed in such a way that it can either be decommissioned or re-used or removed in compliance with the radiological protection regulations.

Regarding the planning and construction of radioactive waste management facilities, the design ensures that the decommissioning of these facilities at a later stage takes place with due regard for the radiological protection of operating personnel and adherence to the radiological protection regulations. In particular, structural prerequisites must be created in order to ensure the use of specific decontamination and dismantling methods, including remote-controlled methods, during the subsequent decommissioning of the facility.

For this reason, a corresponding decommissioning concept must be available at the design and construction stage of the facility. This concept includes specifications regarding the intended decommissioning option, which depends primarily on whether the radioactive waste management facility is constructed as part of a major nuclear installation, thus being integrated into decommissioning procedure of this facility, or whether it constitutes a separate site, thus entailing an independent decommissioning procedure directly related to this facility. Further decisive parameters of the decommissioning concept are determined by the composition of the radioactive waste treated at the facility, in particular by whether or not it involves waste containing nuclear fuel.

Within the context of the decommissioning concept, the operator plans the decommissioning procedure, assuming that any residual quantities of the radioactive waste treated at the facility have been removed beforehand. The decommissioning concept also incorporates the requirements with regard to decontamination and dismantling methods and thus the radiological protection of the personnel. Since activation by neutrons can be virtually excluded, these requirements result from the contamination of components. In this respect, however, it is important to consider that during treatment of fuel-containing wastes or wastes with other alpha-emitters, contamination from alpha-emitting nuclides is also present.

The requirements relating to the proposed decontamination methods take into account the minimisation of individual and collective doses to achieve a condition adequate for the performance of decommissioning and dismantling work, as well as the reduction of volume and the recovery of residues as harmlessly as possible, with due regard for the secondary waste generated.

The requirements relating to the dismantling methods depend on the technological task (material, size of the components, environmental conditions, accessibility), the radiation protection conditions (existing activity, potential for aerosol formation, risk of contamination, confinement of mobile activity, limitation of the individual and collective dose), and the intended subsequent treatment in the form of residual waste for re-use, conventional disposal, or disposal as radioactive waste.

The decommissioning of the Karlsruhe Vitrification Plant (VEK), which is currently under construction, will be achieved primarily using the equipment required for operation and has already been incorporated into the design of the facility. The planned steps and measures for decommissioning of the facility were described by the applicant in his safety case.

H.4.3. Closure of a Repository

Upon termination of the operational phase, a repository in deep geological formations must be safely sealed against the biosphere in the long term.

As a licensing prerequisite, § 9b, para. 4 of the Atomic Energy Act (AtG) in connection with § 7, para. 2, subpara. 3 stipulates that "the necessary precautions have been taken in the light of the state of the art in science and technology to prevent damage resulting from the erection and operation of the installation". Regarding nuclear safety, the "Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine" of 1983 [3-13] formulate this requirement in more concrete terms:

“After closure, radionuclides which could reach the biosphere as a result of transport processes from a sealed repository which cannot be completely excluded must not lead to individual doses that exceed the levels stipulated in § 45 of the Radiation Protection Ordinance.” § 45 of the former version of the Radiation Protection Ordinance (now § 47 of the Radiation Protection Ordinance of July 2001) limits the annual radiation exposure of individual members of the general public caused by discharges of radioactive materials with air or water from nuclear facilities or installations. The Ordinance does not stipulate expressly any limits for radiation exposure caused by radioactive material released from a repository in its post-closure phase. For this reason, when conducting site-specific investigations into long-term safety, procedures are based on § 47 of the Radiation Protection Ordinance.

Due to requirements in other legal areas, it is necessary to ensure that detrimental environmental impacts are avoided or limited to the bare minimum. Mining law requires that there must be no long-term subsidence on the surface which could have inadmissible consequences for protected commodities. Water legislation stipulates that there must be no reason to fear harmful pollution of groundwater or any other detrimental change to its characteristics.

In order to meet the aforementioned requirements, it is necessary to take into account the respective situation of the repository, such as the natural (geological) and any technical barriers which may be required, the rock-mechanic characteristics of the host rock (such as convergence), the waste inventory, the emplacement technique and the construction materials for backfilling and closing the repository. With the aid of a comprehensive site-specific long-term safety analysis on the basis of a complete scenario analysis and the intended backfilling and closure concept, it is necessary to demonstrate that the closure measures avoid any inadmissible effects caused by the release of radioactive material and non-radioactive chemotoxic components of the waste packages and construction materials, as well as subsidence on the surface.

For this reason, within the context of a plan approval procedure for a repository mine, the long-term safety analyses make allowance for backfilling and sealing. The measures to be taken upon cessation of emplacement operations are specified. The supervisory authority monitors the nature and manner of execution.

H.4.4. Technologies Used

There is no difference between the requirements governing the technologies applied to the design and construction of radioactive waste management facilities and those for facilities for the treatment of spent fuel assemblies. As such, the remarks on Article 7 (iii) apply in full to Article 14 (iv).

H.5. Article 15. Assessment of the Safety of Facilities

Article 15. Assessment of the safety of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;*
- (ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;*
- (iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).*

H.5.1. Assessment of the Safety of Facilities before Construction of Radioactive Waste Management Facilities

Assessment of the safety of radioactive waste management facilities (interim storage facilities for radioactive wastes, and vitrification and other conditioning facilities, repositories), and the assessment of environmental impacts prior to construction of such a facility, are carried out as part of a licensing procedure (cf. the remarks on Article 19). An assessment of the safety and of the environmental effects prior to commissioning takes place within the framework of the accompanying nuclear regulatory supervision (see Chapter H.5.3).

Regulatory Basis

Under § 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8], the handling of radioactive materials in nuclear facilities for the management of radioactive wastes requires a licence.

Being a special case, the erection of vitrification facilities must be licensed in accordance with § 7 of the Atomic Energy Act (AtG) [1A-3], since apart from the processing of high-active waste, nuclear fuels will also be treated or processed in such facilities. The essential features of the safety assessment in the licensing procedure pursuant to § 7 AtG are outlined in the remarks on Article 8, and apply *mutatis mutandis* to the licensing procedure for facilities for the vitrification of highly radioactive wastes.

Whereas the licence pursuant to § 7 AtG combines the licences required for the erection and operation of the nuclear facility and for the handling of nuclear fuels (cf. the remarks on Article 8), § 7 of the Radiation Protection Ordinance regulates only the handling of radioactive materials. A building permit under the applicable building code must also be applied for.

Applications for licences under the Atomic Energy Act must be submitted to the respective competent authority of the *Land* (Federal State). The application must outline the extent to which the nuclear facility possesses the required safety characteristics, and conforms to the specifications of the applicable rules and regulations. In the licensing procedure under § 7 of the Radiation Protection Ordinance (StrlSchV), the documents listed in Appendix II, Part A, of that Ordinance must be enclosed with the licence application. The preconditions for a licence for handling radioactive materials are governed by § 9 StrlSchV. They are described in detail in the remarks on Article 13.

Regulatory Inspections

Among other things, one licensing condition is that on handling radioactive waste, the equipment must be available and the measures taken in accordance with the state of the art in science and technology to ensure that the protective provisions are observed (§ 9 StrlSchV). The standards of the Nuclear Safety Standards Commission (*KTA*) and the German Standards Institute & German Association of Electrical Engineers (*DIN/VDE*) are used as the basis for checking the licensing requirements, and are applied *mutatis mutandis*. During the course of verifying the licensing requirements, the competent licensing authority may call upon the services of independent experts in accordance with § 20 of the Atomic Energy Act.

According to the Environmental Impact Assessment Act (UVPG) [1B-14], an environmental impact assessment is mandatory for nuclear facilities designed to store radioactive wastes for more than ten years at a location other than that where they were generated, and for nuclear facilities requiring a licence under § 7 of the Atomic Energy Act (AtG). However, it also applies to facilities that do not require an environmental impact assessment that all radiological effects have to be examined within the framework of the safety assessments of the licensing procedure. More information on the EIA Act can be found in the remarks on Article 13 and Article 6.

In addition, the Environmental Impact Assessment Act provides for general screening of individual cases in the case of nuclear facilities for the storage, handling, or processing of radioactive wastes whose activity reaches or exceeds specified values. For such facilities, an environmental impact assessment must be performed if the competent authority feels that the project may have substantial adverse environmental impacts.

According to § 12b of the Atomic Energy Act, the competent authorities are required to investigate the reliability of the persons responsible for the handling of radioactive materials, in accordance with the Reliability Assessment Ordinance (*Atomrechtliche Zuverlässigkeitsüberprüfungs-Regulation = AtZüV*) [1A-19], so as to safeguard against unauthorised actions that might lead to a misappropriation or substantial release of radioactive materials.

Requirements for Design and Operation

The requirements for the design and operation of facilities for the treatment of radioactive waste are shown by the example of the requirements for interim storage facilities:

In 2002, the Reactor Safety Commission prepared safety requirements specially for the longer-term interim storage of low- and medium-active waste [4-3]. These contain the base lines of the requirements and recommendations. These criteria are used to assess the safety of a facility for the storage of radioactive waste as well as its effects on the environment. As for facilities for the treatment of radioactive waste, these safety requirements have to be applied at least to their storage areas and in analogy to the areas where treatment takes place.

Facilities for the interim storage of radioactive waste are generally designed for the handling and storage of sealed sources. The waste containers thus assume the function the safe activity confinement for the entire storage period. It is also admissible to design the storage facility with a view to handling radioactive waste that may cause emissions of radioactive substances, but this requires additional technical efforts with regard to the assumed release of radioactive substances with exhaust air and waste water.

According to the RSK safety requirements [4-3], among others the following requirements for the waste products and packages have to be fulfilled in the longer-term interim storage of low- and medium-active waste:

- The waste products shall be chemically/physically sufficiently stable in the long term. This has to be ensured by adequate conditioning measures (e. g. drying of the waste). Changes of the waste characteristics by digestion, fermentation or corrosion processes shall be minimised. For packages with waste where major pressure build-up resulting from gas formation cannot be excluded also in case of proper conditioning, pressure relief measures are to be provided, as far as there are no requirements regarding the leak-tightness of the waste containers. Waste with non-negligible heat generation shall be stable at the temperatures reached. Within the framework of procedure qualification, the entire conditioning procedure is to be demonstrated to the BfS or the respective competent regulatory authority of the *Land*.
- For the assessment of waste characteristics with regard to a longer-term interim storage, possible changes in the waste package characteristics through reactions developing within the waste product or between waste product and waste container have to be considered for the period of interim storage (e. g. shrinking in the case of cement products, reactions between residues of organic solvents and coating materials on the inner container wall).
- The origin and characteristics of the raw waste have to be recorded and documented. The waste products generated according to qualified procedures and possible interim products have to be assessed with regard to their suitability for longer-term interim storage. Requirements regarding the data to be documented are specified in Appendix X of the Radiation Pro-

tection Ordinance. Access to and legibility of the documentation has to be guaranteed until the waste is emplaced in a repository or released according to § 29 StrlSchV.

- According to the RSK safety requirements, the scope of the administrative monitoring measures to be performed for the compliance with the protection goals during the interim storage at each waste package and in the storage room shall be as small as possible, taking into consideration the safety-related requirements. In view of the longer-term interim storage, the waste packages shall be maintenance free.

The requirements for the waste containers result in particular from the safety analyses and are specified in the technical acceptance criteria of the interim storage facilities. In most cases, the requirements of the transport regulations also have to be observed, or compliance has to be ensured for the consignment at a later stage by means of an additional outer packaging. Waste containers and packagings for interim storage are licensed by the respective competent authority. Among others, the following requirements for waste containers regarding longer-term interim storage ensue from [4-3]:

- The design of the waste containers has to be such that their handling can also be ensured during and after interim storage. In this respect, long-term stability of the container materials has to be taken into consideration. The long-term integrity has to be ensured by means of an adequate design of the waste containers (e. g. corrosion protection, thick container walls). The potential for any impairment of the container integrity caused by impacts from the interior of the container (characteristics of the waste product) and from outside (e. g. atmospheric conditions of the interim storage facility) has to be considered.
- As far as the waste containers are not suitable for a longer-term interim storage without any doubt due to their design, recurrent controls of the waste containers by non-destructive tests (e. g. visual inspections) shall be performed. To enable these controls, accessibility has to be ensured in the interim storage facility (e. g. by providing alleys between the package stacks or separate storage of packages). The scope of the controls shall be defined individually.

Accident Analysis

The RSK recommendation [4-3] contains i. a. requirements for structural and technical installations in order to limit the effects of accidents. The facilities that are identical in construction are to be built according to the respective building codes of the *Länder* and according to the generally recognised engineering rules. Furthermore, the following applies:

- Upon the planning of structural or other technical protective provisions, measures have to be taken to limit the release of radioactive materials into the environment in the event of an incident. Here, the emergency reference levels of § 49 StrlSchV have to be observed for on-site interim storage facilities at nuclear power plants; for other interim waste storage facilities, the requirements of § 50 StrlSchV apply. The kind and scope of the protective measures and the protection objectives are to be specified in a general administrative provision pertaining to § 50 StrlSchV. This general administrative provision has yet to be drawn up.
- Within the framework of an incident analysis it has to be examined which operational disturbances and incidents may occur during the storage of low- and medium-active waste. On the basis of this analysis, the design basis accidents for storage shall be derived and distinguished from operational disturbance belonging to abnormal operation and residual-risk events. Human errors shall be considered in the analysis. The following plant-internal events (internal impacts) are generally to be considered as design basis accidents:
 - mechanical impacts (drop of a waste package or drop of a load onto a waste package),
 - fire,

- failures of safety-relevant systems and equipment (loss of preferred power, failure of instrumentation and control systems as well as of hoisting gear and transport vehicles).

Also, the following external events have to be taken into account in the analysis of potential impacts:

- natural external events, e. g. storm, rain, snowfall, freeze, lightning, flooding, forest fires, earthquakes, landslides,
- man-induced external events, e. g. impacts of harmful substances, blast waves caused by chemical reactions, external fires spreading to the interior, damage by mines caving, aircraft crashes.

Adaptations during Operation

The deadlines laid down in the licences for the interim storage of waste differ from authority to authority; they reach from about 20 years to unlimited periods. For the adaptation to the state of the art in science and technology during the period of storage of the waste packages and the operational lifetime of the facility, the competent authority may impose additional requirements for licensing.

For example, as a result of deficiencies found during the operating lives of radioactive waste management facilities, the following adaptations to the state of the art in science and technology were demanded and carried out in the past:

- changes in the documentation of the waste due to false declarations,
- adaptation of the design of waste containers (e. g. gradual transition to drums with internal coating),
- changes in storage configuration to allow inspections,
- equipment of the storage buildings with air conditioning systems as a result of the detection of condensation water and the associated corrosion risk for the containers, and
- adaptation of the monitoring systems (e. g. as a result of the detection of gas formation from the waste and the resulting pressure increase inside the waste containers).

H.5.2. Assessment of Safety before Construction of a Disposal Facility

Assessment of Safety before Construction of a Disposal Facility for the Period Following Closure

§ 9b as well as § 7, para. 2, subpara. 3 of the Atomic Energy Act (AtG) [1A-3] stipulate that the necessary precautions must be taken according to the state of the art in science and technology to prevent damage from ionising radiation. These precautions are also pertinent to the period following closure of a repository. As the disposal of radioactive waste in Germany is defined as the maintenance-free, safe emplacement of these materials for an unlimited period of time, the long-term safety assessment is of particular importance within the licensing procedure.

Evidence of compliance with the dose limits may be provided in the form of model calculations. These calculations are used to ascertain and quantify potential releases of radionuclides from the repository through the geosphere into the biosphere and to calculate the possible radiation exposure of humans using a variety of exposure scenarios and model assumptions. The input data for these models is derived from the characteristic data of the radioactive waste, a description of the deposition and technical barrier concept, and the geological data of the model area obtained from a site investigation. The dose is calculated with due regard for § 47 StrlSchV and the associated

General Administrative Provision [2-1]. Evidence is additionally based on an assessment of the overall geological situation of the site.

The current state of the art in science and technology is decisive when specifying a forecasting period for the required precautionary measures (isolation period). In other words, all relevant scientific and technological knowledge and experience must be taken into account. With the aid of a geo-scientific long-term forecast, an isolation potential of $> 10^5$ years has been calculated for the Konrad repository as a repository for radioactive waste with negligible heat generation.

Point 5.2 of the Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine [3-13] stipulates that

“.... site-specific safety analyses must be performed in accordance with scientific methods. Within the scope of the safety analysis, sub-systems and scenarios are emulated by means of suitable models using sufficiently conservative assumptions.”

This implies that releases of radionuclides and non-radioactive contaminants from the repository through the geosphere into the biosphere, as well as the resultant possible radiation exposure for humans and the effects on groundwater, must be evaluated and assessed within the context of model calculations.

Assessment of Impacts on the Environment

§ 9b of the Atomic Energy Act (AtG) stipulates that a plan approval procedure (licensing procedure) is mandatory for repositories for radioactive waste. The plan approval notice may only be granted if the prerequisites listed in the aforementioned section of the AtG have been met by the applicant (cf. the remarks on Article 4 (i) to (iv)). This also includes consideration of the common good and other provisions of public law, particularly with respect to the environmental impacts.

The Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10] and the Administrative Procedures Act (VwVfG) regulate the design and implementation of the plan approval procedure. In addition, the Environmental Impact Assessment Act (UVPG) requires the performance of an environmental impact assessment.

Stipulating that the state of the art in science and technology is a prerequisite for the plan approval notice ensures that the safety assessments and the environmental impact assessment are up-to-date at the time of issuing the plan approval notice.

H.5.3. Assessment of Safety before the Operation of Radioactive Waste Management Facilities

Under § 19 of the Atomic Energy Act (AtG), the handling and trafficking of radioactive substances is subject to government supervision. An assessment of the safety and the environmental impacts prior to commissioning of the nuclear facility occurs within the context of supervision which accompanies construction under the Atomic Energy Act.

If material deviations in the handling as specified in the licensing documents occur between the time of licensing until the commissioning of a facility for the treatment of radioactive waste, licensing under § 7 of the Radiation Protection Ordinance (or § 7 of the Atomic Energy Act in the case of vitrification facilities) is required (cf. the remarks made in Chapter G.5.2). Modification licences are applied for by the operator of the nuclear facility affected, sometimes within the framework of a nuclear regulatory authority order, at the competent licensing authority. The documents to be submitted together with the licence application have to reflect the state of the art in science and technology regarding the scope of effects of the part to be modified. The safety assessment carried out by the safety authority also has to be based on the state of the art in science and technology. Where applicable, in the case of projects requiring an environmental impact assessment under § 3e of the

Environmental Impact Assessment Act (UVPG), the assessment of environmental impacts must be repeated, e. g. if the alteration applied for could entail substantially altered impacts on the environment. This means that public participation will again be necessary as part of the environmental impact assessment.

H.6. Article 16: Operation of Facilities

Article 16: Operation of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

- i) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;*
- ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;*
- iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;*
- iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;*
- v) procedures for characterisation and segregation of radioactive waste are applied;*
- vi) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;*
- vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;*
- viii) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;*
- ix) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.*

H.6.1. Licensing of Operation

Before commencing operation, all systems and equipment are subjected to commissioning tests in accordance with the safety requirements for the longer-term interim storage of low- and medium-active waste [4-3]. These tests are specified as part of the licensing documents in a commissioning programme which ensures that the safety requirements outlined in Article 15 are met. The commissioning programme is subject to approval by the competent authority. The tests serve to demonstrate that the systems and equipment are qualified for the intended operation and can be operated as specified. The results are documented and assessed.

The overall operation must be suitably structured to ensure the safe performance of the operational processes. In particular, the administrative prerequisites regarding personnel, organisation and safety must be fulfilled. The authority supervises compliance with these prerequisites. Clear instructions must be drawn up in the form of an operating manual for operational processes, accident management and the removal of the consequences of incidents and accidents. Competencies and responsibilities must be clearly defined. The competent authority supervises compliance with these requirements.

Prior to initial emplacement or treatment of waste, the entire handling procedure, including the radiation protection measures, is tested. During the course of testing, any potential deficiencies in the procedure are identified. In this way, optimisations can be tested prior to handling the waste packages, and the envisaged procedures provided can be adapted and finalised.

H.6.2. Specification and Revision of Operational Limits

All operational processes and the measures to be taken in case of an incident or accident are outlined in an operating manual, or in the case of a repository, in a mine book/operating manual, in form of clear operating instructions. These pay particular attention to all aspects affecting safety and define operational limits and conditions. The operational limits are defined on the basis of the Atomic Energy Act (AtG) [1A-3] in compliance with the corresponding stipulations of the Radiation protection Ordinance (StrlSchV) [1A-8]. Here, the fundamental protection goals, such as the safe enclosure of activity and the guarantee of decay heat removal, have to be achieved both during normal operation and under corresponding accident conditions. In the licensing of operational release limits (e.g. for radiolysis gases) the principle of minimisation is applied by providing measures that are as reasonable as achievable. Furthermore, the procedure in case of modification or supplementation of components and processes must also be specified. The operating manual forms part of the licensing documents and is therefore subject to examination. This ensures that operatives are able to initiate and perform the necessary measures swiftly and competently in case of abnormal operation or incidents. This procedure is subject to regulatory supervision.

H.6.3. Compliance with Established Values

Regulatory supervision ensures observance of the procedures on operation, maintenance, monitoring, inspection and testing established in the nuclear licensing procedure for a radioactive waste management facility (cf. Table L-5 to Table L-13) as well as the consideration of the safety requirements for the longer-term interim storage of low- and medium-active waste [4-3].

For the treatment of radioactive waste, conditioning plants are used in this context that are subjected to qualification by the BfS, or the conditioned waste is subjected to product control procedures to ensure its suitability for final disposal (cf. the remarks made on Article 23 "Quality Assurance").

For storage facilities it applies in particular that the waste is subjected to incoming inspection prior to any form of treatment or emplacement. The incoming inspection serves the purpose of verification and must facilitate the following evidence:

- Identification control: The incoming inspection verifies whether the wastes are the same as those declared for acceptance.
- Fulfilment of acceptance criteria: The incoming inspection ensures that the acceptance criteria defined in the licence are fulfilled. For this purpose, reference may also be made to the quality-assured data of the conditioner.
- Verification of the data stated by the delivering party: The incoming inspection checks specific waste parameters independently from the data supplied by the delivering party. Specific parameters may include, for example, mass, dose rate and surface contamination.

As a general rule, the following aspects are controlled for the purposes of emplacement operation:

- mass, dose rate and surface contamination of the waste packages,
- condition and labelling of the waste packages,
- compliance with declared data.

Furthermore, the following is also observed:

- The incoming inspections are only performed by trained personnel.
- In the case of non-compliance, extended controls are performed.
- Any disturbances and findings are reported immediately.

The emplacement is logged.

When removing waste from the storage facility, exit inspections are performed. Waste packages leaving the facility are subject to unequivocal identification. In addition, the removal of waste is also logged.

Execution provisions are developed for compliance with the acceptance criteria. These include operating instructions and test procedures which must be observed during handling of the packages.

All the systems and equipment of the facility requiring testing or maintenance must be readily accessible or made accessible by technical means. The spatial conditions are designed in such a way as to allow sufficient space for maintenance work, and any additional shielding required for radiological protection reasons must be kept available. Regulations governing the preparation and performance of maintenance work are included in the operating manual.

At the site of the interim storage facility or management facility, adequate numbers of qualified personnel are employed to ensure fulfilment of all safety requirements; this personnel must be subject to regular training. With regard to said personnel, a distinction is made between the following cases:

- Management and storage facilities that have to be classified as being nuclear installations which are either in operation or in the process of dismantling: in such cases, the personnel of the nuclear installation perform most functions.
- Management and storage facilities with permanent staffing covered by own personnel: these facilities are regarded as being independent with regard to operation.
- Management and storage facilities which do not require permanent staffing. The functions are restricted to deployment on demand in case of treatment, emplacement or removal operations, and/or regular inspections. The demand is temporary and is generally covered by personnel who primarily perform other tasks.

The technical qualification required for the respective position is demonstrated in accordance with the requirements of the Radiation Protection Ordinance (StrlSchV) or separate regulations. The requirements concerning responsibility for nuclear safety issues are regulated by the Atomic Energy Act (AtG) [1A-3] and the Radiation Protection Ordinance (StrlSchV) [1A-8]. The responsibilities and regulations on representation are defined unambiguously in the operating manual.

Due regard is given to the development and promotion of a pronounced safety culture. This is particularly applicable to facilities where personnel activities are required relatively seldom or where changing personnel are deployed for different tasks. With regard to long-term operation of the storage facilities, it is assumed that changes of personnel are required. In this respect, measures are taken to ensure that the required personnel resources are available in order to maintain a sustainable safety culture. This is achieved by long-term personnel planning and careful planning with regard to the maintenance of experience.

Different emergency procedures may be required, depending on the type of management or storage facility and the wastes stored. Based on the possibilities for the release of radioactive substances from the storage facility, an on-site emergency preparedness plan is drawn up, coordinated and agreed, where applicable, with the emergency preparedness plans of neighbouring

facilities and the competent local and regional authorities. Hard copies of the on-site emergency preparedness plan are always kept available at a permanently staffed location. Further copies are submitted to the neighbouring facilities, the competent authorities and safety bodies, where applicable.

H.6.4. Availability of Technical Support

Report has already been given on the measures to ensure engineering support during the facility's operating lifetime via the provision of adequate competent personnel in the comments on Article 22 (i). The requirements for interim storage facilities ensue from the safety requirements for the longer-term interim storage of low- and medium-active waste [4-3], which stipulate that irrespective of the situation at the site, the interim storage facility must provide qualified personnel in sufficient numbers that ensures compliance with safety requirements and is regularly trained.

Recurrent tests are performed on the safety-relevant systems and equipment of the facility, such as

- conditioning facilities,
- lifting devices,
- alarm systems,
- equipment and systems for radiation protection,
- ventilation systems, where applicable.

The frequency of such testing is determined according to the safety significance of the components to be checked. Typical testing intervals are one or two years. The recurrent tests are specified in a testing manual. The results of the recurrent tests are documented and assessed.

The technical equipment used for the handling of the packages and the transportation thereof must remain available until all packages have been removed. In this respect, it is assumed that removal of the packages, e.g. for the purposes of emplacement in a repository, may take place over a longer period of time. To this end,

- the necessary systems and equipment of the facility (e.g. lifting devices) are kept either in a state of operational readiness or in such a state that operational readiness can be restored in the short term (e.g. by a recurrent test),
- auxiliary equipment (e.g. overpacks, special lading devices) required for transport is kept available,
- necessary type approvals for the cask types are permanently maintained,
- the packages are maintained in a condition that generally facilitates approval under traffic law provisions, and
- any aids required for obtaining approval under transport law provisions are available (e.g. measuring and test devices, documentation).

H.6.5. Characterisation and Segregation of Radioactive Waste

The sorting and segregation of the waste (if possible, already of the raw waste) and the preparation of the associated documentation is performed initially by the waste producer or by the delivering party. If required, the waste management or storage facilities should be equipped with the necessary means for the sorting of wastes with due regard for all requirements relating to the radiological protection of personnel and the environment.

In view of the intended pre-treatment and conditioning, Appendix X StrlSchV demands the sorting and segregation of the waste. Here, a distinction is made between five main groups:

- solid inorganic waste,
- solid organic waste,
- liquid inorganic waste,
- liquid organic waste, and
- gaseous waste.

These are subdivided into further subgroups.

The process-oriented treatment of waste is also subdivided in great detail into corresponding waste management categories. In all, there are 22 different categories.

The waste characterisation system is sufficiently flexible to ensure that the relevant waste types can be optimally prepared for the corresponding storage conditions and that the clear allocation of the waste according to its processing condition, characterisation and treatment is always ensured.

Moreover, the waste is also to be sorted according to activity and decay period to allow the determination of suitable storage and conditioning procedures. In practice, the sorting, declaration and documentation is carried out according to the Waste Flow Tracking and Product Control System (AVK) or similar procedures.

H.6.6. Reporting of Significant Incidents

At present, the obligation of the licensee to report safety-relevant incidents to the regulatory body is based on the appropriate application of the Nuclear Safety Officer and Reporting Ordinance (AtSMV) or on the stipulations in connection with licensing of the facility. The reporting duties and the reporting procedure are largely identical with the situation described in the remarks on Article 9 (v). The Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17] is currently under revision. This ordinance specifies the concrete elements of reporting for the facilities in question.

H.6.7. Collection and Analysis of Operating Experience

In view of the obligation of the authorities to take precautionary action, reports of incidents significant to safety are registered and evaluated at the incident registration centre of the Federal Office for Radiation Protection (cf. the remarks on Article 9 (vi) in Chapter G.6.6).

Experiences from the operation of similar plants are taken into account by the plant management. This ensures that experiences, especially regarding

- the behaviour of package material,
- observations on gradual changes of the waste products,
- ageing phenomena of facility equipment as well as
- improvements to or deficiencies in the conditioning procedures

are examined and evaluated with regard to their transferability. Here, international reporting systems (of the IAEA and the OECD) are also considered. In this way, plant operation also makes adequate allowance for processes that occur very slowly as well as occurrences taking place rarely or only in case of certain wastes. Procedures are provided which ensure the exchange of experiences (e.g. on the basis of operating reports) between the operators on the one hand, and the

competent licensing and supervisory authorities and the experts consulted by them on the other, at adequate intervals.

A monitoring concept is drawn up to allow the detection and control of long-term and ageing effects during the useful life of the storage facility. On the one hand, the monitoring concept includes an evaluation of results from previous inspections, including the experience from other facilities. On the other hand, it can also include special analyses that cannot be performed recurrently at regular intervals due to the effort involved and the slow speed of any anticipated detrimental changes.

The monitoring concept stipulates monitoring of the overall condition of the facility and the packages stored, and as a minimum requirement, must meet the following:

- At ten-year intervals, the licensee prepares regular reports on the condition of the storage building, the components required for storage and handling, and the waste packages. In particular, these reports should also incorporate the findings of in-service inspections. The reports include a prognosis on the continued storability of the packages and waste types, as well as on the further development of the relevant retention properties of the building.
- The condition of the storage building and the components necessary for interim storage are also subjected to a special inspection at intervals of ten years. As a minimum requirement, these should include walk-downs and appropriate measurements. In addition, recurrent subsidence measurements are performed on the storage building and evaluated with regard to long-term detrimental changes.

All operational measures, controls, inspections and modifications are subject to the supervision of the competent authorities.

H.6.8. Preparation of Decommissioning Plans

For radioactive waste treatment facilities, the remarks made on Article 9 (vii) apply, too.

H.6.9. Closure of Repositories

The Atomic Energy Act (AtG) is applicable to the Morsleben repository, which is destined for closure and backfilling, as well as to the licensed Konrad repository. However, since these are either located or planned to be located in deep geological formations, they are also subject to mining law as well as the Atomic Energy Act. According to § 55, para. 1 of the Federal Mining Act (BBergG) [1B-15], operational plans for the construction and management of a plant may only be approved if the required precautions to facilitate reutilisation of the surface have been taken into account to the extent required under the prevailing circumstances. Furthermore, the relevant § 7, para. 2 of the General Mining Ordinance on Underground Mines, Open-Cast Mines and Salt Mines (ABVO) [ABVO 96] stipulates that open shafts maintained in a state which is neither safe nor descendible are to be backfilled. An application for such backfilling must be submitted in a timely manner in the form of an operational plan.

This aspect of mining legislation therefore ensures that at the time of filing the final operational plan – which may be many years in the future from the date of approval of operation – any new knowledge acquired in the interim period can be duly taken into account.

The licensing procedure under nuclear law stipulates that the “Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine” [3-13] must be taken into account. This was the case in the licensing procedure for the Konrad repository. These safety criteria were likewise taken into account in the licensing procedure for the closure of the Morsleben repository. The safety criteria include provisions regulating to closure under point 9 (closure in the sense of the Joint Convention). These provide that voids must be backfilled and sealed with suitable materials, using appropriate techniques, in order to increase stability by means of void reduction. As a general rule, the

potential release of radionuclides and non-radioactive pollutants from a repository must be limited to an admissible extent. Consequently, due regard for these guidelines ensures in the field of nuclear legislation that all necessary measures are planned prior to closure but may only be carried out after licensing.

Konrad Repository

The official plan approval for the Konrad repository of 22 May 2002 has been affirmed. This also stipulates regulations pertaining to the closure of the repository. The applicant (BfS) filed plans for the closure of both the mine openings and the shafts. Expert evaluation indicates that these plans conform to the current state of the art in science and technology.

So far, no repository in deep geological formations has been either backfilled or closed in the Federal Republic of Germany. Plans in this respect for the Konrad mine as a repository for radioactive waste with negligible heat generation were filed and approved within the scope of the licensing procedure that was concluded in May 2002. Concrete details of the measures required in order to comply with the protection targets following the cessation of emplacement operations have not yet been finalised. Since closure does not generally take place for several decades, such details must be specified according to the state of the art in science and technology existing at that time within the context of separate procedures encompassing the requirements of nuclear legislation, mining and water legislation as well as other legal requirements.

Morsleben Repository

The closure of the Morsleben repository is in preparation. During this phase, all relevant information gathered during the operational period (until today) is taken into consideration. For example, the closure concept incorporates findings from the geological, geotechnical, geochemical and mining fields. With respect to radiation protection, the potential release of radionuclides during the post-operational phase shall be limited to an acceptable level by the closure. During the post-operational phase it is required that the entire repository is safely sealed against the biosphere (cf. the remarks on Article 14 (iii)). This has to be demonstrated by a site-specific long-term safety analysis. For such an analysis, partial systems and scenarios within the whole system are modelled using suitable models based on conservative assumptions. Apart from the requirements posed by radiation protection, the requirements from other legal areas, mainly the mining law and water legislation, have to be taken into account.

According to § 9b of the Atomic Energy Act (AtG), any major modifications of the Morsleben repository, i.e. also any measures concerning its closure, require a plan approval by the competent environmental ministry of the Land Saxony-Anhalt. In the scope of the licensing procedure for the Morsleben repository, the only difference to the plan approval procedure for § 9b AtG (cf. the remarks on Article 19) consists in the fact that for this existing repository the operational phase is finished and that the corresponding procedures can only be directed at the requirements for safe closure. The plan approval according to the Atomic Law states that the plan for closure is permissible with respect to all public interests which are touched. The licensing of the operating plans according to mining law lies within the responsibility of the mining authority of Saxony-Anhalt.

The plan approval procedure for operation of the repository which had been initiated in 1992 was restricted to decommissioning (or closure in the sense of the Convention) upon application of the BfS in 1997. The first step in the environmental impact assessment which is required as part of the plan approval procedure was to define the required documents according to § 5 of the Environmental Impact Assessment Act (UVPG). A large part of the documents is already available, they are currently further amended.

In parallel to the environmental impact assessment, other measures for hazard control were carried out on the basis of licences according to mining law. This aimed at the long-term stability of the mine by backfilling cavities in the central part. In the course of these measures, 24 mine workings with a total volume of 750 000 m³ will be filled until the end of 2009. This will not anticipate any measures for closure, in particular as the disposal areas are not backfilled as part of the premature backfilling. It is planned to terminate the plan approval procedure until the end of 2012 and to start the measures for closure afterwards.

The Morsleben repository was designed and taken into operation at the time of the former GDR. A closure concept was developed in 1989 which included the scheduled flooding of the mine. After takeover as a federal repository in the course of the German reunification, new conclusions from the operational phase and from dedicated geological, geotechnical, geochemical and mining technique assessments for the development of a new closure concept were included. The closure concept intends to hydraulically isolate the disposal areas, i. e. the mine workings used for disposal of radioactive waste and their wider surroundings, from the rest of the mine workings by sealing the drifts. The sealing of drifts poses high demands with respect to their hydraulic properties. The access of solutions into the disposal areas shall be impeded in the long term. In addition, the entire mine works are to be backfilled as far as possible with salt concrete in order to reduce the cavities available to solutions, to geomechanically stabilise the mine works and to minimise potential extraction processes at soluble layers of potash salt by water access, which cannot be totally excluded. The concept for backfilling and sealing further includes the closure of both shafts of the ERAM by systems of sealing elements of various materials with low penetrability in order to minimise the influx of groundwater from the overlying rock into the mine and the discharge of radionuclides in solution from the mine into the overlying rock. The measures within the closure concept aim at stabilizing the mine works and to isolate the radioactive wastes in such a way that the protection targets of the AtG are complied with. The closure concept of the Morsleben repository requires approval by a plan approval procedure.

Asse Mine

After the end of extraction operation, the former Asse II salt mine was designed as a research mine and has been operated by the Helmholtz Zentrum München on behalf of the BMBF. As part of experimental disposal, a total of 124 494 containers with low-active waste were emplaced between 1967 and 1978 and of 1 293 containers with medium-active waste between 1972 and 1977. Since 1979, the mine has only been used for research purposes with the aim of development and demonstration of procedures for disposal of low- and medium-level waste as well as for the development and testing of techniques for filling and closing of boreholes, chambers, drifts and shafts in a repository.

The Asse mine is subject to supervision according to mining law and atomic law. Operation, research activities, filling and closure are governed by the operating plan procedure according to the Federal Mining Act (*Bundesberggesetz*, BBergG) and other regulations, e.g. Radiation Protection Ordinance (StrlSchV), with framework operational plans, main operational plans and extra operational plans as well as a framework operational plan for closure, if necessary with amendments and modifications. Licensing and supervision are carried out according to BBergG and StrlSchV by the State Office for Mining, Energy and Geology (*Landesamt für Bergbau, Energie und Geologie*, LBEG) under the technical oversight of the Environmental Ministry of Lower Saxony (NMU).

In 1997, the Helmholtz Zentrum München filed a framework operational plan for closure of the Asse mine on the basis of the BBergG, which was approved by the mining authority with a number of collateral clauses at the end of November 1997. Apart from the framework operational plan for closure, the Helmholtz Zentrum München was obliged to provide a safety report with an assessment of long-term safety in line with the state of the art in science and technology, according to

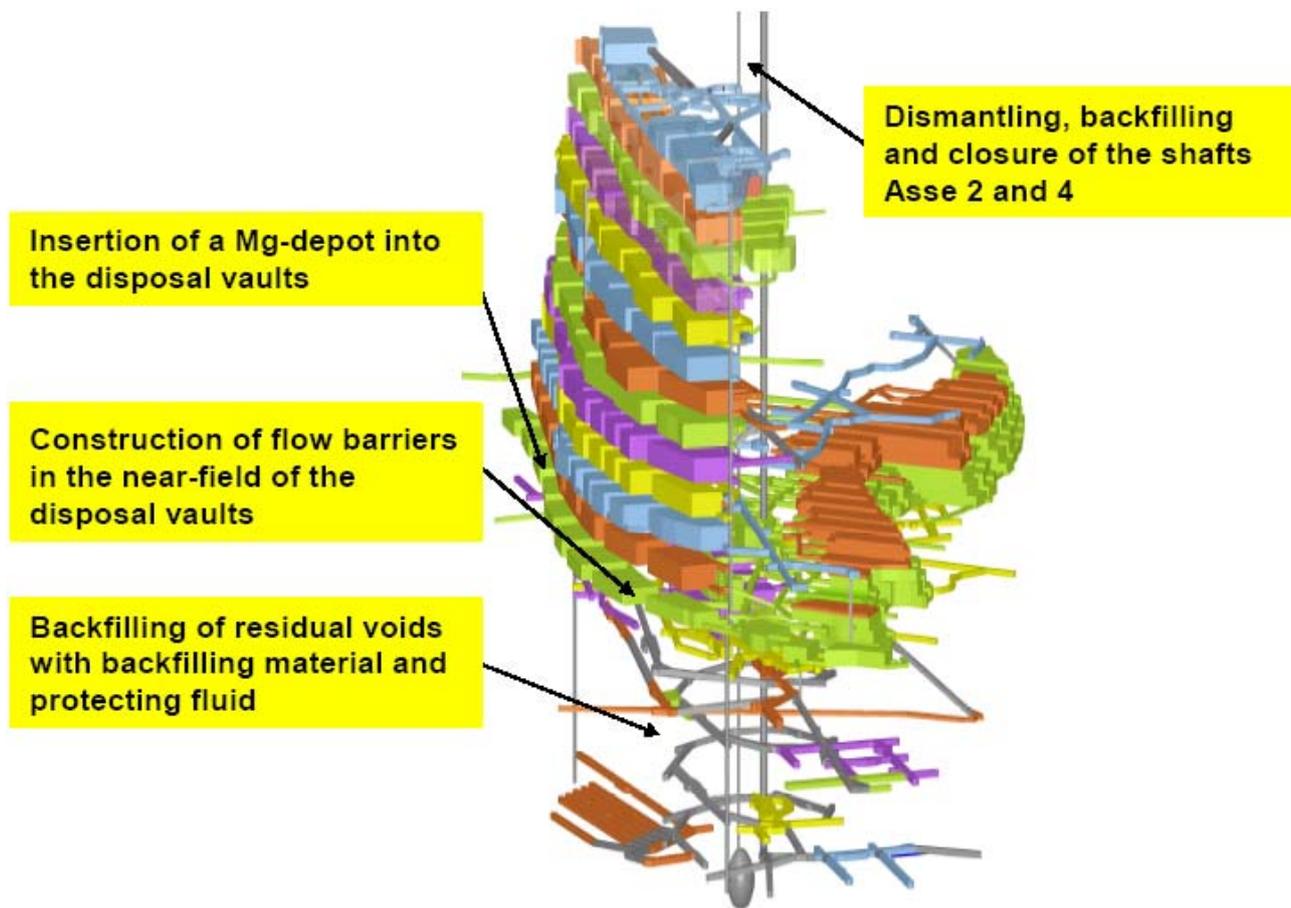
§ 53 BBergG, and in analogy and with a similar level of detail as required for a repository for radioactive waste under atomic law. Following formal process regulations of AtG and AtVfV, the licensing procedure according to mining law is carried out with involvement of the general public, which is in line with all requirements of similar procedures under atomic law. The procedure is carried out under the auspices of the *Land* authorities (LBEG, supported by the Ministry for the Environment and Climate Protection of Lower Saxony).

An influx of solution in the range of the southern flank was observed in 1988, which was triggered by movement of the salt rock strata induced by mining activities. The solutions, which enter at a quantity of 12.5 m³ per day, are fully collected. The chemical composition is largely constant. During the residual operation, the collected solution is pumped to the surface and is put at the disposal of the Kali und Salz AG for further use.

In order to stabilise the mine, old chambers in the southern flank were filled between August 1995 and December 2003. A total of about 2.1 million Mg (corresponding to 1.75 million m³) fill material was inserted into the southern flank of the Asse mine. The Helmholtz Zentrum München has then started to fill the shafts and drifts below the disposal areas. Filling of these sections is carried out with rock salt with addition of magnesium chloride solution, acting as liquid fill material, which is to permanently protect the carnallitic potash salt occurring in the mine against future dissolution by entering sodium chloride solution. Disposal areas are not affected by the filling actions taken so far.

The final closure of the Asse mine envisages the complete filling of all cavities and shafts in the mine with suitable backfill and sealing materials with the addition of the protective fluid magnesium chloride (see Figure H-2).

Figure H-2: Main components for closure of the Asse mine (Copyright: Schachtanlage Asse)



The Helmholtz Zentrum München provided an operational plan for closure and a safety report on 29 January 2007. The licensing authority, LBEG, and their independent experts have started the formal detailed review process of the technical documents that were filed in support of the safety report. A decision whether the currently intended procedure for filling with use of a protective fluid will be continued or whether other options have to be taken into account is part of the review process.

On 4 September 2008 the competent Federal Ministries BMU and BMBF and the Ministry for the Environment and Climate Protection of Lower Saxony agreed that BfS will take over responsibility for the decommissioning as future operator. The Asse mine shall be subjected to the legal procedure applying to repositories.

H.7. Article 17. Institutional Measures after Closure

Article 17. Institutional measures after closure

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility

- (i) records of the location, design and inventory of that facility required by the regulatory body are preserved;*

- (ii) *active or passive institutional controls such as monitoring or access restrictions are carried out, if required;*
- (iii) *if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.*

H.7.1. Documentation

Official plan approval has only been issued for the Konrad repository. This also includes regulations governing the post-operational period following. A collateral clause stipulates that:

“Documentation must be provided during construction, operation and decommissioning of the repository, comprised of data relating to the mine survey of the repository, the characteristics of the wastes deposited (type, quantity, emplacement area, nuclide spectrum, activities), as well as the relevant technical measures. Full sets of documentation must be kept by the operator of the repository at a suitable place and must be duly protected. In addition, the operator must provide full sets of documentation for the atomic authority and for the competent mining office, respectively, which are to be kept under protection in separate locations. The sets of documentation kept by the supervisory authorities must be updated on an annual basis as long as the repository is operational or in the process of decommissioning. For the period following its closure, the form, extent and the storage locations (at least at two separate locations) of the long-term documentation must be specified in the closure plan and submitted to the supervisory authorities for approval.”

It can be assumed that the regulations laid down in the plan approval decision for the post-operation phase of the Konrad repository will act as a precedent for the Morsleben repository. This repository is being closed, and the required measures for backfilling and closure are currently being planned.

H.7.2. Monitoring and Institutional Control

So far, there exist no corresponding regulations. Examinations are provided as part of the plan approval procedures for repositories which kinds of controls have to be carried out after closure. Institutional control after closure is regulated in the licence for the Konrad repository as follows:

“No special control and surveillance programme is envisaged for the period following closure. However, routine measurements of the environmental media air, water and soil must be conducted on the area surrounding the repository in accordance with the relevant regulations. These measurements must be examined for any evidence of impacts from the repository and documented in a suitable format. The extent and format must be specified in the closure plan and the results added to the long-term documentation.”

As such, the required institutional controls are primarily limited to passive measures. Active measures are not envisaged in view of the design of the repository. Should the results from routine surveillance so require, counteractive action may be initiated by means of intervention on the part of the authorities.

The procedure for the Morsleben repository has not yet been specified.

H.7.3. Unplanned Release

As outlined in the remarks on Article 17 (ii), no special control or surveillance measures are required following the closure of a repository or a mine in deep geological formations. The usual inspection of surface settlement is carried out within the regime of mining law. The routine measurements of air, water and soil samples are likewise carried out in the area surrounding a reposi-

tory, in accordance with legal requirements. In this way, any unplanned releases of radioactive substances may be detected and any measures which may be required by the competent authorities in order to avoid or mitigate any hazards can then be initiated.

Collateral clauses in the plan approval decision for the Konrad repository stipulate that routine surveillance data must likewise be evaluated in this respect.

The closure of the Morsleben repository (ERAM) is currently in the planning phase, and therefore plan approval is not yet available. However, the routine surveillance programme as stipulated in the radiation protection regulations must be carried out for this site.

The closure of the Asse mine is currently still at the planning stage, which means that there is no final plan approval decision available yet. Routine monitoring of the site according to radiation protection regulations has to be performed.

I. Transboundary Movement

This section deals with the obligations according to Article 27 of the Convention.

I.1. Article 27. Transboundary Movement

Article 27. Transboundary movement

1. *Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.*

In so doing:

- (i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorised and takes place only with the prior notification and consent of the State of destination;*
 - (ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilised;*
 - (iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;*
 - (iv) a Contracting Party which is a State of origin shall authorise a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary movement;*
 - (v) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.*
2. *A Contracting Party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.*
3. *Nothing in this Convention prejudices or affects:*
 - (i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;*
 - (ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;*
 - (iii) the right of a Contracting Party to export its spent fuel for reprocessing;*
 - (iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.*

I.2. Obligation of Licensing Transboundary Movement

Transboundary movements of spent fuel assemblies and radioactive waste are subject to licensing in Germany. Current German legislation requires that the delivering party (i.e. exporter) must submit an application to the competent authority (the Federal Office of Economics and Export Control (BAFA)) for each shipment of these materials. The BAFA must determine whether all nuclear legal provisions have been met and if so, grants the licence and subsequently, within the framework of

waste management control, monitors compliance with the legal requirements during each individual shipment. In principle, a licence for a given quantity of material may be used for several individual shipments of partial amounts. In the case of shipment of radioactive waste from other EU states to Germany, the licensing authority in the delivering country shall be responsible; however, the BAFA is also consulted.

Transboundary movements of spent fuel assemblies and radioactive waste will only be authorised if compliance with the safety measures outlined in the comments on Articles 4 to 17 and 21 to 26 is ensured, and compliance with the provisions of international conventions has been checked.

I.2.1. Authorisation of Transports and Co-ordination with State of Destination

Spent Fuel Assemblies

Essential for all transboundary movements of spent fuel assemblies to or from the Federal Republic of Germany is a licence according to § 3 of the German Atomic Energy Act (AtG) [1A-3]; here, the competent authority according to § 22 para. 1 AtG is the BAFA. Such a licence will only be granted if there are no concerns regarding the applicant's reliability and if compliance with national and international safety regulations is guaranteed.

In the case of shipments out of Germany, it is additionally necessary to ensure that the State of destination will not put the consignment to any use whatsoever in a manner that will endanger Germany's international obligations in the field of nuclear power or its internal or external security (§ 3, para. 3 AtG).

Observance of these additional provisions is checked by the BAFA on the basis of contracts and declarations which must be submitted by the State of destination. Within the context of parallel supervision of a material's movements by EURATOM, to whom monthly reports about any inventory changes must be submitted, the correctness of which is verified by inspectors on a regular basis, notification also occurs prior to each individual shipment.

In the case of return deliveries e.g. of spent fuel assemblies from research reactors back to the USA, export cannot take place until the BAFA has received an official import certificate from the United States. For other states, an exchange of notes takes place between the affected government prior to the delivery, as part of the licensing procedure under foreign trade law.

Radioactive Waste

Each transboundary movement of radioactive waste is subject to the provisions of Directives 92/3/EURATOM [EUR 92] and 2006/117/EURATOM [EUR 06]. Directive 92/3/EURATOM has been transformed into national law with the Ordinance on the Transboundary Movement of Radioactive Waste (AtAV) [1A-18]. It is currently being revised to implement 2006/117/EURATOM. It primarily comprises the following provisions:

Transboundary Movement within the European Community

The holder of radioactive waste applies to the competent authority in his country (in Germany, this is the BAFA) for a licence. There is a standard form available for this purpose, which is divided into different sections. Section 1 is the application form. The competent authority forwards a copy of this section together with section 2 ("Approval of the consulted competent authority") to this competent authority in the State of destination (which in the case of shipments to Germany is the BAFA). This section 2 is only approved by the BAFA and mailed back to the competent licensing authority provided both the consignee and his competent supervising authority have likewise given their consent to the proposed shipment. Section 3, the licence itself, can then be issued and handed over to the applicant.

During a shipment, all documents must be carried, including section 4 ("loading list") and 5 ("acknowledgement of receipt"). In the case of transportation by rail, all the aforementioned documents must be transmitted to all authorities concerned in advance of each shipment. In order to ensure that all authorities concerned are informed about every shipment, and to enable them to log the quantities delivered, they regularly receive copies of the respective sections 4 and 5.

Transboundary Movement to or from States which are not Members of the European Community (Third Countries)

In the case of shipments from Germany to a third country, the BAFA will only grant a licence to the holder of the radioactive waste provided the competent authority of that third country has confirmed to the BAFA that the consignee holds the necessary licence and the necessary equipment to handle such radioactive waste, and it has been proven that the respective specified criteria for the export of radioactive waste to third countries have been met.

In case of a shipment from a third country to Germany, the consignee is the applicant, and will only receive a licence from the BAFA provided he holds the necessary licence and the necessary equipment to handle such radioactive waste or has notified such handling in accordance with an existing obligation.

I.2.2. Transboundary Movement through States of Transit

In the case of transit through Germany of spent fuel assemblies, which are not radioactive waste and therefore do not fall under the provisions of the AtAV, the BAFA is not involved. Supervision of the transit of such spent fuel assemblies is the responsibility of the Federal Office for Radiation Protection (BfS), and in the case of transportation by rail, the Federal Office for Railways (EBA).

In the case of transit of radioactive waste, the BAFA must be consulted under the provisions of Directive 92/3/EURATOM [EUR 92] or of the AtAV; the transit therefore is subject to approval. Such approval will only be granted if there are no facts leading to concerns vis-à-vis proper delivery to the country of destination.

I.2.3. Compliance with Safety Provisions by the Consignee in Germany

Transboundary movements of spent fuel assemblies and of radioactive waste will only be licensed by the expert staff at Germany's competent authority, the BAFA, provided the consignee in Germany ensures that such materials conform to the safety measures outlined in the comments on Articles 4 to 17 and 21 to 26. Prior to receiving such material, the consignee must apply to the BAFA for a licence under the statutory provisions outlined in with respect to Article 27 1. (i). The BAFA will verify compliance with these provisions. Under EU law, this procedure does not apply within the Member States of the EU.

I.2.4. Compliance with Safety Provisions by the Consignee in the State of Destination

In the case of deliveries of spent fuel assemblies from Germany, a licence will only be granted provided the consignee, according to the documents available, fulfils the provisions outlined under Article 27 1. (iii), i.e. the international and/or European provisions are met and there are no substantiated doubts that this is so. In the case of deliveries of radioactive waste out of Germany, the requirements outlined in Article 27 1. (iii) are met by the consultation process pursuant to the AtAV in conjunction with Directive 92/3/EURATOM [EUR 92] (in this respect, cf. the comments on Article 27 1. (i) and (ii)).

I.2.5. Possibility of Re-Import

In accordance with § 3 of the Atomic Energy Act (AtG), the re-import of spent fuel assemblies into Germany is possible in principle; the provisions in this respect were explained under Article 27 1. (i).

Generally speaking, a shipment of radioactive waste under the AtAV in conjunction with Directive 92/3/EURATOM facilitates the option of return shipment in case the envisaged delivery cannot be completed.

According to § 7, para. 1, subpara. 3 AtAV, shipment to another EU Member State will only be licensed provided measures are taken to ensure that the radioactive waste will be taken back by the original owner if delivery cannot be completed or the provisions for its shipment cannot be met.

According to § 8, para. 1, subpara. 4 AtAV, shipment to a third country will likewise only be licensed provided measures are taken to ensure that the radioactive waste will be taken back by the original owner if delivery cannot be completed or the provisions for its shipment cannot be met.

According to § 9, para. 1, subpara. 3 AtAV, shipment from a third country into Germany will only be licensed provided the domestic consignee of the radioactive waste has reached a binding agreement with the foreign owner of the radioactive waste, with the consent of the competent authority in the third country, that the foreign owner will take back the radioactive waste if the shipment process cannot be completed.

Finally, according to § 13, para. 1, subpara. 2 AtAV, the BAFA may only give its approval to a shipment from another EU Member State to Germany provided measures have been taken to ensure that the radioactive waste will be taken back by the original owner if delivery cannot be completed or the provisions for its shipment cannot be met.

I.3. Antarctic Treaty

Germany ratified the Antarctic Treaty of 1 December 1959 [ANT 78] on 22 December 1978. Article V of this Treaty includes a ban on the shipment of radioactive waste south of latitude 60 degrees South. The Treaty was incorporated into national law and entered into force on 5 February 1979, thereby obligating Germany to comply with this ban. § 5 AtAV likewise prohibits shipments into this region.

I.4. Sovereignty Demarcations

I.4.1. Maritime Traffic and River Navigation

With respect to the freedom of international maritime traffic, Germany has legally committed itself to observe the requirements of this Article insofar as it has acceded to the United Nations Convention on the Law of the Sea of 10 December 1982. It was transformed into national law by the Act on the United Nations Convention on the Law of the Sea of 10 December 1982 [UNCLOS 94].

With regard to the freedom of river navigation, it should be noted that Germany is a Party to the Revised Convention on Navigation on the Rhine (*Revidierte Rheinschiffahrtsakte*) of 17 October 1868 [Rhein 68] and to the Convention of 27 October 1956 on the Canalisation of the Moselle [Mosel 57].

I.4.2. Air Traffic

With respect to air traffic, the requirements of this Article are met by Germany's accession to the International Agreement on the Transit of Air Services (*Vereinbarung über den Durchflug im inter-*

nationalen Linienverkehr) [Linien 56]. This Agreement stipulates that the Member States shall reciprocally grant one other the rights of the so-called first and second freedoms of air traffic, i. e. the right to pass over and to land for technical reasons. These commitments have been transformed into national law by the Act of Approval (*Zustimmungsgesetz*) on the basis of Article 59, para. 2 of Germany's Basic Law (*Grundgesetz*).

I.4.3. Return of Radioactive Waste after Processing

The right referred to in this Article is not impaired by the incorporation of the Convention into German legislation. German legislation does not include an obligation to accept the return of waste; it is instead agreed contractually with these export procedures.

I.4.4. Shipment of Spent Fuel Assemblies for Reprocessing

This right remained unaffected until 30 June 2005. From this date on, the shipment of German spent fuel assemblies from power reactors for reprocessing is no longer admissible, not because of the incorporation of this Convention into German legislation, but by virtue of the Amendment of the German Atomic Energy Act of 22 April 2002.

I.4.5. Return of Material from Reprocessing

The right referred to in this Article is not impaired by including the Convention in German legislation. On the contrary: in an exchange of notes with the French government and with the British government of 1979 and 1990/1991, respectively, the German government reinforced the rights of both these nations to return the waste and other products arising from the reprocessing of spent German fuel assemblies to Germany.

I.5. Progress and Major Changes since the Last Review Meeting

The AtAV is being revised on the basis of Directive 2006/117/EURATOM of 20 November 2006.

J. Disused Sealed Sources

This section deals with the requirements of Article 28 of the Convention.

J.1. Article 28. Disused Sealed Sources

Article 28. Disused Sealed Sources

1. *Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.*
2. *A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.*

J.1.1. Measures for the Safe Handling of Disused Sealed Sources

In Germany, the safety of disused sealed sources has been ensured for a long time by a legal framework in accordance with European and international legal standards and by an extensive system of licensing and supervision.

Loss or discovery of sources does therefore constitute an exceptional case. In the vast majority of the very rare cases of so-called “orphan sources” in Germany, radioactive sources of low activity are concerned. Loss and discovery of radioactive materials are recorded in the annual reports of the BfS [BfS 04], BfS 06]. In this way, the public is kept informed and is sensitised for this subject.

Improvement of the control of disused sealed sources is therefore a key factor in the efforts to avoid any exceptional exposure of humans, the environment and material goods. A number of amendments to the European and international regulatory framework concerning high-active sources and orphan sources have been implemented against the background of globally increasing danger of terrorism and safety concerns. These amendments have been swiftly transposed into national legislation in Germany, as far as necessary.

Council Directive 2003/122/EURATOM of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources (Official Journal of the European Union, L 346/57, of 31 December 2003) [EUR 03] is one of the important regulations in this area. In August 2005, the Law on the Control of High-Activity Radioactive Sources [1A-23] entered into force. The scope of the Council Directive 2003/122/EURATOM and of the Law [1A-23] is limited on high-activity sealed radioactive sources. The main issues of this law are:

- implementation of a central register at the Federal Office for Radiation Protection (BfS), from which the location of any high-activity radioactive source can be traced at any time,
- a legally fixed obligation of the manufacturer to take back disused radioactive source,
- labelling of radioactive sources with an unambiguous identification code by the manufacturer,
- a general requirement for licensing for use as well as
- more stringent requirements for import into and export from the European Union.

The implementation of the Law on the Control of High-Activity Radioactive Sources [1A-23] has entailed substantial changes to the Atomic Energy Act [1A-3], the Radiation Protection Ordinance [1A-8], the Ordinance on the Financial Security Pursuant to the Atomic Energy Act (AtDeckV) [1A-11] as well as the Nuclear Waste Transfer Ordinance (AtAV) [1A-18]. Changes to the Radiation Protection Ordinance mainly consisted of the insertion of column 3a in Appendix III Table 1 StrISchV, which contains the activity values for high-activity radioactive sources as 1/100 of the A₁

values in Bq, as well as in the adaptation of various regulations, like transboundary movement requiring a licence or a notification, the obligation for labelling, taking back of high-activity radioactive sources as well as in the implementation of suitable transitional regulations.

The use of sealed radioactive sources requires a licence according to § 7 StrlSchV. There is only an exception for very small test sources with an activity below the exemption values of Appendix III Table 1 Column 2 or 3 StrlSchV (§ 8 para. 1 in connection with Appendix I Part B no. 1 and 2 StrlSchV), and for type-approved devices that may contain radioactive sealed sources that may not be high-active in the sense of the definitions given above (§ 8 para. 1 in connection with Appendix I Part B no. 4 StrlSchV).

Furthermore, § 69 para. 1 StrlSchV stipulates that radioactive materials, which may only be used under a licence i. a. according to § 7 StrlSchV, may only be transferred to persons who are in possession of the requisite license. According to § 69 para. 2 StrlSchV, anyone transferring radioactive substances to third parties for further use has to certify to the procuring party that the casing is leak-proof and free of contamination. High-active radioactive sources must only be transferred if they are accompanied by a documentation of the manufacturer, which is specified there. § 69 para. 3 and 4 StrlSchV regulate shipment and transfer to the recipient. Noncompliance with these regulations of § 69 is fined according to § 116 StrlSchV as an administrative offense. In addition, the storage, shipment, handling, processing, other use as well as import and export of other radioactive materials without appropriate licence or against an executable interdiction, by which – depending on its type, nature and quantity – death or damage to health of other persons by ionising radiation may be caused, is even punishable according to § 328 para. 1 subpara. 2 Criminal Code (StGB) [1B-1].

According to § 69 para. 5 StrlSchV, high-active radioactive sources, which are disused or for which no further use is intended, have to be transferred to the manufacturer, the carrier or another licensee or have to be disposed of as radioactive waste or kept in interim storage. Manufacturers and carriers are obliged to take the sources back.

According to § 70, para. 1 StrlSchV, the competent authority must be notified within one month of any extraction, production, acquisition, disposal and whereabouts of radioactive material and therefore also of radioactive sources, including details of type and activity, and records must be kept. In addition, the use of high-active radioactive sources requires information of the BfS. The information to be provided is unambiguously defined (see below). § 70, para. 4 StrlSchV requires that the certificate of tightness of sealed radioactive materials referred to above must also include notification regarding acquisition of the radiation source. Type-approved radiation sources that may be used without a licence in accordance with § 8 para. 1 in conjunction with Appendix 1 part B no. 4 of the Radiation Protection Ordinance (StrlSchV) must be returned immediately to the holder of the approval upon completion of use in accordance with § 27 para. 1 subpara. 5 StrlSchV.

The newly introduced § 70a StrlSchV contains requirements for the register of high-active radioactive sources that is kept at the BfS. The data according to § 12d para. 2 of the Atomic Energy Act (AtG) concerning such sources have to be transmitted by the licensee using the standardised data sheet of Appendix XV StrlSchV in secured electronic form.

§ 71 StrlSchV regulates the loss, discovery and acquisition of actual control over radioactive materials and is therefore also relevant for radiation sources. Any loss of actual control over radioactive materials whose activity exceeds the exemption levels stipulated in Appendix III table 1 columns 2 and 3 of the StrlSchV must be reported immediately to the competent nuclear supervisory authority or to the authority responsible for public safety and order by the owner of the material. Loss of a high-active radioactive source also requires immediate reporting to the register for high-active radioactive sources at the BfS in electronic form, using the standardised data sheet specified in the Radiation Protection Ordinance. Any discovery of radioactive materials or acquisition of actual control over such materials must be reported immediately to the competent nuclear supervisory authority or to the authority responsible for public safety and order.

The German regulatory framework transposes those parts of the EURATOM Basic Safety Standards (Council Directive 96/29/EURATOM) [1F-18] that pertain to radiation sources as well as the Council Directive 2003/122/EURATOM into national legislation. The amendments that were implemented in the German regulatory framework on the basis of Directive 2003/122/EURATOM also include the recommendations of the IAEA Code of Conduct on the Safety and Security of Radioactive Sources [IAEA 04] and of the associated newly issued IAEA Guidance on the Import and Export of Radioactive Sources⁴, IAEA-GOV/2004/62-GC(48)/13 [IAEA 04a], which stipulate licensing requirements for import and export of radiation sources exceeding activities prescribed in the Code of Conduct. This is in accordance with the declaration of the G 8 Summit in the summer of 2003 and with the G 8 Action Programme of the summer of 2003 and the summer of 2004, where consideration of IAEA recommendations was stipulated (e.g. [G-8 03]). The requirements for the necessary knowledge in radiation protection of persons who handle radiation sources are regulated in the Guideline on Technical Qualification in Radiation Protection [3-40].

J.1.2. Re-Entry of Disused Sealed Sources

Sealed radiation sources are manufactured in Germany and are also exported to other countries. Therefore, regulatory requirements for re-entry of disused sealed radiation sources to Germany have existed for a long time. Because of the generally high risk potential, the regulatory framework has been tightened especially in this area.

The Code of Conduct on the Safety and Security of Radioactive Sources of the IAEA [IAEA 04] and the associated IAEA Guidance on the Import and Export of Radioactive Sources [IAEA 04a] are intended to bring about a harmonisation of the different international practices in connection with the import and export of radioactive sources for non-IAEA Member States, too. The IAEA Code of Conduct deals with the import and export of radiation sources in §§ 23 to 29. The IAEA Guidance now demands a co-operation of the authorities involved in shipments (i.e. also in the re-entry) of similar extent and intensity as for shipment of radioactive waste.

After the Law on the Control of High-Activity Radioactive Sources [1A-23] entered into force, the regulations for the transboundary shipment contained in §§ 19 to 22 of the Radiation Protection Ordinance, which so far had implemented the requirements of the Directive 96/29/EURATOM, were adapted. It needs to be mentioned that shipment within the EU is not subject to licensing requirements and that in addition a licence for shipment from or into third countries may be replaced by a notification. Transboundary shipment inside the EU is regulated by Directive 1493/93/EURATOM (see below). With respect to sealed radiation sources, the prior notice of the competent authority based on a declaration of the addressee is essential (in Germany: the Federal Office of Economics and Export Control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*, BAFA)). The competent authority of the country of destination must also be notified of the completion of the shipment.

As far as transboundary shipment is subject to legal requirements for licensing or notification, e.g. for re-entry of a radiation source from a non-EU country like Canada, the competent authority according to § 22 AtG is the BAFA.

According to § 69 para. 5 StrlSchV, high-active radioactive sources that are disused or for which no further use is intended have to be transferred to the manufacturer, the carrier or another licensee or have to be disposed of as radioactive waste or kept in interim storage. Recycling of disused radiation sources after their return is also possible in principle, e.g. at the manufacturer's or by another authorised company possessing an appropriate licence. The previous user is therefore not allowed to continually keep a source after termination of its use. This is intended to prevent forgetting about a disused radiation source, which might then be disposed of without precautionary measures, e.g. in scrap. The manufacturer and the carrier of high-active radioactive sources are obliged to take back these sources or have to ascertain that they are taken back by third parties, as has been outlined above.

Disused sealed radiation sources may only be re-imported into Germany as other radioactive substances if they are delivered only to the manufacturer or the carrier, who have to fulfil the preconditions stated above (this is prescribed in § 5 para. 2 sentence 4 of the Nuclear Waste Transfer Ordinance (AtAV) [1A-18]), or if the consignee demonstrably delivers the sources to a further licensed use or to recycling. The AtAV does not apply to disused high-active radioactive sources that have to be returned as described above.

According to § 20 para. 1 of the Radiation Protection Ordinance (StrlSchV), such sources may only be shipped from a third country to Germany without a licence under § 19 para. 1 of the same ordinance, provided the importing deliverer

1. has taken precautions to ensure that after shipment, the delivered radioactive materials may only initially be bought by persons who hold the necessary licence according to §§ 6, 7 or 9 AtG or according to § 7 para. 1 or § 11 para. 2 StrlSchV, and
2. reports the shipment to the competent authority as stipulated in § 22 para. 2 of the Atomic Energy Act or another office designated by it in connection with customs processing at the latest, using a form stipulated by it.

In the case of shipment of such radioactive material between EU Member States, the provisions of Regulation (EURATOM) no. 1493/93/EURATOM [EUR 93] apply. This stipulates the following with regard to sealed sources:

(Article 4)

- (1) A holder of sealed sources who intends to carry out a shipment of such sources, or to arrange for such a shipment to be carried out, shall obtain a prior written declaration by the consignee of the radioactive substances to the effect that the consignee has complied, in the Member State of destination, with all applicable provisions implementing Directive 96/29/EURATOM [1F-18] and with national requirements for safe storage, usage or disposal of that class or source of waste.

The declaration shall be made by means of the standard documents set out in Annex I to this Regulation (i.e. Regulation (EURATOM) no. 1493/93/EURATOM).

- (2) The declaration referred to in paragraph 1 shall be sent by the consignee to the competent authority of the Member State to which the shipment is to be made. The competent authority shall confirm with its stamp on the document that it has taken note of the declaration and the declaration shall then be sent by the consignee to the holder.

However, this is merely a statement of intent, which does not permit any control over shipments that have actually taken place, since the Regulation furthermore stipulates:

(Article 5)

- (1) The declaration referred to in Article 4 may refer to more than one shipment, provided that:
 - the sealed sources or radioactive waste to which it relates have essentially the same physical and chemical properties,
 - the sealed sources or radioactive waste to which it relates do not exceed the levels of activity set out in the declaration and
 - the shipments are to be made from the same holder to the same consignee and involve the same competent authorities.
- (2) The declaration shall be valid for a period of not more than three years from the date of stamping by the competent authority as referred to in Article 4 (2).

A reporting system for realised shipments of radioactive materials is outlined below:

(Article 6)

A holder of sealed sources, other relevant sources and radioactive waste who has carried out a shipment of such sources or waste, or arranged for such a shipment to be carried out, shall, within 21 days of the end of each calendar quarter, provide the competent authorities in the Member State of destination with the following information in respect of deliveries during the quarter:

- names and addresses of consignees;
- the total activity per radionuclide delivered to each consignee and the number of such deliveries made;
- the highest single quantity of each radionuclide delivered to each consignee
- the type of substance: sealed source, other relevant source or radioactive waste.

As a result of this reporting procedure, it is evident that the competent authorities in each EU Member State (in Germany, the Federal Office of Economics and Export Control (BAFA)) only receive data about shipments into their country on a quarterly basis, the completeness of which cannot otherwise be verified. There is no provision under this Regulation for reports regarding shipments from one country to another EU Member State. In order to fill this loophole, Germany has submitted a proposal to the EU Commission outlining the need to report to the authority of the delivering country as well.

J.2. Progress and Major Changes since the Last Review Meeting

The transposition of the Law on the Control of High-Activity Radioactive Sources [1A-23] in its amended form of 11 October 2005 has led to necessary changes

- in the Atomic Energy Act [1A-3] (concerning §§ 1, 12, 23, 46 and 54),
- in the Radiation Protection Ordinance [1A-8] (changes to the overview of contents, changes to the text in §§ 3, 8, 10, 17, 19, 20, 22, 25, 33, 66, 68, 69, 70, 71, 115, 116, 117 as well as amendment of §§ 69a and 70a, changes of Appendix III and addition of a new Appendix XV),
- in the Ordinance on the Financial Security Pursuant to the Atomic Energy Act (AtDeckV) [1A-11] (concerning §§ 8 and 20 and the modified Appendix 2) as well as
- in the Nuclear Waste Transfer Ordinance (AtAV) (concerning § 1),

which have been implemented and published.

Since the successful commissioning of the register on high-activity sources in electronic form on 1 July 2006, this register has been in routine operation since 1 January 2007. As of October 2007, a total of about 6 550 sources have been registered, for which notifications are issued if the sources are transferred. In the entire period, no notification concerning orphan sources has reached the HRQ register.

The amendments of the German regulatory framework have transposed the requirements of the IAEA Code of Conduct on the Safety and Security of Radioactive Sources [IAEA 04] and of the associated newly issued IAEA Guidance on the Import and Export of Radioactive Sources⁴, IAEA-GOV/2004/62-GC(48)/13 [IAEA 04a]).

K. Planned Activities to Improve Safety

K.1. Repository Concept for Heat-Generating Radioactive Waste

The different positions among the Federal Government, the Länder and the energy utilities regarding the issues related to the final disposal particularly of heat-generating radioactive waste are reported in Chapter A.2.

The Federal Government has not yet come to a decision on how to proceed with the realisation of a repository for this kind of radioactive waste. As stated in the justification of the amendment of the Atomic Energy Act (AtG) [1A-3] in the year 2002, the aim is to provide a repository around the year 2030.

K.2. National Waste Management Plan

In December 2001, the German Bundestag ordered the Federal Environment Ministry to present to it during the 15th legislative period a National Waste Management Plan in which the status, further proceeding and schedule for the management of radioactive waste and its disposal are described. The German Bundestag decided that this waste management plan would have to be updated and presented to the German Bundestag one year after it has convened for its respective first session. In 2002, work on the National Waste Management Plan was begun. Owing to the early termination of the 15th legislative period, the demand of the German Bundestag could not be fulfilled.

At the end of 2007, the status of the work was documented in a Working Basis Report by the Federal Office for Radiation Protection and sent to the *Länder* and the Federal Ministries for commenting.

A waste management plan is under preparation at the BMU, which has scheduled its presentation for the first half of 2009. For the reasons mentioned in Chapter K.1, this waste management plan will not include a definitive statement with regard to the final disposal especially of heat-generating radioactive waste.

K.3. EU-Standards

The Federal Government supports the Council of the European Communities' initiative according to the Council Conclusions of 25 April 2007 to establish uniform standards also for those facilities falling under the scope of this Convention throughout the extended European Union, with the aim to achieve a high level of safety across the EU. A working group composed of representatives from all Member States should compile possible contents of rules for the determination of common norms within the Community regarding the safety of these facilities. The results of the review processes of this Convention, the relevant IAEA Safety Standards as well as NEA and WENRA reports are to be considered in this context (cf. Chapter K.1). By comparing the state of the art in science and technology as presented by these regulations with the current condition in the EU Member States, the harmonisation needs are to be identified which are to be answered by corresponding standardisation in the EU.

K.4. Interim Storage of Spent Fuel Assemblies and Radioactive Waste

With the ban on the transportation to reprocessing facilities effective since 1 July 2005, interim storage of the spent fuel assemblies until their final disposal has become necessary. In order to avoid transports, decentralised interim storage facilities at the power plant sites are mandatory. All on-site interim storage facilities of the operating nuclear power plants have been operational since 2007. As the storage licences are valid for 40 years, safe storage is ensured for this period.

For the interim storage of operational waste and especially of waste arising from the dismantling of decommissioned nuclear facilities (as a direct result of the nuclear phase-out), storage facilities have also been or will be erected at the places of origin of the waste, ensuring the longer-term safe keeping of the waste in special waste packages until it can be dispatched to the Konrad repository, which will probably be as from the year 2013.

K.5. Updating of the German Regulations in the Area of Waste Management

The regulations governing fuel supply and waste management are put more and more in concrete terms by international organisations such as the IAEA, and the state of the art in science and technology is constantly progressing. There is furthermore a trend to include international standards more and more in the respective national regulations. The Federal Government welcomes this development and takes the opportunity to subject the body of German regulations to a review process. Within the framework of the revision of the German regulations, a first step is to comprise the identification and assessment of the differences between the international regulation and the German rules and regulations for nuclear facilities falling under this Convention, with the aim to amend the German regulations accordingly if any deficiencies are found. A first focus of this task is represented by the results of the assessment of the work within the framework of WENRA regarding interim storage (cf. the remarks in section K.6).

K.6. Western European Nuclear Regulators Association – WENRA – Harmonised Approaches in the European Nuclear Regulations Regarding the Areas of Interim Storage and Decommissioning

Apart from the joint development of safety criteria within national responsibility in the field of nuclear safety in Europe, the objective of the 17 WENRA Member States is also the joint development of safety criteria in the area of interim storage of spent fuel assemblies and radioactive waste and in the area of decommissioning of nuclear installations.

The safety criteria are to be developed further by way of a comparison of the general national safety requirements with the general safety levels elaborated by WENRA in the corresponding areas. Following such an understanding, the aim is not to fully and exactly standardise the safety approaches of individual institutions in the Member States but instead to constantly improve any assumed major deficiencies in the respective historically grown national general regulatory safety approaches.

The "WGWD" - Working Group on Waste and Decommissioning that was set up specially for these purposes by WENRA in 2002 defined requirements in the form of safety reference levels in the areas of interim storage and decommissioning in two reports that were published in July 2007. These requirements are based on the international state of the art in science and technology and are presented by WENRA as a "joint approach". These reports have to be understood as "living documents" which will be adapted and improved whenever this is demanded by new developments and insights.

The "Waste and Spent Fuel Storage Safety Reference Levels Report" and the "Decommissioning Safety Reference Levels Report" contain 77 and 81 safety reference levels, respectively, covering the topics of safety management, design, operation and safety verification (interim storage) as well as the issues of safety management, decommissioning strategy and planning, conduct of decommissioning, and safety verification (decommissioning).

These safety reference levels represent the basis of the national self-assessments carried out by all WENRA Member States. The aim of the self-assessments is above all the identification of the major deficiencies of the national approaches as compared to the joint approach. This involves on the one hand an assessment of the national regulations (Regulatory Self Assessment) and on the other hand an assessment of the practices in the individual nuclear installations (Implementation Self Assessment) in comparison with the requirements of the safety reference levels. In this con-

text, the respective nuclear regulations regarding interim storage facilities for radioactive waste (Waste), interim storage facilities for spent fuel assemblies (Spent Fuel) and those regarding decommissioning projects for nuclear installations are considered separately. The assessment will be along the marks "A" (meets the requirements of the safety reference levels), "B" (differences exist but can be justified under safety aspects or may be assessed as being "A" by the end of 2007) and "C" (differences exist and should be considered for an improvement in the sense of the safety reference levels).

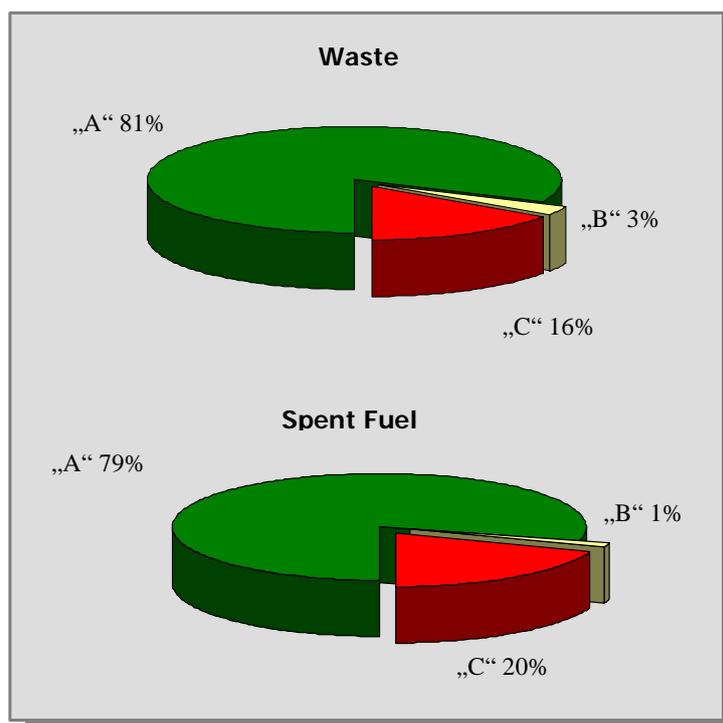
Each WENRA Member has committed itself to adapting and improving its corresponding national regulations to the required safety level if the jointly agreed safety reference levels are not reached.

For Germany, it has turned out that according to the assessment criteria and targets of WENRA, deficiencies of the German regulations in the area of interim storage as compared with the joint approach exist mainly in the areas of "emergency preparedness", "quality management" and "periodic safety review". However, it has to be pointed out that currently around 80 % (Figure K-1) of the requirements of the safety reference levels of the WENRA / WGWD are fulfilled by the German regulations.

In the area of decommissioning, a conclusion of the assessments of the regulations is expected for the autumn of 2008. The results of the immediately following assessments of the respective practices are to be available by mid-2009.

The necessary improvements for the individual WENRA Members can be derived from the results of all assessments. Current scheduling provides that the implementation of the national action plans that are to be developed and contain specific regulatory measures for an adaptation to the safety reference levels ensure the further development of the respective national safety criteria by the end of 2010 and thereby fulfil the objective of WENRA.

Figure K-1: Provisional percentages of the marks "A", "B" and "C" of the assessments of the regulations in the areas of interim storage of "Waste" and "Spent Fuel" in Germany



L. Annexes**(a) List of Spent Fuel Management Facilities**

The following tables list the facilities for spent fuel management:

- Wet storage facilities for spent fuel assemblies and their inventories (Table L-1),
- Central interim storage facilities for spent fuel assemblies (Table L-2),
- Pilot conditioning plant at Gorleben (Table L-3),
- Interim storage facilities for spent fuel assemblies for which licensing applications have been submitted under § 6 of the Atomic Energy Act (Table L-4),

Table L-1: Wet storage facilities for spent fuel assemblies and their inventories
(as at: 31 December 2007)

Reactor, site	Licensed positions	Number of positions available for storage ¹⁾	Of which not yet occupied	Stored quantity ²⁾ [Mg HM]
Cooling ponds at the reactor:				
Brunsbüttel	817	285	38	43
Krümmel	1 690	846	97	133
Brokdorf	768	535	55	260
Unterweser	615	397	12	207
Grohnde	768	569	87	263
Emsland	768	569	215	190
Biblis A	582	388	88	157
Biblis B	578	385	42	181
Obrigheim ³⁾	1 210	1 210	868	100
Philippsburg 1 ⁴⁾	948+169	356+169	13+158	60+2
Philippsburg 2	716	523	140	207
Neckarwestheim 1 ⁵⁾	310+128	133+128	25+40	39+31
Neckarwestheim 2	786	465	88	203
Gundremmingen B	3 219	2 423	199	387
Gundremmingen C	3 219	2 423	377	356
Isar 1	2 232	1 436	90	234
Isar 2	792	555	68	261
Grafenrheinfeld	715	504	82	227

¹⁾ taking into account the positions that must be kept free for unloading of the core and other positions that cannot be used

²⁾ spent and partially spent fuel assemblies

³⁾ including extension outside the reactor building

⁴⁾ in addition to the capacity of the pool in unit 1 there are 169 positions usable in unit 2, 11 of which occupied, 158 vacant

⁵⁾ in addition to the capacity of the pool in unit 1 there are 128 positions usable in unit 2, 88 of which occupied, 40 vacant

Table L-2: Central storage facilities for spent fuel assemblies and heat-generating radioactive waste (as at: 31 December 2007)

Site	Types of casks	Licensed quantities	Already stored
Ahaus	CASTOR [®] Ia, Ib, Ic, IIa, V/19, V/19, Series 06 onwards and V/52 at a total of 370 storage positions CASTOR [®] THTR/AVR at a total of 320 casks positions (50 storage positions) CASTOR [®] MTR 2	3 960 Mg HM 2x10 ²⁰ Bq	3 CASTOR [®] V/52 (26 Mg HM) 3 CASTOR [®] V/19 (29 Mg HM) 305 CASTOR [®] THTR/AVR (50 storage positions in total) 18 CASTOR [®] MTR 2
Gorleben	CASTOR [®] Ia, Ib, Ic, IIa, V/19, V/52, TN 900/1-21 and CASTOR [®] HAW 20/28 CG, HAW 20/28, Series no. 16 onwards, and TS 28V at a total of 420 storage positions	3 800 Mg HM 2x10 ²⁰ Bq	1 CASTOR [®] IIa (5 Mg HM) 1 CASTOR [®] Ic (3 Mg HM) 3 CASTOR [®] V/19 (29 Mg HM) 74 CASTOR [®] HAW 20/28 CG with 2 072 glass canisters 1 TS 28 V with 28 glass canisters
Greifswald (ZLN)	CASTOR [®] 440/84 at 80 storage-positions	585 Mg HM 7.5x10 ¹⁸ Bq	4 CASTOR [®] 440/84 from Rheinsberg (48 Mg HM) 39 CASTOR [®] 440/84 from Greifswald (535 Mg HM)
Jülich	CASTOR [®] THTR/AVR (max. 158 casks)	225 kg nuclear fuel; no activity limit	approx. 250 000 AVR fuel assembly spheres in 139 CASTOR [®] THTR/AVR

Table L-3: Pilot conditioning plant (PKA), Gorleben

Site	Purpose	Capacity	Status
Gorleben	<u>Design:</u> Conditioning of spent fuel assemblies from power and research reactors; reloading of HLW glass canisters into packages suitable for disposal <u>According to stipulation of 11 June 2001:</u> Use restricted to the repair of defect casks	35 Mg HM/a at conditioning	Constructed, but not yet operational. Licensed by 3rd Partial License (TEG) of 18/19 December 2000. Immediate execution has not been applied for.

Table L-4: Main characteristics of the interim spent fuel storage facilities applied for under § 6 (AtG), as at: 31 December 2007)

Nuclear power plant, <i>Land</i> (Federal State)	Applicant Date of application	Mass HM	Activity	Thermal power	Storage positions	Type Dimensions L x W x H wall/roof [m]	Cask	Mass being stored (Casks)
		[Mg]	[Bq]	[MW]				
Kernkraftwerk Biblis (KWB) Hesse	RWE Power AG 23 December 1999	1 400	$8,5 \times 10^{19}$	5,3	135	WTI concept 92x38x18 0,85/0,55	CASTOR [®] V/19	366 Mg HM (36 casks)
Kernkraftwerk Brokdorf (KBR) Schleswig-Holstein	E.ON Kernkraft GmbH 20 December 1999	1 000	$5,5 \times 10^{19}$	3,75	100	STEAG concept 93x27x23 1,20/1,30	CASTOR [®] V/19	62 Mg HM (6 casks)
Kernkraftwerk Brunsbüttel (KKB) Schleswig-Holstein	Kernkraftwerk Brunsbüttel GmbH 30 November 1999	450	6×10^{19}	2,0	80	STEAG concept 88x27x23 1,20/1,30	CASTOR [®] V/52 CASTOR [®] V/32	33 Mg HM (4 casks)
Kernkraftwerk Grafenrheinfeld (KKG) Bavaria	E.ON Kernkraft GmbH 23 February 2000	800	5×10^{19}	3,5	88	WTI concept 62x38x18 0,85/0,55	CASTOR [®] V/19	71 Mg HM (7 casks)
Kernkraftwerk Grohnde (KWG) Lower Saxony	E.ON Kernkraft GmbH 20 December 1999	1 000	$5,5 \times 10^{19}$	3,75	100	STEAG concept 93x27x23 1,20/1,30	CASTOR [®] V/19	62 Mg HM (6 casks)
Kernkraftwerk Gundremmingen (KRB) Bavaria	RWE Energie AG (now: RWE Power AG) 25 February 2000	1 850	$2,4 \times 10^{20}$	6,0	192	WTI concept 104x38x18 0,85/0,55	CASTOR [®] V/52	117 Mg HM (13 casks)
Kernkraftwerk Isar (KKI) Bavaria	E.ON Kernkraft GmbH 23 February 2000	1 500	$1,5 \times 10^{20}$	6,0	152	WTI concept 92x38x18 0,85/0,55	CASTOR [®] V/52 CASTOR [®] V/19	61 Mg HM (6 casks)
Kernkraftwerk Krümmel (KKK) Schleswig-Holstein	Kernkraftwerk Krümmel GmbH 30 November 1999	775	$0,96 \times 10^{20}$	3,0	80	STEAG concept 83x27x23 1,20/1,30	CASTOR [®] V/52	92 Mg HM (10 casks)
Kernkraftwerk Emsland (KKE) Lower Saxony	Kernkraftwerke Lippe-Ems GmbH 22 December 1998	1 250	$6,9 \times 10^{19}$	4,7	130	STEAG concept 110x30x20 1,20/1,30	CASTOR [®] V/19	245 Mg HM (24 casks)

Nuclear power plant, <i>Land</i> (Federal State)	Applicant Date of application	Mass HM	Activity	Thermal power	Storage positions	Type Dimensions L x W x H wall/roof [m]	Cask	Mass being stored (Casks)
		[Mg]	[Bq]	[MW]				
Kernkraftwerk Neckarwestheim (GKN) Baden-Württemberg	Gemeinschaftskernkraftwerk Neckar GmbH 20 December 1999	1 600	$8,3 \times 10^{19}$	3,5	151	2 tunnel tubes 112 x 12,8 x 17,3 and 82 x 12,8 x 17,3 respectively	CASTOR [®] V/19	254 Mg HM (27 casks)
Kernkraftwerk Philippsburg (KKP) Baden-Württemberg	EnBW Kraftwerke AG 20 December 1999	1 600	$1,5 \times 10^{20}$	6,0	152	WTI concept 92x37x18 0,70/0,55	CASTOR [®] V/19 CASTOR [®] V/52	241 Mg HM (24 casks)
Kernkraftwerk Unterweser (KKU) Lower Saxony	E.ON Kernkraft GmbH 20 December 1999	800	$4,4 \times 10^{19}$	3,0	80	STEAG concept 80x27x23 1,20/1,30	CASTOR [®] V/19	10 Mg HM (1 cask)
Kernkraftwerk Obrigheim (KWO) Baden-Württemberg	Kernkraftwerk Obrigheim GmbH 22 April 2005	<100	$<4,4 \times 10^{18}$	<0,3	15	Special hybrid solution 35x18x17 0,85/0,55	CASTOR [®] 440 mvK	-- (License not yet granted)

(b) List of Radioactive Waste Management Facilities

The following tables list the radioactive waste management facilities.

- Stationary facilities for own needs and third parties (Table L-5),
- Mobile facilities (Table L-6)
- Interim storage facilities for radioactive waste – central interim storage facilities (Table L-7),
- Interim storage facilities for radioactive waste – storage facilities in Nuclear Power Plants (in operation) (Table L-8),
- Interim storage facilities for radioactive waste – storage facilities in Nuclear Power Plants (in decommissioning or decommissioning decided) (Table L-9),
- Interim storage facilities for radioactive waste – interim storage facilities in research institutions (Table L-10),
- Interim storage facilities for radioactive waste – interim storage facilities of the nuclear industry (Table L-11),
- Interim storage facilities for radioactive waste – *Land* collecting facilities (Table L-12),
- Repositories for radioactive waste and planned repositories (projects) in the Federal Republic of Germany (Table L-13).

Table L-5: Stationary facilities for the conditioning of radioactive waste for own needs and third parties

Operator	Facility site	Facility name	Facility description
GNS Gesellschaft für Nuklear-Service mbH	Duisburg	PETRA drying facility	Drying of high-pressure compressed waste in 200-l drums, 280-l drums or 400-l drums
		FAKIR high-pressure hydraulic press	High-pressure compaction of waste to pellets with the aid of metal cartridges Waste volume reduction up to Factor 10
		MARS metal cutting facility	Compression (pressing) and subsequent cutting up of metal parts that can be melted afterwards
		Plasma cutting facility	Segmentation of steel components for further treatment
		Cable shredding facility	Recycling of cable scrap
		Disassembly and cleaning cabins	Use of mechanical disassembly and cleaning processes
		Clearance measurement facilities	Clearance measurement according to § 29 StrlSchV
	Karlsruhe	TORA drying facility	Drying facility for moist solid radioactive waste (e.g. core scrap) being packaged in MOSAIK® containers
	Jülich	PETRA drying facility	Drying of high-pressure compressed waste in 200-l drums, 280-l drums or 400-l drums
		FAKIR high-pressure hydraulic press	High-pressure compaction of waste to pellets with the aid of metal cartridges or 200-l drums Waste volume reduction up to Factor 10
QSA Global GmbH	Braunschweig	Drying facility	Drying of drums up to the defined residual humidity
		Compacting facility	Compaction of 200-l drums and of collapsible drums, pressure ≥ 30 MPa Capacity : 5000 – 10000 pressing operations / a
		Decontamination cell	Decontamination of equipment parts (e. g. sandblasting), crushing of equipment parts (e. g. flexing, sawing) Max. weight 1 Mg/piece
		Cementing facility	Immobilisation of waste water with fixing materials, immobilisation of ion-exchange resins with fixing materials
		Shredding facility	Crushing of waste, segregation of solid and liquid constituents, homogenisation, sampling

Operator	Facility site	Facility name	Facility description
Energiewerke Nord GmbH	Greifswald (Lubmin/Rubenow) Zwischenlager Nord	FAKIR high-pressure hydraulic press	Compaction of loose waste to pellets with the aid of metal cartridges Waste volume reduction up to Factor 10
		PETRA drying facility	Drying of high-pressure compressed waste in 200-l drums, 280-l drums or 400-l drums
		MARS metal cutting facility	Compression (pressing) and subsequent cutting up of metal parts that can be melted afterwards
		Decontamination tubs for chemical decontamination	Capacity of first tub 2 x 2.5 m ³ Capacity of second tub 5 m ³
		Evaporation facility	Processing of radioactive liquid waste Throughput 1 m ³ /h
		Rotary thin-film evaporation facility RDVA	Processing of radioactive liquid waste Throughput 200 to 250 l/h Reservoir 7 m ³
		Band-saw	Cutting up of solid waste
		Vertical longitudinal cut band-saw	Cutting up of solid waste
		Hydraulic shear	Cutting up of solid waste of C and stainless steels (round bars, square bars)
		Cable stripping machine	Removal of insulation from cable diameter range: Ø 1.5 mm to 90 mm
		Plasma cutting facility	Dismantling of austenitic steels Max. cutting range
		Thermal dismantling room	With air extraction and filter device, 1 Mg bridge crane,
		High-pressure wet blast facility with working cabin	Working cabin with air extraction and filter system Dismantling/cutting by means of automatic device Decontamination by means of hand-held lance
		Dry blast facility with working cabin	Cabin with air extraction and filter system, decontamination by means of hand-held blast pipe, treatment and re-use of the grit

Operator	Facility site	Facility name	Facility description
Forschungszentrum Karlsruhe GmbH (FZK)	Karlsruhe	Compacting facility	Non-heat-generating waste with low dose rates Caisson technology with gas protection clothing, max. throughput 3 000 m ³ /a Volume reduction factor 6; Non-heat-generating waste with high dose rates Remote handling technology with air-lock and work cells, manipulators, hydraulic shears, hydraulic press
		Combustion facilities	Combustion of solid and liquid waste
		Vitrification plant	Vitrification of approx. 60 m ³ high-level radioactive fission product concentrate from the operation of the WAK; inactive commissioning underway; active commissioning planned for 2009
		Evaporation and immobilisation facility	Evaporation of low-level radioactive waste water with subsequent cementation of the residues. Max. throughput 6 000 m ³ /a Volume reduction factor 100
Forschungszentrum Jülich GmbH (FZJ)	Jülich	Dismantling/decontamination cabin REBEKA	Decontamination in two steel cabins of parts weighing up to 25 Mg by mechanical means with subsequent dismantling
		Fluidised bed granulation drying facility	Drying facility for radioactive waste water concentrates
		Evaporation facility	Processing of low-active waste water, concentrates and sludges; total volume 825 m ³ , delivery in tankers
		Combustion facility JÜV	Processing of low-active waste water and solids; Annual throughput up to 240 Mg of solids and 40 Mg of liquids

Operator	Facility site	Facility name	Facility description
GKSS Forschungszentrum Geesthacht GmbH	Geesthacht	Drying facility	Vacuum drying facility for single drums (200-l to 400-l drums)
Verein für Kernverfahrens- technik und Analytik Rossendorf e. V. (VKTA)	Rossendorf	Dismantling installations	Plasma cutting facility up to 20 mm Cold and band-saws up to 350 mm Ø Hydraulic shear
		In-drum press	30-l to 40-l bags are pressed directly into waste drums.
		Drying facility for drums	2-drum drying facility for the drying of sludges, ion- exchange resins, humid soil Drying time: 10-14 days Volume reduction: max. 60 %
		Resin drying facility	Drying of max. 240 l of spent ion-exchange resin; volume reduction approx. 50 %
		Dismantling box for aerosol filters	In the dismantling box, aerosol filters are dismantled until the parts can be placed in a docked 200-l drum.
		Ion exchange facility	Treatment of radioactive waste water, plant throughput 2 m ³ /h
		High-pressure blast facility	Decontamination of components by means of blasting in a box; manageable dimensions of the components 600 mm x 600 mm x 200 mm, mass up to 20 kg
		Ultrasonic cleaning facility	Decontamination of components up to a size of 800 mm x 500 mm x 200 mm with a maximum mass of 20 kg

Table L-6: Mobile facilities for the conditioning of radioactive waste

Operator	Facility name	Facility description	License
GNS Gesellschaft für Nuklear-Service mbH	High-pressure hydraulic press FAKIR	Processing of loose waste to pellets with the aid of metal cartridges Waste volume reduction up to Factor 10	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Drying facility of the FAVORIT type	Decanting and drying facility for liquid radioactive waste (evaporator concentrates, decontamination solutions, resins) as well as drying of solid waste after the principle of vacuum drying	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Drying facility of the PETRA type	Drying facility for humid radioactive waste being packaged in 200-, 280- and 400-l drums after the principle of vacuum drying	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Drying facility of the KETRA type	Drying facility for humid solid radioactive waste (e.g. core scrap) being packaged in MOSAIK® containers	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Decanting facility of the FAFNIR type	Decanting facility for radioactive resins (e.g. powder and bead resins)	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Final dewatering facility of the NEWA type	Final dewatering of decanted radioactive resins (e.g. powder and bead resins)	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Disassembling and precompaction facility of the ZVA type	Underwater disassembly of core scrap with subsequent high-pressure compaction in insert baskets	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Underwater shear of the UWS type	Underwater disassembly of core scrap	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrISchV
	Handling equipment for underwater disassembling	Handling equipment for underwater disassembling in nuclear installations (e.g. traverses, saws, pincers)	KTA 3902/03/05 Section 4.3

Operator	Facility name	Facility description	License
Hansa Projekt Anlagentechnik GmbH (HPA), Hamburg	SUPERPACK Mobile high-pressure press 2 000 Mg	Vertical high-pressure press for the processing of 180-l, 200-l or 220-l drums Capacity: max. 20 drums/h	Integrated in the licence of the power plant (change announcement)
	Drying facility	Drying facilities for mixed waste and sludges	Integrated in the licence of the power plant (change announcement)
	Conditioning facility for concentrates (tandem conditioning facility)	Load capacity: 1 x 200-l drum Evaporation capacity: 3 to 4 l/h Drying temperature: 150 to 250 °C	Integrated in the licence of the power plant (change announcement)
	Decanting and dewatering facility	Decanting and dewatering of bead resins in press cartridges, 200-l drums or cast iron containers	Integrated in the licence of the power plant (change announcement)
Energiewerke Nord, Lubmin	Dry blast facility	Jet area 8 m ² , height 2,5 m, blasting abrasive: grit or garnet sand	Integrated in the licence of the power plant (change announcement)
RWE NUKEM GmbH, Alzenau (Bayern)	Mobile facility for the extraction, mixing, emplacement in containers and conditioning of bead resins and/or filtering aids of the MAVAK type	Extraction, mixing, emplacement in containers and dewatering of bead resins and/or filtering aids from the operation of water cleaning systems in nuclear installations, emplacement in MOSAIK [®] containers	Nationwide valid exclusive licence for all nuclear facilities according to §§ 7, 9, 9a AtG and § 7 StrlSchV

Table L-7: Interim storage facilities for radioactive waste – Central interim storage facilities

Name of facility and site	Purpose of the facility	Capacity acc. to licence	Licence	Remarks
ABFALLLAGER GORLEBEN (FASSLAGER) Lower Saxony	Storage of radioactive waste from nuclear power plants, medicine, research and trade	200-I, 400-I drums, type III concrete containers, type I-II cast-iron containers, type I-IV containers with a total activity of up to 5×10^{18} Bq	Handling licences according to § 3 StrlSchV ^{*)} of 27 October 1983, 13 October 1987 and 13 September 1995	In operation since October 1984
ABFALLLAGER ESENSHAMM Lower Saxony	Storage of low-level radioactive waste from the nuclear power plants Unterweser and Stade	200-I and 400-I drums, concrete containers, sheet-steel containers, cast-iron containers with a total activity of up to 1.85×10^{15} Bq	Handling licences according to § 3 StrlSchV ^{*)} of 24 June 1981, 29 November 1991 and 6 November 1998	In operation since autumn 1981
ZWISCHENLAGER DER EVU MITTERTEICH Bavaria	Interim storage of waste with negligible heat generation from Bavarian nuclear facilities	40 000 waste packages (200-I, 400-I drums or cast-iron containers)	Handling licences according to § 3 StrlSchV ^{*)} of 7 July 1982	In operation since July 1987
ZWISCHENLAGER NORD (ZLN) Rubenow/Greifswald Mecklenburg-West Pomerania	Interim storage of operational and decommissioning waste from the nuclear power plants Greifswald and Rheinsberg, including interim storage of dismantled large components	200 000 m ³	Handling licences according to § 3 StrlSchV ^{*)} of 20 February 1998	In operation since March 1998

^{*)} As amended on 13 October 1976 and 30 June 1989, respectively

Table L-8: Interim storage facilities for radioactive waste – Interim storage facilities in Nuclear Power Plants (in operation)

Name of facility and site	Purpose of the facility	Capacity according to licence	Licence	Remarks
NPP Biblis Units A and B	Storage of radioactive waste from the operation of the NPP	7 500 packages	§ 7 AtG, § 7 StrlSchV ^{*)}	Licence according to § 7 StrlSchV for the interim storage of radioactive operational wastes at the on-site interim storage facility
NPP Brokdorf	Storage of radioactive waste from the operation of the NPP	560 m ³	§ 7 AtG	
NPP Brunsbüttel	Storage of radioactive waste from the operation of the NPP	3 225 m ³ /4 150 m ³	§ 7 AtG	
NPP Emsland	Storage of radioactive waste from the operation of the NPP	185 m ³	§ 7 AtG	
NPP Grafenrheinfeld	Storage of radioactive waste from the operation of the NPP	Raw waste: 200 m ³ Conditioned waste: 200 m ³	§ 7 AtG	
NPP Grohnde	Storage of radioactive waste from the operation of the NPP	280 m ³	§ 7 AtG	
NPP Gundremmingen Units B and C	Storage of radioactive waste from the operation of the NPP	300 m ³ conditioned waste 1 305 m ³ liquid waste	§ 7 AtG	
NPP Isar 1	Storage of radioactive waste from the operation of the NPP	4 000 m ³	§ 7 AtG	
NPP Isar 2	Storage of radioactive waste from the operation of the NPP	160 m ³	§ 7 AtG	

*) As amended on 20 July 2001

Name of facility and site	Purpose of he facility	Capacity according to licence	Licence	Remarks
NPP Krümmel	Storage of radioactive waste from the operation of the NPP	1 340 m ³	§ 7 AtG	
NPP Neckarwestheim Units 1 and 2	Storage of radioactive waste from the operation of the NPP	3 264 m ³	§ 7 AtG	
NPP Philippsburg Units 1 and 2	Storage of radioactive waste from the operation of the NPP	3 775 m ³	§ 7 AtG	
NPP Unterweser	Storage of radioactive waste from the operation of the NPP	200 m ³	§ 7 AtG	

Table L-9: Interim storage facilities for radioactive waste – Interim storage facilities in Nuclear Power Plants (in decommissioning or decommissioning decided)

Name of facility and site	Purpose of the facility	Capacity according to licence	Licence	Remarks
NPP Greifswald Units 1 – 5	Storage of radioactive waste from the decommissioning of the NPP		§ 3 StrlSchV ^{*)}	Containers, premises and charging space for the collection and storage of radioactive waste/residues
NPP Gundremmingen Unit A	Storage of radioactive waste from the decommissioning of the NPP	1 678 m ³ conditioned waste 318 m ³ liquid waste	§ 7 AtG	Conditioned waste
NPP Hamm-Uentrop	Storage of radioactive waste from the operation and decommissioning of the NPP	1 160 m ³	§ 7 AtG	
NPP Jülich (AVR)	Storage of radioactive waste from the decommissioning of the NPP	235 m ³	§ 7 AtG	
NPP Lingen	Storage of radioactive waste from the operation and decommissioning of the NPP	170 m ³	§ 7 AtG	
NPP Mülheim-Kärlich	Storage of radioactive waste from the operation of the NPP	43 m ³	§ 7 AtG	
NPP Obrigheim	Storage of radioactive waste from the operation and the post-operational phase of the NPP	3 300 m ³	§ 7 AtG	Additional storage capacity planned?
NPP Rheinsberg	Storage of radioactive waste from the decommissioning of the NPP		§ 7 AtG	Only buffer storage

*) As amended on 13 October 1976, 30 June 1989 and 12 December 2007 respectively

Name of facility and site	Purpose of the facility	Capacity according to licence	Licence	Remarks
NPP Stade	Storage of radioactive waste from the operation and the post-operational phase of the NPP	100 m ³	§ 7 AtG	
NPP Stade	Storage of radioactive waste from the decommissioning of the NPP	4 000 m ³	§ 7 StrlSchV	Commissioning: 1 August 2007
NPP Würgassen	Storage of radioactive waste from the decommissioning of the NPP	4 600 m ³	§ 7 AtG	
Versuchsatomkraftwerk Kahl (VAK)	Storage of radioactive waste from the decommissioning of the NPP	560 m ³	§ 7 AtG	

Table L-10: Interim storage facilities for radioactive waste – Interim storage facilities in research institutions

Name of facility and site	Kind of waste stored	Capacity according to licence	Licence	Remarks
Forschungs- und Messreaktor Braunschweig (FMRB)	Operational waste from FMRB	Not determined in the licence	§ 7 AtG	Buffering of waste
Forschungsreaktor Garching	Operational waste from the research reactor	Not determined in the licence	§ 7 AtG	Approx. 100 m ³ available
Forschungszentrum Geesthacht	Operational waste from the research reactor	Not determined in the licence	§ 3 StrISchV ^{*)}	Approx. 154 m ² space for conditioned waste
Forschungszentrum Jülich	Waste with negligible heat generation, AVR fuel spheres, activated bulky waste	Not determined in the licence	§§ 6, 9 AtG § 3 StrISchV ^{*)}	Approx. 8 140 m ³ available
Forschungszentrum Karlsruhe	1. Waste with negligible heat generation, 2. Heat-generating waste	1. 77 424 m ³ (storage volume) 2. 1 240 m ³ (storage volume)	§ 9 AtG	Incl. waste produced by some clients
Institut für Radiochemie Garching	Operational waste from the research centre	Approx. 22 m ³	§ 9 AtG, § 3 StrISchV ^{*)}	
VKTA Rossendorf	Operational and decommissioning waste from the research institution	2 270 m ³ (total gross storage volume)	§ 3 StrISchV ^{*)}	Zwischenlager Rossendorf (ZLR)

^{*)} as amended on 13 October 1976 and 30 June 1989, respectively

Table L-11: Interim storage facilities for radioactive waste – Interim storage facilities of the nuclear industry

Name of facility and site	Kind of waste stored	Capacity according to licence	Licence	Remarks
Advanced Nuclear Fuels GmbH (ANF), Lingen	Operational waste from fuel assembly fabrication	440 m ³	§§ 6, 7 AtG,	
Siemens, Karlstein	Waste from dismantling	4 800 m ³	§ 3 StrISchV ^{*)}	
Interim storage facility of NCS, Hanau	Conditioned waste with negligible heat generation, operational waste and waste from dismantling originating from 1. Siemens, 2. NUKEM, GNS et al.	1. approx. 9 000 m ³ 2. approx. 4 000 m ³	§ 7 StrISchV	Joint licensees of the interim storage facility
Urenco, Gronau	Operational waste from uranium enrichment	Approx. 40 m ³	§ 7 AtG	

^{*)} as amended on 13 October 1976 and 30 June 1989, respectively

Table L-12: Interim storage facilities for radioactive waste – *Land* collecting facilities

Name of facility and site	Kind of waste stored	Capacity according to licence	Licence	Remarks
<i>Land</i> collecting facility Baden-Württemberg, Karlsruhe	Waste from the medical field, research and industry	No capacity limit stated (capacity HDB: 78 276 m ³)	§ 9 AtG	<i>Land</i> collecting facility at FZK in HDB, operator HDB
<i>Land</i> collecting facility Bavaria, Mitterteich	Waste from the medical field, research and industry	10 000 packages	§ 3 StrlSchV ^{*)}	Approx. 2 900 m ³ available
<i>Land</i> collecting facility Berlin, Berlin	Waste from the medical field, research and industry	445 m ³	§ 3 StrlSchV ^{*)}	At the Hahn-Meitner-Institut
<i>Land</i> collecting facility Hesse, Ebsdorfergrund	Waste from the medical field, research and industry	400 m ³	§ 6 AtG, § 3 StrlSchV ^{*)}	
<i>Land</i> collecting facility Mecklenburg-Western Pomerania, Rubenow/Greifswald	Waste from the medical field, research and industry	One 20'-container	§ 3 StrlSchV ^{*)}	<i>Land</i> collecting facility at ZLN, approx. 33 m ³ available joint use by Brandenburg
<i>Land</i> collecting facility Lower Saxony, Jülich	Waste from the medical field, research and industry	Capacity acc. to licence of approx. 300 200-l drums	§ 3 StrlSchV ^{*)}	Replaces closed Lower Saxon <i>Land</i> collecting facility at Steyerberg
<i>Land</i> collecting facility Northrhine-Westphalia, Jülich	Waste from the medical field, research and industry	2 430 m ³	§ 3 StrlSchV ^{*)} , § 9 AtG	On the site of the <i>Forschungszentrum Jülich</i> (Jülich Research Centre)
<i>Land</i> collecting facility Rhine-land-Palatinate, Ellweiler	Waste from the medical field, research and industry	500 m ³	§ 9 AtG, § 3 StrlSchV ^{*)}	
<i>Land</i> collecting facility Saar-land, Elm-Derlen	Waste from the medical field, research and industry	50 m ³	§ 3 StrlSchV ^{*)}	
<i>Land</i> collecting facility Saxony, Rossendorf/Dresden	Waste from the medical field, research and industry	570 m ³	§ 3 StrlSchV ^{*)}	At VKTA, also used by Thuringia and Saxony-Anhalt
<i>Land</i> collecting facility of the four north German coastal Federal State, Geesthacht	Waste from the medical field, research and industry	68 m ² storage area	§ 3 StrlSchV ^{*)}	Shared use by Schleswig-Holstein, Hamburg and Bremen, the Lower Saxon contingent has been exhausted for several years already
QSA Global GmbH	Waste from the medical field, research and industry	3 240 m ³	§ 3 StrlSchV ^{*)}	Waste from the closed Steyerberg site of the Lower Saxony <i>Land</i> collecting facility

*) in the versions dated 13 October 1976 and 30 June 1989, respectively

Table L-13: Repositories for radioactive waste and planned repositories (projects) in the Federal Republic of Germany

Name of facility and location	Purpose of the facility	Amounts/activity disposed of	Licence	Remarks
SCHACHTANLAGE ASSE Remlingen, Niedersachsen	Research and development work for the disposal of radioactive and radiotoxic waste	Between 1967 and 1978 approx. 124 500 LAW and approx. 1 300 MAW waste packages were emplaced for trial purposes	Licence according to § 3 StrlSchV in the version dated 15 October 1965	Geological host formation: rock salt
BERGWERK ZUR ERKUNDUNG DES SALZSTOCKS GORLEBEN Gorleben, Lower Saxony	Proof of the site's suitability for the disposal of all types of radioactive waste		Application according to § 9b AtG in 1977 (plan-approval application)	Geological host formation: rock salt Exploration of the site has been put on hold since 1 October 2000 whilst conceptual and safety-related issues are clarified.
ENDLAGER SCHACHT KONRAD Salzgitter, Lower Saxony	Repository for radioactive waste with negligible heat generation		Licence according to § 9b AtG, approval of the plan was granted on 22 May 2002, decision is definitive since 26 March 2007	Geological host formation: coral oolite (iron ore) Beneath a water-impermeable barrier from the cretaceous period
ENDLAGER FÜR RADIOAKTIVE ABFÄLLE MORSLEBEN (ERAM) Saxony-Anhalt	Disposal of low-active and medium-active waste with mainly short-lived radionuclides	Disposal of 36 753 m ³ low-active and medium-active waste in total, total activity of all radioactive waste emplaced in the order of magnitude of 10 ¹⁴ Bq, activity of alpha-emitters in the order of magnitude of 10 ¹¹ Bq.	22 April 1986: Permanent operating licence granted. 12 April 2001: A statement is made to the effect that no further radioactive waste will be accepted for disposal	Geological host formation: rock salt On 28 September 1998 emplacement operations were discontinued. Decommissioning has been applied for.

(c) List of Nuclear Facilities in the Process of being Decommissioned

The following tables list those nuclear facilities which are currently in the process of decommissioning, divided into the following categories:

- Nuclear power plants including prototype reactors with electrical power generation (Table L-14),
- Research reactors with a thermal power of 1 MW or above (Table L-15),
- Research reactors with a thermal power of less than 1 MW (Table L-16),
- Commercial fuel cycle facilities (Table L-17).
- Research and prototype fuel cycle facilities (Table L-18)

In each table the facilities are listed in alphabetical order.

Table L-14: Nuclear power plants including prototype reactors with electrical power generation as per 1 August 2006

	Name of facility, location	Last operator	Type of facility, electrical output (gross)	First criticality	Final shut-down	Status	Planned final status
1	VAK Versuchsatomkraftwerk, Kahl, Bavaria	Versuchsatomkraftwerk Kahl GmbH	BWR 16 MWe	11/1960	11/1985	Dismantling	Removal, clearance of the site
2	MZFR Mehrzweckforschungsreaktor, Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	PWR with D ₂ O 57 MWe	09/1965	05/1984	Dismantling	Removal, clearance of the site
3	KKR Rheinsberg, Rheinsberg, Brandenburg	Energiewerke Nord GmbH	PWR (WWER) 70 MWe	03/1966	06/1990	Dismantling	Clearance of the site
4	KRB A Gundremmingen A, Gundremmingen, Bavaria	Kernkraftwerk RWE-Bayernwerk GmbH	BWR 250 MWe	08/1966	01/1977	Dismantling	Not yet decided
5	AVR Atomversuchskraftwerk, Jülich, North Rhine-Westphalia	Arbeitsgemeinschaft Versuchsreaktor GmbH	HTGR 15 MWe	08/1966	12/1988	Dismantling	Removal, clearance of the site
6	KWL Lingen, Lingen, Lower Saxony	Kernkraftwerk Lingen GmbH	BWR 252 MWe	01/1968	01/1977	Safe containment	Removal, clearance of the site
7	KWO Obrigheim, Obrigheim, Baden-Württemberg	Kernkraftwerk Obrigheim GmbH	PWR 357 MWe	09/1968	05/2005	Application for decommissioning	Clearance of the site
8	HDR Heißdampfreaktor, Großwelzheim, Bavaria	Forschungszentrum Karlsruhe GmbH	BWR 25 MWe	10/1969	04/1971	Removed	-

	Name of facility, location	Last operator	Type of facility, electrical output (gross)	First criticality	Final shut-down	Status	Planned final status
9	KWW Würgassen, Würgassen, North Rhine-Westphalia	E.ON Kernkraft	BWR 670 MWe	10/1971	08/1994	Dismantling	Clearance of the site
10	KKN Niederaichbach Niederaichbach, Bavaria	Forschungszentrum Karlsruhe GmbH	HWGCR 106 MWe	12/1972	07/1974	Removed	-
11	KKS Stade, Stade, Lower Saxony	KKW Stade GmbH	PWR 672 MWe	01/1972	11/2003	Dismantling	Clearance of the site
12	KGR 1 Greifswald 1 Lubmin, Mecklenburg-Western Pomerania	Energiewerke Nord GmbH	PWR (WWER) 440 MWe	12/1973	12/1990	Dismantling	Clearance of the site
13	KGR 2 Greifswald 2 Lubmin, Mecklenburg-Western Pomerania	Energiewerke Nord GmbH	PWR (WWER) 440 MWe	12/1974	02/1990	Dismantling	Clearance of the site
14	KGR 3 Greifswald 3 Lubmin, Mecklenburg-Western Pomerania	Energiewerke Nord GmbH	PWR (WWER) 440 MWe	10/1977	02/1990	Dismantling	Clearance of the site
15	KNK II Kompakte Natriumgekühlte Reaktoranlage, Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	FBR 21 MWe	10/1977	08/1991	Dismantling	Removal, clearance of the site
16	KGR 4 Greifswald 4 Lubmin, Mecklenburg-Western Pomerania	Energiewerke Nord GmbH	PWR (WWER) 440 MWe	07/1979	06/1990	Dismantling	Clearance of the site
17	THTR-300 Thorium-Hochtemperaturreaktor, Hamm-Uentrop, North Rhine-Westphalia	Hochtemperatur-Kernkraft GmbH	HTGR 308 MWe	09/1983	09/1988	Safe containment	Not yet decided
18	KMK Mülheim-Kärlich Mülheim-Kärlich, Rhineland-Palatinate	RWE Power AG	PWR 1302 MWe	03/1986	09/1988	Dismantling	Clearance of the site
19	KGR 5 Greifswald 5 Lubmin, Mecklenburg-Western Pomerania	Energiewerke Nord GmbH	PWR (WWER) 440 MWe	03/1989	11/1989	Dismantling	Clearance of the site

Table L-15: Research reactors with a thermal power of 1 MW or above that have been removed or are in the decommissioning phase

	Name of facility, location	Last operator	Type, thermal. output	First criticality	Final shut-down	Status	Planned final status
1	FMRB – Braunschweig, Lower Saxony	Physikalisch-Technische Bundesanstalt	Pool 1 MW	10/1967	12/1995	Removed	-
2	FR-2 – Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	Tank 44 MW	03/1961	12/1981	Safe containment	Removal
3	FRG-2 – Geesthacht, Schleswig-Holstein	GKSS Forschungszentrum Geesthacht GmbH	Pool 15 MW	03/1963	01/1993	Shut down	Removal
4	FRJ-1 MERLIN – Jülich, North Rhine-Westphalia	Forschungszentrum Jülich GmbH	Pool 10 MW	02/1962	03/1985	Dismantling	Removal
5	FRJ-2 DIDO – Jülich, North Rhine-Westphalia	Forschungszentrum Jülich GmbH	DIDO 23 MW	11/1962	05/2006	Shut down	Removal
6	FRM – München, Bavaria	Technische Universität München	Pool 4 MW	10/1957	07/2000	Shut down, fuel assemblies removed	Not yet decided
7	FRN – Neuherberg, Bavaria	Helmholtz Zentrum München GmbH	TRIGA 1 MW	08/1972	12/1982	Safe containment	Not yet decided
8	Nuklearschiff Otto Hahn, Geesthacht, Schleswig-Holstein	GKSS Forschungszentrum Geesthacht GmbH	PWR, ship propulsion 38 MW	08/1968	03/1979	Ship's reactor dismantled; ship conventionally used	Removal
9	RFR – Rossendorf, Saxony	VKTA Rossendorf	Tank, WWR 10 MW	12/1957	06/1991	Dismantling	Removal

Table L-16: Research reactors with a thermal power of less than 1 MW that have been removed or are in the decommissioning phase as per 31 December 2006

	Name of facility, location	Last operator	Type, thermal output	First criticality	Final shut-down	Status	Planned final status
1	ADIBKA – Jülich, North Rhine-Westphalia	Forschungszentrum Jülich GmbH	Homog. reactor 0.1 kW	03/1967	10/1972	Removed	-
2	AEG Nullenergie-Reaktor – Karlstein, Bavaria	Kraftwerk Union	Tank 0.1 kW	06/1967	01/1973	Removed	-
3	AKR-1 – Dresden	Technische Universität	Homog. reactor 2 W	07/1978	03/2004	Rebuilt and rededicated to AKR-2, in operation since 07/2005	
4	ANEX – Geesthacht, Schleswig-Holstein	GKSS Forschungszentrum Geesthacht GmbH	Critical formation, 0.1 kW	05/1964	02/1975	Removed	-
5	BER-I – Berlin	Hahn-Meitner-Institut Berlin	Homog. reactor 50 kW	07/1958	08/1972	Removed	-
6	FRF-1 – Frankfurt/M.	Johann-Wolfgang-Goethe-Universität Frankfurt/M.	Homog. reactor 10 kW	01/1958	03/1968	Removed	-
7	FRH – Hannover, Lower Saxony	Medizinische Hochschule Hannover	TRIGA 250 kW	01/1973	12/1996	Removed	-
8	HD I – Heidelberg, Baden-Württemberg	Deutsches Krebsforschungszentrum Heidelberg	TRIGA 250 kW	08/1966	03/1977	Removed	-
9	HD II – Heidelberg, Baden-Württemberg	Deutsches Krebsforschungszentrum Heidelberg	TRIGA 250 kW	02/1978	11/1999	Removed	-
10	KAHTER, Jülich, North Rhine-Westphalia	Forschungszentrum Jülich GmbH	Critical formation, 0.1 kW	07/1973	02/1984	Removed	-
11	KEITER, Jülich, North Rhine-Westphalia	Forschungszentrum Jülich GmbH	Critical formation, 1 W	06/1971	03/1982	Removed	-
12	PR-10, AEG Prüfreaktor, Karlstein, Bavaria	Kraftwerk Union	Argonaut 0.18 kW	01/1961	11/1975	Removed	-
13	RAKE, Rossendorf, Saxony	VKTA Rossendorf	Tank 0.01 kW	10/1969	11/1991	Removed	-
14	RRR, Rossendorf, Saxony	VKTA Rossendorf	Argonaut 1 kW	12/1962	09/1991	Removed	-
15	SAR, Munich, Bavaria	Technische Universität München	Argonaut 1 kW	06/1959	10/1968	Removed	-
16	SNEAK, Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	Homog. reactor 1 kW	12/1966	11/1985	Removed	-

	Name of facility, location	Last operator	Type, thermal output	First criticality	Final shut-down	Status	Planned final status
17	STARK, Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	Argonaut 0.01 kW	01/1963	03/1976	Removed	-
18	SUR Berlin – Berlin	Technische Hochschule Berlin	Homog. reactor < 1 W	07/1963	2000	Decommissioning planned	Removal
19	SUR Bremen – Bremen	Hochschule Bremen	Homog. reactor < 1 W	10/1967	06/1993	Removed	-
20	SUR Darmstadt – Darmstadt, Hesse	Technische Hochschule Darmstadt	Homog. reactor < 1 W	09/1963	02/1985	Removed	-
21	SUR Hamburg – Hamburg	Fachhochschule Hamburg	Homog. reactor < 1 W	01/1965	08/1992	Removed	-
22	SUR Karlsruhe – Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	Homog. reactor < 1 W	03/1966	09/1996	Removed	-
23	SUR Kiel – Kiel, Schleswig-Holstein	Fachhochschule Kiel	Homog. reactor < 1 W	03/1966	12/1997	Removed	-
24	SUR München – Munich, Bavaria	Technische Universität München	Homog. Reactor < 1 W	02/1962	08/1981	Removed	-
25	SUAK – Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	Fast subcrit. formation, < 1 W	11/1964	12/1978	Removed	-
26	SUA – Munich, Bavaria	Technische Universität München	Subcrit. formation, < 1 W	06/1959	10/1968	Removed	-
27	ZLFR – Zittau, Saxony	Hochschule Zittau/Görlitz	10 W	05/1979	06/2005	Removed	-

Table L-17: Commercial fuel cycle facilities that have been removed or are in the decommissioning phase

	Name of facility, location	Operator	Start of operation	End of operation	Status	Planned final status
1	HOBEG Brennelementwerk–Hanau, Hesse	Hobeg GmbH	1962	1988	Removed	-
2	NUKEM-A Brennelementwerk–Hanau, Hesse	Nukem GmbH	1962	1988	Installation removed; clearance of the site	Removal
3	Siemens Brennelementwerk Betriebsteil Uran, Hanau, Hesse	Siemens AG	1969	1995	Removed	-
4	Siemens Brennelementwerk Betriebsteil MOX, Hanau, Hesse	Siemens AG	1968	1991	Removed	-
5	Siemens Brennelementwerk Betriebsteil Karlstein – Karlstein, Bavaria	Siemens AG	1966	1993	Continued conventional use	-
6	WAK Wiederaufarbeitungsanlage Karlsruhe, Karlsruhe, Baden-Württemberg	WAK Betriebsgesellschaft mbH	1971	1990	Dis-mantling	Removal

Table L-18: Removed research and prototype facilities with relevance for the nuclear fuel cycle

	Name of facility, location	Operator	Begin of operation	Final shut-down	Status	Planned final status
1	JUPITER Testanlage Wiederaufarbeitung – Jülich, North Rhine-Westphalia	Forschungszentrum Jülich GmbH	1978	1987	Removed	-
2	MILLI Laborextraktionsanlage – Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	1970	1991	Removed	-
3	PUTE Plutoniumextraktionsanlage – Karlsruhe, Baden-Württemberg	Forschungszentrum Karlsruhe GmbH	1980	1991	Removed	-

(f) References to National Laws, Regulations, Requirements, Guides, etc.

These references are listed largely according to the structure and sequence outlined in the "Reactor Safety and Radiation Protection Handbook". As a general rule, they must be taken into account during licensing and supervisory procedures by the regulatory body. The list contains only those regulations that are relevant directly or by appropriate application in connection with the treatment of spent fuel assemblies and radioactive waste. This is why there are gaps in the numbering of the references.

- 1 Regulations
 - 1A National nuclear and radiation protection regulations
 - 1B Regulations concerning the safety of nuclear installations
 - 1C Regulations for the transport of radioactive material and accompanying regulations
 - 1D Bilateral agreements in the nuclear field and in the area of radiation protection
 - 1E Multilateral agreements on nuclear safety and radiation protection with national implementing regulations
 - 1F Law of the European Union
- 2 General Administrative Regulations
- 3 Announcements by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the formerly competent ministry, the Federal Ministry for the Interior
- 4 Recommendations of the RSK
- 5 Rules of the Nuclear Safety Standards Commission (KTA)

1 Regulations**1A National Nuclear and Radiation Protection Regulations**

- | | | |
|--------|---|-------------------|
| [1A-1] | Gesetz zur Ergänzung des Grundgesetzes vom 23. Dezember 1959, betreffend Artikel 74a Nr. 11, 87c (BGBl. I, S. 813), erneut geändert bzgl. Kernenergie durch Gesetz vom 28. August 2006 betreffend Artikel 73, 74 und 87c (BGBl. I 2006, Nr. 41, S. 2034)
Note: The nuclear energy area has been relocated to the exclusive legislative competence of the Federation. | |
| [1A-2] | Gesetz zur geordneten Beendigung der Kernenergienutzung zur gewerblichen Erzeugung von Elektrizität vom 22. April 2002 (BGBl. I S. 1351) | p. 18, 21 |
| [1A-3] | Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (Atomgesetz - AtG) vom 23. Dezember 1959, Neufassung vom 15. Juli 1985 (BGBl. I, Nr. 41, S. 1565), zuletzt geändert durch Artikel 4 des Gesetzes vom 26. Februar 2008 (BGBl. I 2008, Nr. 6, S. 215) | various citations |

[1A-4]	<p>Fortgeltendes Recht der Deutschen Demokratischen Republik aufgrund von Artikel 9 Abs. 2 in Verbindung mit Anlage II Kapitel XII Abschnitt III Nr. 2 und 3 des Einigungsvertrages vom 31. August 1990 in Verbindung mit Artikel 1 des Gesetzes zum Einigungsvertrag vom 23. September 1990 (BGBl. II, S. 885, 1226), soweit dabei radioaktive Stoffe, insbesondere Radonfolgeprodukte, anwesend sind:</p> <ul style="list-style-type: none"> • Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984 und Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984 (GBl.(DDR) I 1984, Nr. 30, berichtigt GBl.(DDR) I 1987, Nr. 18, S. 196) • Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei Verwendung darin abgelagerter Materialien vom 17. November 1990 (GBl.(DDR) I 1990, Nr. 34, S. 347) 	p. 11
[1A-5]	<p>Gesetz zum vorsorgenden Schutz der Bevölkerung gegen Strahlenbelastung (Strahlenschutzvorsorgegesetz - StrVG) vom 19. Dezember 1986 (BGBl. I, S. 2610), zuletzt geändert durch Artikel 1 des Gesetzes vom 8. April 2008 (BGBl.I 2008, Nr. 14, S. 686)</p>	p. 73, 113, 115, 120, 153
[1A-6]	<p>Gesetz über die Errichtung eines Bundesamtes für Strahlenschutz - BAStriSchG vom 9. Oktober 1989 (BGBl.I, S. 1830), zuletzt geändert durch Gesetz vom 6. April 1998 (BGBl.I 1998, Nr. 21), zuletzt geändert durch Gesetz vom 3. Mai 2000 (BGBl.I 2000, S. 636)</p>	p. 73
[1A-8]	<p>Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung - StriSchV) vom 20. Juli 2001 (BGBl. I 2001, Nr. 38), zuletzt geändert durch Gesetz vom 1. September 2005 (BGBl.I 2005, Nr. 55), Dosiskoeffizienten in (BAnz 2001, Nr. 16)</p>	various citations
[1A-10]	<p>Verordnung über das Verfahren bei der Genehmigung von Anlagen nach § 7 des Atomgesetzes (Atomrechtliche Verfahrensverordnung - AtVfV) vom 18. Februar 1977, Neufassung vom 3. Februar 1995 (BGBl. I 1995, Nr. 8), letzte Änderung durch das Öffentlichkeitsbeteiligungsgesetz vom 9. Dezember 2006 (BGBl.I 2006, Nr. 58, S. 2819)</p>	p. 73, 78, 79, 80, 82, 122, 133, 138, 155, 164
[1A-11]	<p>Verordnung über die Deckungsvorsorge nach dem Atomgesetz (Atomrechtliche Deckungsvorsorge-Verordnung - AtDeckV) vom 25. Januar 1977 (BGBl. I 1977, S. 220), zuletzt geändert durch Artikel 9 Abs. 12 des Gesetzes vom 23. November 2007 (BGBl.I 2007, Nr. 59, S. 2631)</p>	p. 73, 79, 129, 182, 186
[1A-12]	<p>Kostenverordnung zum Atomgesetz (AtKostV) vom 17. Dezember 1981 (BGBl. I, S. 1457), zuletzt geändert durch die zweite Verordnung zur Änderung der Kostenverordnung zum Atomgesetz vom 15. Dezember 2004 (BGBl.I 2004, Nr. 69, S. 3463)</p>	
[1A-13]	<p>Verordnung über Vorausleistungen für die Einrichtung von Anlagen des Bundes zur Sicherstellung und zur Endlagerung radioaktiver Abfälle (Endlagervorausleistungsverordnung - EndlagerVIV) vom 28. April 1982 (BGBl. I, S. 562), zuletzt geändert durch VO vom 26. Juli 2004 (BGBl. I 2004, Nr. 33, S. 1476)</p>	p. 73, 130
[1A-14]	<p>Verordnung zur Errichtung eines Strahlenschutzregisters vom 3. April 1990 (BGBl. I, S. 607)</p>	
[1A-17]	<p>Verordnung über den kerntechnischen Sicherheitsbeauftragten und über die Meldungen von Störfällen und sonstigen Ereignissen (Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung - AtSMV) vom 14. Oktober 1992 (BGBl. I 1992, Nr. 48), zuletzt geändert durch VO vom 18. Juni 2002 (BGBl. I 2002, Nr. 36)</p>	p. 74, 87, 96, 110, 145, 169
[1A-18]	<p>Verordnung über die Verbringung radioaktiver Abfälle in das oder aus dem Bundesgebiet (Atomrechtliche Abfallverbringungsverordnung - AtAV) vom 27. Juli 1998 (BGBl. I 1998, Nr. 47), zuletzt geändert durch Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365)</p>	p. 73, 178, 182, 185

- [1A-19] Verordnung für die Überprüfung der Zuverlässigkeit zum Schutz gegen Entwendung oder erhebliche Freisetzung radioaktiver Stoffe nach dem Atomgesetz (Atomrechtliche Zuverlässigkeitsüberprüfungs-Verordnung - AtZÜV) vom 1. Juli 1999 (BGBl. I 1999, Nr. 35), zuletzt geändert durch Gesetz vom 11. Oktober 2002 (BGBl. I 2002, Nr. 73, S. 3970) p. 139, 161
- [1A-20] Verordnung zur Abgabe von kaliumiodidhaltigen Arzneimitteln zur Iodblockade der Schilddrüse bei radiologischen Ereignissen (Kaliumiodidverordnung - KIV) vom 5. Juni 2003 (BGBl. I 2003, Nr. 25), zuletzt geändert durch Gesetz vom 21. Juni 2005 (BGBl. I 2005, Nr. 39)
- [1A-21] Abkommen vom 16. Mai 1991 zwischen der Regierung der Bundesrepublik Deutschland und der Regierung der Union der Sozialistischen Sowjetrepubliken über die Beendigung der Tätigkeit der sowjetisch/deutschen Aktiengesellschaft Wismut, Gesetz dazu vom 12. Dezember 1991 (BGBl. II 1991, S. 1138), zuletzt geändert durch Gesetz vom 21. November 1996 (BGBl. I 1996, Nr. 61)
- [1A-22] Verordnung zur Festlegung einer Veränderungssperre zur Sicherung der Standorterkundung für eine Anlage zur Endlagerung radioaktiver Abfälle im Bereich des Salzstocks Gorleben (Gorleben-Veränderungssperren-Verordnung - GorlebenVSpV) vom 25. Juli 2005 (BAnz. Nr. 153a vom 16. August 2005) p. 19, 74
- [1A-23] Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365) berichtigt am 11. Oktober 2005 (BGBl. I 2005, Nr. 64, S. 2976) p. 182, 184, 186

1B Regulations Concerning the Safety of Nuclear Installations

- [1B-1] Strafgesetzbuch vom 15. Mai 1871 (RGBl. S. 127) in der Fassung der Bekanntmachung vom 13. November 1998 (BGBl. I 1998, S. 3322), zuletzt geändert durch Artikel 6 des Gesetzes vom 8. April 2008 (BGBl. I 2008, Nr. 14, S. 666) p. 87, 183
- [1B-2] Bau- und Raumordnungsgesetz 1998 vom 18. August 1997 (BGBl. I 1997, Nr. 59, S. 2081), zuletzt geändert durch Artikel 10 des Gesetzes vom 9. Dezember 2006 (BGBl. I 2006, Nr. 59, S. 2833) p. 76
- [1B-3] Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge (Bundes-Immissionsschutzgesetz - BImSchG) in der Fassung der Bekanntmachung vom 14. Mai 1990 (BGBl. I 1990, S. 880), Neufassung vom 26. September 2002 (BGBl. I 2002, Nr. 71, S. 3830), zuletzt geändert durch Artikel 1 des Gesetzes vom 23. Oktober 2007 (BGBl. I 2007, Nr. 53, S. 2470), mit diversen Verordnungen p. 76
- [1B-5] Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz) vom 27. Juli 1957, Neufassung vom 12. November 1996 (BGBl. I 1996, Nr. 58), Neufassung vom 19. August 2002 (BGBl. I 2002, Nr. 59, S. 3245), zuletzt geändert durch Artikel 2 des Gesetzes vom 10. Mai 2007 (BGBl. I 2007, Nr. 19, S. 666) p. 76
- [1B-6] Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz) vom 12. März 1987 (BGBl. I 1987, S. 889), Neufassung vom 21. September 1998 (BGBl. I 1998, Nr. 66), Neufassung vom 25. März 2002 (BGBl. I 2002, Nr. 22, S. 1193), zuletzt geändert durch Artikel 2 des Gesetzes vom 8. April 2008 (BGBl. I 2008, Nr. 14, S. 686) p. 76
- [1B-7] Gesetz über technische Arbeitsmittel (Gerätesicherheitsgesetz) vom 24. Juni 1968, Fassung vom 11. Mai 2001 (BGBl. I Nr. 22 vom 21. Mai 2001), aufgehoben/ersetzt durch Gesetz über technische Arbeitsmittel und Verbraucherprodukte (Geräte- und Produktsicherheitsgesetz) vom 6. Januar 2004 (BGBl. I Nr. 1 vom 9. Januar 2004 S. 2, ber. 2004 S. 219; 21. Juni 2005 S. 1818; 30. Juni 2005 S. 1865; 7. Juli 2005 S. 1970)

- [1B-8] Betriebssicherheitsverordnung vom 27. September 2002 (BGBl. I 2002, S. 3777), zuletzt geändert durch Artikel 5 der Verordnung vom 6. März 2007 (BGBl. I 2007, Nr. 8, S. 261)
Hinweis: es bleiben "atomrechtliche Vorschriften des Bundes und der Länder unberührt, soweit in ihnen weitergehende oder andere Anforderungen gestellt oder zugelassen werden."
- [1B-12] Gesetz über Betriebsärzte, Sicherheitsingenieure und andere Fachkräfte für Arbeitssicherheit vom 12. Dezember 1973 (BGBl. I 1973, S. 1885), zuletzt geändert durch Artikel 226 der Verordnung vom 31. Oktober 2006 (BGBl. I 2006, Nr. 50, S. 2407)
- [1B-13] Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Beseitigung von Abfällen (Kreislaufwirtschafts- und Abfallgesetz) vom 27. September 1994 (BGBl. I 1994, Nr. 66, S. 2705); zuletzt geändert durch Art. 2 G v. 19. Juli 2007 I 1462 p. 76, 130
- [1B-14] Umweltverträglichkeitsprüfungsgesetz (UVPG) vom 12. Februar 1990 (BGBl. I, S. 205), Neufassung vom 25. Juni 2005 (BGBl. I 2005, Nr. 37, S. 1757), zuletzt geändert durch Artikel 2 des Gesetzes vom 23. Oktober 2007 (BGBl. I 2007, Nr. 53, S. 2470), Hinweis: Umsetzung der RL 2001/42/EG p, 76, 78, 82, 133, 138, 155, 160
- [1B-15] Bundesberggesetz i. d. F. vom 13. August 1980 (BGBl. I S. 1310), zuletzt geändert durch Artikel 11 des Gesetzes vom 9. Dezember 2006 (BGBl. I, Nr. 59, S. 2833) p. 76, 170
- [1B-16] Umweltinformationsgesetz (UIG) vom 8. Juli 1994 (BGBl. I 1994, Nr. 42), Neugestaltung vom 22. Dezember 2004 (BGBl. I 2004, Nr. 73, S. 3704), Hinweis: Umsetzung der RL 2003/4/EG
- [1B-17] Verordnung zum Schutz vor Gefahrstoffen (Gefahrstoffverordnung - GefStoffV) vom 23. Dezember 2004 (BGBl. I 2004, Nr. 74, S. 3759), zuletzt geändert durch Artikel 2 der Verordnung vom 12. Oktober 2007 (BGBl. I 2007, Nr. 52, S. 2382)

1C Regulations for the Transport of Radioactive Material and Accompanying Regulations

- [1C-1] Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series TS-R-1 (2005)
Note: The international and national rules fall back on this source. States have committed to implement these regulations.
- [1C-2] Code of Practice on the International Transboundary Movement of Radioactive Waste (INCIRC/386) of September 1990
- [1C-3] Europäisches Übereinkommen vom 30. September 1957 über die internationale Beförderung gefährlicher Güter auf der Straße (ADR)
- [1C-4] Übereinkommen vom 9. Mai 1980 über den internationalen Eisenbahnverkehr (COTIF), Gesetz dazu vom 23. Januar 1985 (BGBl. II 1985, Nr. 5), Neufassung vom 3. Juni 1999 (BGBl. II 1999, Nr. 33, S. 2149)
- [1C-5] Internationale Vorschriften über die Beförderung gefährlicher Güter im Seeverkehr (IMDG-Code) der International Maritime Organisation (IMO), einer Sonderorganisation der UN, Bekanntmachung des IMDG-Code 17. November 2006 (VkB. 2006, Nr. 23, S. 844)
Note: The regulation is based on IAEA recommendations.
- [1C-6] Internationaler Code für die sichere Beförderung von verpackten bestrahlten Kernbrennstoffen, Plutonium und hochradioaktiven Abfällen mit Seeschiffen (INF-Code), Bekanntmachung vom 17. November 2000 (BAnz. 2000, Nr. 236, S. 23322), berichtigt BAnz 2001, Nr. 44, S. 3318 und BAnz 2002, S. 24986, Änderung vom 19. Februar 2001 (BAnz 2001, Nr. 44), geändert am 8. Mai 2005 (VkB. 2005, Nr. 6, S. 176) und am 4. März 2006 (VkB. 2006, Nr. 11, S. 486)

- [1C-16] Gesetz über die Beförderung gefährlicher Güter (Gefahrgutbeförderungsgesetz - GGBefG vom 6. August 1975 (BGBl. I 1975, S. 2121), Neufassung vom 29. September 1998 (BGBl. I 1998, Nr. 68, S. 3114), zuletzt geändert durch Artikel 294 der Verordnung vom 31. Oktober 2006 (BGBl. I 2006, Nr. 50, S. 2407)
- [1C-17] Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße und mit Eisenbahnen (Gefahrgutverordnung Straße und Eisenbahn - GGVSE) vom 11. Dezember 2001 (BGBl. 2001 I, Nr. 67), , Neufassung vom 24. November 2006 (BGBl. I 2006, Nr. 55, S. 2683)
Note: This ordinance replaces the „GefahrgutVO Straße“ and the „GefahrgutVO Eisenbahn“
- [1C-18] Verordnung über die Beförderung gefährlicher Güter mit Seeschiffen (Gefahrgutverordnung See – GGVSee) vom 4. März 1998 (BGBl. I 1998, Nr. 13, S. 419), Neufassung vom 3. Dezember 2007 (BGBl. I 2007, Nr. 62, S. 2815)
- [1C-19] Luftverkehrsgesetz (LuftVG) vom 1. August 1922 (RGBl. I 1922, S. 681), Neufassung vom 10. Mai 2007 (BGBl. I, Nr. 20, S. 698), zuletzt geändert durch Artikel 9 Abs. 20 des Gesetzes vom 23. November 2007 (BGBl. I 2007, Nr. 59, S. 2631)

1D Bilateral Agreements in the Nuclear Field and in the Area of Radiation Protection

- [1D-1] Abkommen zwischen der Bundesrepublik Deutschland und der Bundesrepublik Österreich über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 23. Dezember 1988; Gesetz dazu vom 20. März 1992 (BGBl. II 1992, Nr. 9); in Kraft seit 1. Oktober 1992 (BGBl. II 1992, Nr. 27) p. 121
- [1D-2] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich Belgien über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 6. November 1980; Gesetz dazu vom 30. November 1982 (BGBl. II 1982, S. 1006); in Kraft seit 1. Mai 1984 (BGBl. II 1984, S. 327) p. 121
- [1D-3]. Abkommen zwischen der Bundesrepublik Deutschland und der Schweizerischen Eidgenossenschaft über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 28. November 1984; Gesetz dazu vom 22. Januar 1987 (BGBl. II 1987, S. 74); in Kraft seit 1. Dezember 1988 (BGBl. II 1988, S. 967) p. 121
- [1D-4] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich Dänemark über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 16. Mai 1985; Gesetz dazu vom 17. März 1988 (BGBl. II 1988, S. 286); in Kraft seit 1. August 1988 (BGBl. II 1988, S. 619) p. 121
- [1D-5] Abkommen zwischen der Bundesrepublik Deutschland und der Französischen Republik über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 3. Februar 1977; Gesetz dazu vom 14. Januar 1980 (BGBl. II 1980, S. 33); in Kraft seit 1. Dezember 1980 (BGBl. II 1980, S. 1438) p. 121
- [1D-6] Abkommen zwischen der Bundesrepublik Deutschland und der Regierung der Republik Ungarn über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 9. Juni 1997; Gesetz dazu vom 7. Juli 1998 (BGBl. II 1998, Nr. 24); in Kraft seit 11. September 1998 (BGBl. II 1999, Nr. 6) p. 121
- [1D-7] Abkommen zwischen der Bundesrepublik Deutschland und der Republik Litauen über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 15. März 1994; Gesetz dazu vom 12. Januar 1996 (BGBl. II 1996, Nr. 2); in Kraft seit 1. September 1996 (BGBl. II 1996, Nr. 40) p. 121
- [1D-8] Abkommen zwischen der Bundesrepublik Deutschland und dem Großherzogtum Luxemburg über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 7. Juli 1981; Gesetz dazu vom 7. Juli 1981 (BGBl. II 1981, S. 445); in Kraft seit 1. Dezember 1981 (BGBl. II 1981, S. 1067) p. 121

- [1D-9] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich der Niederlande über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 7. Juni 1988; Gesetz dazu vom 20. März 1992 (BGBl. II 1992, Nr. 9); in Kraft seit 1. März 1997 (BGBl. II 1997, Nr. 12) p. 121
- [1D-10] Abkommen zwischen der Bundesrepublik Deutschland und der Republik Polen über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 10. April 1997; Gesetz dazu vom 7. Juli 1998 (BGBl. II 1998, Nr. 24); in Kraft seit 1. März 1999 (BGBl. II 1999, Nr.1) p. 121
- [1D-11] Abkommen zwischen der Bundesrepublik Deutschland und der Russischen Föderation über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 16. Dezember 1992; Gesetz dazu vom 19. Oktober 1994 (BGBl. II 1994, Nr. 52); in Kraft seit 11. Juli 1995 (BGBl. II 1997, Nr. 12) p. 121
- [1D-12] Vertrag zwischen der Bundesrepublik Deutschland und der Tschechischen Republik über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 19. September 2000; Gesetz hierzu vom 16. August 2002 (BGBl. II 2002, Nr. 31); in Kraft seit dem 1. Januar 2003 (BGBl. II 2003, Nr. 2) p. 121

1E Multilateral Agreements on Nuclear Safety and Radiation Protection with National Implementing Regulations

Nuclear Safety and Radiation Protection

- [1E-1] Übereinkommen über die Umweltverträglichkeitsprüfung im grenzüberschreitenden Rahmen - Espoo-Konvention (Convention on Environmental Impact Assessment in a Transboundary Context) vom 25. Februar 1991, in Kraft seit 10. September 1997, 1. Änderung vom Februar 2001, 2. Änderung vom Juni 2004; Gesetz dazu vom 7. Juni 2001 (BGBl.II 2001, Nr. 22); in Kraft für Deutschland seit 8. August 2002
2. Espoo-Vertragsgesetz vom 17. März 2006 (BGBl.II 2006, Nr. 7, S. 224)
- [1E-2] Konvention über den Zugang zu Informationen, die Öffentlichkeitsbeteiligung an Entscheidungsverfahren und den Zugang zu Gerichten in Umweltangelegenheiten – Aarhus-Konvention (Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters) vom 25. Juni 1998, in Kraft seit 30. Oktober 2001; von Deutschland gezeichnet am 21. Dezember 1998
Gesetz dazu (Informationsfreiheitsgesetz) vom 5. September 2005 (BGBl.I 2005, Nr. 57, S. 2722)
Gesetz dazu (Vertragsgesetz) vom 9. Dezember 2006 (BGBl.II 2006, Nr. 31, S. 1251)
- [1E-3] Übereinkommen Nr. 115 der Internationalen Arbeitsorganisation über den Schutz der Arbeitnehmer vor ionisierenden Strahlen (Convention Concerning the Protection of Workers against Ionising Radiations), vom 22. Juni 1960, in Kraft seit 17. Juni 1962
Gesetz hierzu vom 23. Juli 1973 (BGBl. II 1973, Nr. 37)
in Kraft für Deutschland seit 26. September 1974 (BGBl. II 1973, Nr. 63)
- [1E-4] Ratsbeschluss der Organisation für Wirtschaftliche Zusammenarbeit und Entwicklung (OECD) vom 18. Dezember 1962 über die Annahme von Grundnormen für den Strahlenschutz (OECD-Grundnormen) (Radiation Protection Norms)
Gesetz hierzu vom 29. Juli 1964 (BGBl. II 1964, S. 857)
in Kraft für Deutschland seit 3. Mai 1965
Neufassung vom 25. April 1968 (BGBl. II 1970, Nr. 20)

- [1E-5] Übereinkommen über den physischen Schutz von Kernmaterial (Convention on the Physical Protection of Nuclear Material (INFCIRC/274 Rev.1), vom 26. Oktober 1979, in Kraft seit 8. Februar 1987
Gesetz hierzu vom 24. April 1990 (BGBl. II 1990, S. 326, zuletzt geändert durch Artikel 4 Abs. 4 des Gesetzes vom 26. Januar 1998 (BGBl. I 1998, Nr. 6, S. 164), in Kraft für Deutschland seit 6. Oktober 1991 (BGBl. II 1995, Nr. 11, S. 299)
Ergänzung vom 6. September 2005 und Umbenennung in Übereinkommen über den physischen Schutz von Kernmaterial und Kernanlagen (Convention on the Physical Protection of Nuclear Material and Nuclear Facilities), noch nicht in Kraft
15 Vertragsparteien (05/08), Depositar: IAEA
Gesetz dazu vom 6. Juni 2008 (BGBl. II 2008, Nr. 14, S. 574)
- [1E-6] Übereinkommen über die frühzeitige Benachrichtigung bei nuklearen Unfällen (Convention on Early Notification of a Nuclear Accident, INFCIRC/335) vom 26. September 1986 und Übereinkommen über Hilfeleistung bei nuklearen Unfällen oder radiologischen Notfällen (Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336) vom 26. September 1986, beide in Kraft seit 27. Oktober 1986
Gesetz zu den beiden IAEA-Übereinkommen vom 16. Mai 1989 (BGBl. II 1989, Nr. 18)
in Kraft für Deutschland seit 15. Oktober 1989 (BGBl. II 1993, Nr. 34)
- [1E-7] Übereinkommen über nukleare Sicherheit (Convention on Nuclear Safety (INFCIRC/449)) vom 17. Juni 1994, in Kraft seit 24. Oktober 1996
Gesetz dazu vom 7. Januar 1997 (BGBl. II 1997, Nr. 2, S. 130)
in Kraft für Deutschland seit 20. April 1997 (BGBl. II 1997, Nr. 14, S. 796)
- [1E-8] Gemeinsames Übereinkommen über die Sicherheit der Behandlung abgebrannter Brennelemente und über die Sicherheit der Behandlung radioaktiver Abfälle - Übereinkommen über nukleare Entsorgung (Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546) vom 5. September 1997, in Kraft seit 18. Juni 2001;
Gesetz hierzu vom 13. August 1998 (BGBl. II 1998, Nr. 31, S. 1752), in Kraft für Deutschland seit 18. Juni 2001 (BGBl. II 2001, Nr. 36, S. 1283)
- [1E-9] Vertrag vom 1. Juli 1968 über die Nichtverbreitung von Kernwaffen - Atomwaffensperrvertrag (Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/140) vom 1. Juli 1968, in Kraft seit 5. März 1970
Gesetz dazu vom 4. Juni 1974 (BGBl. II 1974, S. 785)
in Kraft für Deutschland seit 2. Mai 1975 (BGBl. II 1976, S. 552)
Verlängerung des Vertrages auf unbegrenzte Zeit am 11. Mai 1995 (BGBl. II 1995, S. 984))

- [1E-10] Übereinkommen zwischen dem Königreich Belgien, dem Königreich Dänemark, der Bundesrepublik Deutschland, Irland, der Italienischen Republik, dem Großherzogtum Luxemburg, dem Königreich der Niederlande, der Europäischen Atomgemeinschaft und der Internationalen Atomenergie-Organisation in Ausführung von Artikel III Absätze 1 und 4 des Vertrages vom 1. Juli 1968 über die Nichtverbreitung von Kernwaffen - Verifikationsabkommen (Agreement Between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in Implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/193-193/Add.5) vom 5. April 1973, in Kraft für alle Vertragsparteien seit 21. Februar 1977, später ergänzt
Gesetz hierzu vom 4. Juni 1974 (BGBl. II 1974, S. 794)
Ausführungsgesetz hierzu vom 7. Januar 1980 (BGBl. I 1980, S. 17), zuletzt geändert durch VO vom 29. Oktober 2001 (BGBl. I 2001, Nr. 55)
Zusatzprotokoll vom 22. September 1998, in Kraft seit dem 30. April 2004
Gesetz zum Zusatzprotokoll vom 22. September 1998 vom 29. Januar 2000 (BGBl. I 2000, Nr. 4)
Ausführungsgesetz zum Verifikationsabkommen und zum Zusatzprotokoll vom 29. Januar 2000 (BGBl. I 2000, Nr. 5)
Code of Practice on the International Transboundary Movement of Radioactive Waste (INFCIRC/386) of 21 September 1990
Hinweis: keine Implementierung!
Übereinkommen über die Verhütung von Meeresverschmutzung durch das Einbringen von Abfällen und anderen Stoffen - London Dumping Convention (Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, INFCIRC/205) vom 29. Dezember 1972, in Kraft seit 30. August 1975
Gesetz hierzu vom 11. Februar 1977 (BGBl. II 1977, S. 165); in Kraft für Deutschland seit 8. Dezember 1977 (BGBl. II 1979, S. 273)
Protokoll vom 7. November 1996 zu diesem Übereinkommen
Gesetz hierzu vom 9. Juli 1998 (BGBl. II 1998, Nr. 25, S. 1345), Berichtigung in (BGBl. I 1998, Nr. 79, S. 3582)
Note: No dumping of materials with activities above de-minimis concentrations.

Liability

- [1E-11] Übereinkommen über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie - Pariser Atomhaftungs-Übereinkommen (Convention on Third Party Liability in the Field of Nuclear Energy - Paris Convention) vom 29. Juli 1960, ergänzt durch das Protokoll vom 28. Januar 1964 (BGBl. II 1976, S. 310), und das Protokoll vom 16. November 1982, in Kraft seit 1. April 1968;
Gesetz hierzu vom 8. Juli 1975 (BGBl. II 1975, S. 957), geändert durch Gesetz vom 9. Juni 1980 (BGBl. II 1980, S. 721)
in Kraft für Deutschland seit 30. September 1975 (BGBl. II 1976, S. 308); Gesetz hierzu vom 21. Mai 1985 (BGBl. II 1985, S. 690); in Kraft für Deutschland seit 7. Oktober 1988 (BGBl. II 1989, S. 144) p. 79
- [1E-12] Zusatzübereinkommen zum Pariser Übereinkommen vom 29. Juli 1960 - Brüsseler Zusatzübereinkommen, (Convention Supplementary to the Paris Convention of 29 July 1960 on Third Party Liability in the Field of Nuclear Energy (Brussels Supplementary Convention) vom 31. Januar 1963, ergänzt durch das Protokoll vom 28. Januar 1964 (BGBl. II 1976, S. 310) und das Protokoll vom 16. November 1982;
Gesetz hierzu vom 8. Juli 1975 (BGBl. II 1975, S. 957);
in Kraft für Deutschland seit 1. Januar 1976 (BGBl. II 1976, S. 308); Gesetz hierzu vom 21. Mai 1985 (BGBl. II 1985, S. 690)
in Kraft für Deutschland seit 1. August 1991 (BGBl. II 1995, S. 657) p. 79

- [1E-14] Convention on Supplementary Compensation for Nuclear Damage of 12 September 1997, nicht in Kraft
- [1E-15] Abkommen zwischen der Bundesrepublik Deutschland und der Schweizerischen Eidgenossenschaft über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie vom 22. Oktober 1986
Gesetz dazu vom 28. Juni 1988 (BGBl. II 1988, S. 598)
in Kraft für Deutschland seit 21. September 1988 (BGBl. II 1988, S. 955)

1F Law of the European Union

Agreements, General

- [1F-1] Vertrag vom 25. März 1957 zur Gründung der Europäischen Atomgemeinschaft (**EURATOM**) in der Fassung des Vertrages über die **Europäische Union** vom 7. Februar 1992, geändert durch den Beitrittsvertrag vom 24. Juni 1994 in der Fassung des Beschlusses vom 1. Januar 1995 (BGBl. II 1957, S. 753, 1014, 1678; BGBl. II 1992, S. 1251, 1286; BGBl. II 1993, S. 1947; BGBl. II 1994, S. 2022; ABl. EG 1995, Nr. L1)
Der Vertrag ist in seiner ursprünglichen Fassung am 1. Januar 1958 in Kraft getreten (BGBl. 1958 II S. 1), die Neufassung trat am 1. November 1993 in Kraft (BGBl. 1993 II S. 1947), Berichtigung der Übersetzung des EURATOM-Vertrages vom 13. Oktober 1999 (BGBl. II 1999, Nr. 31) p. 71, 135
- [1F-2] Verifikationsabkommen siehe [1E-10]
- [1F-3] Verordnung (EURATOM) 302/2005 der Kommission vom 8. Februar 2005 über die Anwendung der EURATOM-Sicherungsmaßnahmen (ABl. 2005, L 54)
- [1F-4] Bekanntmachung über die Meldung an die Behörden der Mitgliedsstaaten auf dem Gebiet der Sicherheitsmaßnahmen gemäß Artikel 79 Abs. 2 des EURATOM-Vertrages vom 19. August 1999 (BGBl. II 1999, S. 811)
- [1F-7] Agreement for Co-operation in the Peaceful Uses of Nuclear Energy between EURATOM and the United States of America, signed on March 29, 1996 (ABl. EG 1996, Nr. L120) in Kraft seit 12. April 1996
- [1F-10] Empfehlung 2000/473/EURATOM der Kommission vom 8. Juni 2000 zur Anwendung des Artikels 36 des EURATOM-Vertrages zur Überwachung des Radioaktivitätsgehaltes der Umwelt zur Ermittlung der Exposition der Gesamtbevölkerung (ABl. EG 2000, Nr. L191)
- [1F-11] Empfehlung 1999/829/EURATOM der Kommission vom 6. Dezember 1999 betreffend die Anwendung von Artikel 37 des EURATOM-Vertrages (ABl. EG 1999, Nr. L324)
- [1F-12] Richtlinie 85/337/EWG des Rates vom 27. Juni 1985 über die Umweltverträglichkeitsprüfung bei bestimmten öffentlichen und privaten Projekten (ABl. EG 1985, Nr. L175), geändert durch die Richtlinie 2003/35/EG des EP und des Rates vom 26. Mai 2003 (ABl. 2003, Nr. L156), konsolidierte Fassung
Gesetz hierzu ("Gesetz über die Umweltverträglichkeitsprüfung") vom 12. Februar 1990 (BGBl. I 1990, S. 205), Neufassung vom 25. Juni 2005 (BGBl. I 2005, Nr. 37), Berichtigung vom 9. September 2005 (BGBl. I 2005, Nr. 59) p. 80
- [1F-13] Richtlinie 97/11/EG des Rates vom 3. März 1997 zur Änderung der Richtlinie 85/337/EWG über die Umweltverträglichkeitsprüfung bei bestimmten öffentlichen und privaten Projekten (ABl. EG 1997, Nr. L73)
"UVP-Änderungsrichtlinie", derzeit in der Umsetzung p. 138

- [1F-14] Richtlinie 90/313/EWG des Rates vom 7. Juni 1990 über den freien Zugang zu Informationen über die Umwelt (ABl. EG 1990, Nr. L158)
- Gesetz hierzu ("Umweltinformationsgesetz - UIG") vom 8. Juli 1994 (BGBl. I 1994, Nr. 42)
 - Verordnung über Gebühren für Amtshandlungen der Behörden des Bundes beim Vollzug des Umweltinformationsgesetzes (Umweltinformationsgebührenverordnung) vom 7. Dezember 1994 (BGBl. I 1994, Nr. 88)
- [1F-15] Richtlinie 98/34/EG des Europäischen Parlaments und des Rates vom 22. Juni 1998 über ein Informationsverfahren auf dem Gebiet der Normen und technischen Vorschriften (ABl. EG 1998, Nr. L204)
- [1F-16] Richtlinie 98/37/EG des Europäischen Parlaments und des Rates vom 22. Juni 1998 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten für Maschinen (ABl. EG 1998, Nr. L207)
- Note: The date of implementation of the Guideline has not been specified; currently, e.g. pressure vessels, mobile fair equipment and machines are still exempted from nuclear use.

Radiation Protection

- [1F-17] Empfehlung 91/444/EURATOM der Kommission vom 26. Juli 1991 zur Anwendung von Artikel 33 des EURATOM-Vertrages (ABl. EG 1991, Nr. L238)
- [1F-18] Richtlinien des Rates, mit denen die Grundnormen für den Gesundheitsschutz der Bevölkerung und der Arbeitskräfte gegen die Gefahren ionisierender Strahlungen festgelegt wurden (EURATOM-Grundnormen) p. 105, 106, 110, 131, 184, 185
- Richtlinie vom 2. Februar 1959 (ABl. EG 1959, Nr. 11),
 - Richtlinie vom 5. März 1962 (ABl. EG 1962, S. 1633/62),
 - Richtlinie 66/45/EURATOM (ABl. EG 1966, Nr. 216),
 - Richtlinie 76/579/EURATOM vom 1. Juni 1976 (ABl. EG 1976, Nr. L187),
 - Richtlinie 79/343/EURATOM vom 27. März 1977 (ABl. EG 1979, Nr. L83),
 - Richtlinie 80/836/EURATOM vom 15. Juli 1980 (ABl. EG 1980, Nr. L246),
 - Richtlinie 84/467/EURATOM vom 3. September 1984 (ABl. EG 1984, Nr. L265),
 - Neufassung mit Berücksichtigung der ICRP 60 in Richtlinie 96/29/EURATOM vom 13. Mai 1996 (ABl. EG 1996, Nr. L159)
- [1F-19] Mitteilung der Kommission zur Durchführung der Richtlinien des Rates 80/836/EURATOM und 84/467/EURATOM (ABl. EG 1985, Nr. C347)
- [1F-20] Richtlinie 90/641/EURATOM des Rates vom 4. Dezember 1990 über den Schutz externer Arbeitskräfte, die einer Gefährdung durch ionisierende Strahlung bei Einsatz im Kontrollbereich ausgesetzt sind (ABl. EG 1990, Nr. L349)
- [1F-21] Richtlinie 94/33/EG des Rates vom 22. Juni 1994 über Jugendarbeitsschutz (ABl. EG 1994, Nr. L216)
- Note: According to Article 7 of the Guideline the member states are committed to prohibit the employment of young people for work that implicates harmful impacts by radiation.
- [1F-22] Richtlinie 2003/122/EURATOM des Rates vom 22. Dezember 2003 zur Kontrolle hochradioaktiver Strahlenquellen und herrenloser Strahlenquellen (ABl. EG 2003, Nr. L346)

Radiological Emergencies

- [1F-28] Entscheidung 87/600/EURATOM des Rates vom 14. Dezember 1987 über Gemeinschaftsvereinbarungen für den beschleunigten Informationsaustausch im Fall einer radiologischen Notstandssituation (ABl. EG 1987, Nr. L371)

- [1F-29] Richtlinie 89/618/EURATOM des Rates vom 27. November 1989 über die Unter- p. 115
richtung der Bevölkerung über die bei einer radiologischen Notstandssituation
geltenden Verhaltensmaßregeln und zu ergreifenden Gesundheitsschutzmaß-
nahmen (ABl. EG 1989, Nr. L357)
- Mitteilung der Kommission betreffend die Durchführung der Richtlinie
89/618/EURATOM (ABl. EG 1991, Nr. C103)
- [1F-30] Verordnungen zur Festlegung von Höchstwerten an Radioaktivität in Nahrungs-
mitteln und Futtermitteln im Fall eines nuklearen Unfalls oder einer anderen ra-
diologischen Notstandssituation:
- Ratsverordnung (EURATOM) 3954/87 vom 22. Dezember 1987; (ABl. EG
1987, Nr. L371) geändert durch Ratsverordnung (EURATOM) 2218/89 vom
18. Juli 1989 (ABl. EG 1989, Nr. L211),
 - Kommissionsverordnung (EURATOM) 944/89 vom 12. April 89 (ABl. EG
1989, Nr. L101),
 - Kommissionsverordnung (EURATOM) 770/90 vom 29. März 1990 (ABl. EG
1990, Nr. L83)
- [1F-31] Ratsverordnung (EWG) 2219/89 vom 18. Juli 1989 über besondere Bedingungen
für die Ausfuhr von Nahrungsmitteln und Futtermitteln im Falle eines nuklearen
Unfalls oder einer anderen radiologischen Notstandssituation (ABl. EG 1989, Nr.
L211)
- [1F-32] Ratsverordnung (EWG) 3955/87 vom 22. Dezember 1987 über die Einfuhrbedin-
gungen für landwirtschaftliche Erzeugnisse mit Ursprung in Drittländern nach
dem Unfall im Kernkraftwerk Tschernobyl (ABl. EG 1987, Nr. L371),
- Verordnung (EWG) 1983/88 der Kommission vom 5. Juli 1988 mit Durchfüh-
rungsbestimmungen zu der Verordnung (EWG) 3955/87 (ABl. EG 1988, Nr.
L174),
 - Verordnung (EWG) 4003/89 des Rates vom 21. Dezember 1989 zur Ände-
rung der Verordnung (EWG) 3955/87 (ABl. EG 1989, Nr. L382),
 - Verordnung (EWG) 737/90 des Rates vom 22. März 1990 zur Ergänzung der
Verordnung (EWG) 3955/87 (ABl. EG 1990, Nr. L82),
 - Verordnung (EG) 686/95 des Rates zur Verlängerung der Verordnung (EWG)
737/90 (ABl. EG 1995, Nr. L71),
 - Verordnungen der Kommission zur Festlegung einer Liste von Erzeugnissen
die von der Durchführung der Verordnung (EWG) 737/90 des Rates über die
Einfuhrbedingungen für landwirtschaftliche Erzeugnisse mit Ursprung in Dritt-
ländern nach dem Unfall im Kernkraftwerk Tschernobyl ausgenommen sind,
 - Verordnung (EWG) 146/91 vom 22. Januar 1991 (ABl. EG 1991, Nr. L17),
 - Verordnung (EWG) 598/92 vom 9. März 1992 (ABl. EG 1992, Nr. L64),
 - Verordnung (EWG) 1518/93 vom 21. Juni 1993 (ABl. EG 1993, Nr. L150),
 - Verordnung (EG) 3034/94 vom 13. Dezember 1994 (ABl. EG 1994, Nr. L321)

Waste, Hazardous Materials

- [1F-33] Richtlinie 92/3/EURATOM des Rates vom 3. Februar 1992 zur Überwachung und Kontrolle der Verbringung radioaktiver Abfälle von einem Mitgliedstaat in einen anderen, in die Gemeinschaft und aus der Gemeinschaft (ABl. EG 1992, Nr. L35)
- Entscheidung 93/552/EURATOM der Kommission vom 1. Oktober 1993 zur Einführung des einheitlichen Begleitscheins für Verbringung radioaktiver Abfälle gemäß Richtlinie 92/3/EURATOM (ABl. EG 1993, Nr. L268)
 - Empfehlung der Kommission für ein Klassifizierungssystem für radioaktive Abfälle (ABl. EG 1999, Nr. L165)
 - Mitteilung zur Richtlinie 92/3/EURATOM des Rates vom 3. Februar 1992 zur Überwachung und Kontrolle der Verbringung radioaktiver Abfälle von einem Mitgliedstaat in einen anderen, in die Gemeinschaft und aus der Gemeinschaft (ABl. EG 1994, Nr. C224)
- Hinweis: Umsetzung durch die Atomrechtliche Abfallverbringungsverordnung - AtAV) vom 27. Juli 1998 (BGBl. I 1998, Nr. 47)
- [1F-34] Verordnung (EURATOM) 1493/93 des Rates vom 8. Juni 1993 über die Verbringung radioaktiver Stoffe zwischen den Mitgliedstaaten (ABl. EG 1993, Nr. L148),
- Mitteilung der Kommission vom 10. Dezember 1993 zu der Verordnung EURATOM/1493/93 (ABl. EG 1993, Nr. C335)

2 General Administrative Provisions

- [2-1] Allgemeine Verwaltungsvorschrift zu § 45 Strahlenschutzverordnung: Ermittlung der Strahlenexposition durch die Ableitung radioaktiver Stoffe aus kerntechnischen Anlagen oder Einrichtungen vom 21. Februar 1990 (BAnz. 1990, Nr. 64a), in Überarbeitung – neuer Bezug auf § 47 StrlSchV i. d. F. v. 20. Juli 2001 p. 74, 109, 140, 164
- [2-2] Allgemeine Verwaltungsvorschrift zu § 40 Abs. 2, § 95 Abs. 3 StrlSchV und § 35 Abs. 2 RöV (AVV Strahlenpass) vom 20. Juli 2004 (BAnz. 2004, Nr. 142a) p. 74
- [2-3] Allgemeine Verwaltungsvorschrift zur Ausführung des Gesetzes über die Umweltverträglichkeitsprüfung (UVPVwV) vom 18. September 1995 (GMBI. 1995, Nr. 32) p. 74
- [2-4] Allgemeine Verwaltungsvorschrift zum Integrierten Meß- und Informationssystem nach dem Strahlenschutzvorsorgegesetz (AVV-IMIS) vom 13. September 2006 (BAnz. 2006, Nr. 244a) p. 74, 113
- [2-5] Allgemeine Verwaltungsvorschrift zur Durchführung der Überwachung von Lebensmitteln nach der Verordnung (Euratom) Nr. 3954/87 des Rates vom 22. Dezember 1987 zur Festlegung von Höchstwerten an Radioaktivität in Nahrungsmitteln und Futtermitteln im Falle eines nuklearen Unfalls oder einer anderen radiologischen Notstandssituation (AVV-Strahlenschutzvorsorge-Lebensmittelüberwachung - AW-StrahlLe) vom 28. Juni 2000 (GMBI. 2000, Nr. 25) p. 74
- [2-6] Allgemeine Verwaltungsvorschrift zur Überwachung der Höchstwerte für Futtermittel nach der Verordnung (Euratom) Nr. 3954/87 des Rates vom 22. Dezember 1987 zur Festlegung von Höchstwerten an Radioaktivität in Nahrungsmitteln und Futtermitteln im Falle eines nuklearen Unfalls oder einer anderen radiologischen Notstandssituation (Futtermittel-Strahlenschutzvorsorge-Verwaltungsvorschrift - FMStrVVwV) vom 22. Juni 2000 (BAnz. 2000, Nr. 122) p. 74

3 Announcements by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Ministry for the Interior (Extract)

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|----------|---|----------------------|
| [3-1] | Sicherheitskriterien für Kernkraftwerke vom 21. Oktober 1977 (BAnz. 1977, Nr. 206) | p. 74, 126, 138 |
| [3-2] | Richtlinie für den Fachkundenachweis von Kernkraftwerkspersonal vom 14. April 1993 (GMBI. 1993, Nr. 20), eine Ergänzung für das verantwortliche Kernkraftwerkspersonal zur probeweisen Anwendung für 3 Jahre ab 1. Januar 2005 liegt den Ländern vor | p. 99 |
| [3-4] | Richtlinien über die Anforderungen an Sicherheitsspezifikationen für Kernkraftwerke vom 27. April 1976 (GMBI. 1976, S. 199) | |
| [3-5] | Merkpostenaufstellung mit Gliederung für einen Standardsicherheitsbericht für Kernkraftwerke mit Druckwasserreaktor oder Siedewasserreaktor vom 26. Juli 1976 (GMBI. 1976, S. 418) | |
| [3-6] | Richtlinie für den Schutz von Kernkraftwerken gegen Druckwellen aus chemischen Reaktionen durch Auslegung der Kernkraftwerke hinsichtlich ihrer Festigkeit und induzierten Schwingungen sowie durch Sicherheitsabstände vom 13. September 1976 (BAnz. 1976, Nr. 179) | |
| [3-7-1] | Zusammenstellung der in atomrechtlichen Genehmigungs- und Aufsichtsverfahren für Kernkraftwerke zur Prüfung erforderlichen Informationen (ZPI) vom 20. Oktober 1982 (BAnz. 1983, Nr. 6a) | |
| [3-7-2] | Zusammenstellung der zur bauaufsichtlichen Prüfung kerntechnischer Anlagen erforderlichen Unterlagen vom 6. November 1981 (GMBI. 1981, S. 518) | |
| [3-8] | Grundsätze für die Vergabe von Unteraufträgen durch Sachverständige vom 29. Oktober 1981 (GMBI. 1981, S. 517) | |
| [3-9-1] | Grundsätze zur Dokumentation technischer Unterlagen durch Antragsteller/Genehmigungsinhaber bei Errichtung, Betrieb und Stilllegung von Kernkraftwerken vom 19. Februar 1988 (BAnz. 1988, Nr. 56) | |
| [3-9-2] | Anforderungen an die Dokumentation bei Kernkraftwerken vom 5. August 1982 (GMBI. 1982, S. 546) | |
| [3-12] | Bewertungsdaten für Kernkraftwerksstandorte vom 11. Juni 1975 (Umwelt 1975, Nr. 43) | |
| [3-13] | Sicherheitskriterien für die Endlagerung radioaktiver Abfälle in einem Bergwerk vom 20. April 1983 (GMBI. 1983, S. 220) (in Überarbeitung) | various citations |
| [3-15] | 1. Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen vom 9. August 1999 (GMBI. 1999, Nr. 28/29), in Überarbeitung
2. Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei unfallbedingten Freisetzungen von Radionukliden vom 9. August 1999 (GMBI. 1999, Nr. 28/29)
3. Verwendung von Jodtabletten zur Jodblockade der Schilddrüse bei einem kerntechnischen Unfall, Bekanntmachung des BMU vom 20. Oktober 2004 einer Empfehlung der SSK (BAnz. 2004, Nr. 220) | p. 115, 120, 141 |
| [3-23] | Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen (REI) vom 7. Dezember 2005 (GMBI. 2006, Nr. 14-17) | p. 74, 109, 112, 138 |
| [3-23-2] | ergänzt um die Anhänge B und C vom 20. Dezember 1995 (GMBI. 1996, Nr. 9/10), in Überarbeitung | p. 112 |
| [3-24] | Richtlinie über Dichtheitsprüfungen an umschlossenen radioaktiven Stoffen vom 20. Januar und 4. Februar 2004 (GMBI. 2004, Nr. 27) | |

- [3-25] Grundsätze zur Entsorgungsvorsorge für Kernkraftwerke vom 19. März 1980 (BAnz. 1980, Nr. 58)
- [3-27] Richtlinie über die Gewährleistung der notwendigen Kenntnisse der beim Betrieb von Kernkraftwerken sonst tätigen Personen vom 30. November 2000 (GMBI. 2001, Nr. 8) p. 98, 99, 100
- [3-29] Regelung der Rechtsetzungskompetenzen bei der Beförderung radioaktiver Stoffe (Kernbrennstoffe und sonstige radioaktive Stoffe) (BMU RS II 1, Stand März 1993)
- [3-31] Empfehlungen zur Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken vom 27. Dezember 1976 (GMBI. 1977, S. 48), geändert durch GMBI. 1977, S 664) und die REI (GMBI. 1993, Nr. 29)
- [3-32] Änderung der Empfehlungen zur Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken vom 18. Oktober 1977 (GMBI. 1977, S. 664)
- [3-33] Leitlinien zur Beurteilung der Auslegung von Kernkraftwerken mit Druckwasserreaktoren gegen Störfälle im Sinne des § 28 Abs. 3 StrlSchV (Störfall-Leitlinien) vom 18. Oktober 1983 (BAnz. 1983, Nr. 245a) p. 138, 140
Störfallberechnungsgrundlagen für die Leitlinien zur Beurteilung der Auslegung von Kernkraftwerken mit DWR gemäß § 28 Abs. 3 StrlSchV vom 18. Oktober 1983 (BAnz. 1983, Nr. 245a), Fassung des Kapitels 4 „Berechnung der Strahlenexposition“ vom 29. Juni 1994 (BAnz. 1994, Nr. 222a), Neufassung des Kapitels 4 "Berechnung der Strahlenexposition" gemäß § 49 StrlSchV vom 20. Juli 2001 verabschiedet auf der 186. Sitzung der Strahlenschutzkommission am 11. September 2003, veröffentlicht in der Reihe "Berichte der Strahlenschutzkommission", Heft 44, 2004
- [3-34] Rahmenrichtlinie über die Gestaltung von Sachverständigengutachten in atomrechtlichen Verwaltungsverfahren vom 15. Dezember 1983 (GMBI. 1984, S. 21) p. 138
- [3-37-1] Empfehlung über den Regelungsinhalt von Bescheiden bezüglich der Ableitung radioaktiver Stoffe aus Kernkraftwerken mit Leichtwasserreaktor vom 8. August 1984 (GMBI. 1984, S. 327), in Überarbeitung
- [3-38] Richtlinie für Programme zur Erhaltung der Fachkunde des verantwortlichen Schichtpersonals in Kernkraftwerken vom 1. September 1993 (GMBI. 1993, Nr. 36)
- [3-39] Richtlinie für den Inhalt der Fachkundeprüfung des verantwortlichen Schichtpersonals in Kernkraftwerken vom 23. April 1996 (GMBI. 1996, Nr. 26), in Überarbeitung
- [3-40] Richtlinie über die im Strahlenschutz erforderliche Fachkunde (Fachkunderichtlinie Technik nach StrlSchV) vom 21. Juni 2004 (GMBI. 2004, Nr. 40/41), Änderung vom 19. April 2006 (GMBI. 2006, Nr. 38) p. 98, 107, 184
- [3-41] Richtlinie für das Verfahren zur Vorbereitung und Durchführung von Instandhaltungs- und Änderungsarbeiten in Kernkraftwerken vom 1. Juni 1978 (GMBI. 1978, S. 342), in Überarbeitung
- [3-42-1] Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen p. 75
Teil 1: Ermittlung der Körperdosis bei äußerer Strahlenexposition (§§ 40, 41, 42 StrlSchV; §§ 35 RöV) vom 8. Dezember 2003 (GMBI. 2004, Nr.22)
- [3-42-2] Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen p. 75
Teil 2: Ermittlung der Körperdosis bei innerer Strahlenexposition (Inkorporationsüberwachung) (§§ 40, 41 und 42 StrlSchV) vom 12. Januar 2007 (GMBI. 2007, Nr. 31/32, S. 623)

- [3-43-1] Richtlinie für den Strahlenschutz des Personals bei der Durchführung von Instandhaltungsarbeiten in Kernkraftwerken mit Leichtwasserreaktor Teil I: Die während der Planung der Anlage zu treffende Vorsorge vom 10. Juli 1978 (GMBI. 1978, S. 418), in Überarbeitung
- [3-43-2] Richtlinie für den Strahlenschutz des Personals bei Tätigkeiten der Instandhaltung, Änderung, Entsorgung und des Abbaus in kerntechnischen Anlagen und Einrichtungen: Teil 2: Die Strahlenschutzmaßnahmen während des Betriebs und der Stilllegung einer Anlage oder Einrichtung – IWRS II vom 17. Januar 2005 (GMBI. 2005, Nr. 13, S. 258) p. 75
- [3-44] Kontrolle der Eigenüberwachung radioaktiver Emissionen aus Kernkraftwerken vom 5. Februar 1996 (GMBI. 1996, Nr. 9/10)
- [3-49] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke
Einzelfehlerkonzept - Grundsätze für die Anwendung des Einzelfehlerkriteriums vom 2. März 1984 (GMBI. 1984, S. 208)
- [3-50] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke vom 17. Mai 1979 (GMBI. 1979, S. 161); zu Sicherheitskriterium 2.6: Einwirkungen von außen; zu Sicherheitskriterium 8.5: Wärmeabfuhr aus dem Sicherheitseinschluß
- [3-51] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke vom 28. November 1979 (GMBI. 1980, S. 90)
zu Sicherheitskriterium 2.2: Prüfbarkeit
zu Sicherheitskriterium 2.3: Strahlenbelastung in der Umgebung
zu Sicherheitskriterium 2.6: Einwirkungen von außen
zu Sicherheitskriterium 2.7: Brand- und Explosionsschutz
ergänzende Interpretation zu Sicherheitskriterium 4.3: Nachwärmeabfuhr nach Kühlmittelverlusten
- [3-52-2] Erläuterungen zu den Meldekriterien für meldepflichtige Ereignisse in Anlagen zur Spaltung von Kernbrennstoffen (Stand 05/04)
- Zusammenstellung der in den Meldekriterien verwendeten Begriffen (Anlagen zur Spaltung von Kernbrennstoffen) (Stand 05/04)
 - Meldeformular zur Meldung eines meldepflichtigen Ereignisses (Anlagen zur Spaltung von Kernbrennstoffen) (Stand 04/04)
- [3-52-3] Erläuterungen zu den Meldekriterien für meldepflichtige Ereignisse in Anlagen, die nicht der Spaltung von Kernbrennstoffen dienen (Stand 1/97)
- Meldeformular (Anlagen, die nicht der Spaltung von Kernbrennstoffen dienen) (Stand 12/92)
- [3-52-4] Meldung eines Befundes bzgl. Kontamination oder Dosisleistung bei der Beförderung von entleerten Brennelement-Behältern, Behältern mit bestrahlten Brennelementen und Behältern mit verglasten hochradioaktiven Spaltproduktlösungen (Stand 8/00)
- Meldeformular (Behälter) (Stand 7/00)
- [3-54] Rahmenempfehlung für die Fernüberwachung von Kernkraftwerken vom 12. August 2005 (GMBI. 2005, Nr. 51, S. 1049)
- [3-54-1] Empfehlung zur Berechnung der Gebühr nach § 5 AtKostV für die Fernüberwachung von Kernkraftwerken (KFÜ) vom 21. Januar 1983 (GMBI. 1983, S. 146)
- [3-55] Musterbenutzungsordnung der Landessammelstellen für radioaktive Abfälle in der Bundesrepublik Deutschland vom 17. März 1981 (GMBI. 1981, S. 163)
- [3-55-1] Grundsätzliche Konzeption für den Ausbau der Landessammelstellen für radioaktive Abfälle vom 26. Oktober 1981 (GMBI. 1981, S. 511)
- [3-57] Anforderungen an den Objektsicherungsdienst und an Objektsicherungsbeauftragte in kerntechnischen Anlagen der Sicherungskategorie I vom 8. April 1986 (GMBI. 1986, S. 242) p. 98

- [3-57-3] Richtlinie für den Schutz von Kernkraftwerken mit Leichtwasserreaktoren gegen Störmaßnahmen oder sonstige Einwirkungen Dritter vom 6. Dezember 1995 (GMBI. 1996, Nr. 2) (ohne Wortlaut)
- [3-59] Richtlinie zur Kontrolle radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung, die nicht an eine Landessammelstelle abgeliefert werden (Abfallkontrollrichtlinie) vom 16. Januar 1989 (BAnz. 1989, Nr. 63a), letzte Ergänzung vom 14. Januar 1994 (BAnz. 1994, Nr. 19) p. 23, 74, 86, 104, 105, 148
- [3-61] Richtlinie für die Fachkunde von Strahlenschutzbeauftragten in Kernkraftwerken und sonstigen Anlagen zur Spaltung von Kernbrennstoffen vom 10. Dezember 1990 (GMBI. 1991, S. 56)
- [3-62] Richtlinie über Maßnahmen für den Schutz von Anlagen des Kernbrennstoffkreislaufs und sonstigen kerntechnischen Einrichtungen gegen Störmaßnahmen oder sonstige Einwirkungen zugangsberechtigter Einzelpersonen vom 28. Januar 1991 (GMBI. 1991, S. 228) p. 129, 141
- [3-63] Richtlinie für den Schutz von radioaktiven Stoffen gegen Störmaßnahmen oder sonstige Einwirkungen Dritter bei der Beförderung vom 4. Dezember 2003 (GMBI. 2004, Nr. 12)
- [3-64] Anforderungen an das Sicherungspersonal bei Beförderungen von radioaktiven Stoffen vom 4. Juni 1996 (GMBI. 1996, Nr. 29 + 33)
- [3-65] Anforderungen an Lehrgänge zur Vermittlung kerntechnischer Grundlagenkenntnisse für verantwortliches Schichtpersonal in Kernkraftwerken - Anerkennungskriterien vom 10. Oktober 1994
- [3-67] Richtlinie über Anforderungen an Personendosismeßstellen nach Strahlenschutz- und Röntgenverordnung vom 10. Dezember 2001 (GMBI. 2002, Nr. 6)
- [3-71] Richtlinie für die Fachkunde von verantwortlichen Personen in Anlagen zur Herstellung von Brennelementen für Kernkraftwerke vom 30. November 1995 (GMBI. 1996, Nr. 2)
- [3-73] Leitfaden zur Stilllegung von Anlagen nach § 7 des Atomgesetzes vom 14. Juni 1996 (BAnz. 1996, Nr. 211a), in Überarbeitung p. 74, 123, 158
Leitfäden zur Durchführung von Periodischen Sicherheitsüberprüfungen (PSÜ) für Kernkraftwerke in der Bundesrepublik Deutschland, in Überarbeitung
- [3-74-1] - Grundlagen zur Periodischen Sicherheitsprüfung für Kernkraftwerke
- Leitfaden Sicherheitsstatusanalyse
- Leitfaden Probabilistische Sicherheitsanalyse
Bekanntmachung vom 18. August 1997 (BAnz. 1997, Nr. 232a)
- [3-74-2] - Leitfaden Deterministische Sicherheitsanalyse
Bekanntmachung vom 25. Juni 1998 (BAnz. 1998, Nr. 153)
- [3-74-3] - Leitfaden Probabilistische Sicherheitsanalyse
Bekanntmachung vom 30. August 2005 (BAnz. 2005, Nr. 207)

4 Recommendations of the RSK

- [4-1] RSK-Leitlinien für Druckwasserreaktoren
Ursprungsfassung (3. Ausgabe vom 14. Oktober 1981) mit Änderungen vom 15. November 1996
- [4-2] Sicherheitstechnische Leitlinien für die trockene Zwischenlagerung bestrahlter Brennelemente in Behältern, Empfehlung der RSK, Anlage 1 zum Ergebnisprotokoll der 338. Sitzung der Reaktor-Sicherheitskommission am 1. März 2001 various citations
- [4-3] Sicherheitsanforderungen an die längerfristige Zwischenlagerung schwach- und mittelradioaktiver Abfälle, Empfehlung der RSK, Anlage 1 zum Ergebnisprotokoll der 357. Sitzung der Reaktor-Sicherheitskommission am 5. Dezember 2002, mit Neuformulierung in Abschnitt 2.7.1 (dritter Spiegelstrich) vom 16. Oktober 2003 various citations

5 Rules of the Nuclear Safety Standards Commission (KTA)

Rule no. KTA	Title	Most recent edition	Published in <i>Bundesanzeiger</i> / Federal Gazette No. dated	Earlier versions	Confirmation of continued validity	Engl. translation
	<u>1000 KTA-interne Verfahrensregeln</u>					
	<u>1100 Begriffe und Definitionen</u> (Begriffesammlung der KTA-GS)	1/06	-	6/91 1/96 1/04	-	-
	<u>1200 Allgemeines, Administration, Organisation</u>					
1201*	Anforderungen an das Betriebshandbuch	6/98	172 a - 15.09.98	2/78 3/81 12/85		+
1201*	Anforderungen an das Betriebshandbuch	11/07	239 – 21.12.07	-	-	-
1202*	Anforderungen an das Prüfhandbuch	6/84	191 a - 09.10.84 Attachment 51/84	-	15.06.99	+
1202*	Anforderungen an das Prüfhandbuch	11/07	239 – 21.12.07	-	-	-
1203*	Anforderungen an das Notfallhandbuch	-	-	-	-	-
	<u>1300 Radiologischer Arbeitsschutz</u>					
1301.1	Berücksichtigung des Strahlenschutzes der Arbeitskräfte bei Auslegung und Betrieb von Kernkraftwerken; Teil 1: Auslegung	11/84	40 a - 27.02.85	-	16.11.04	+
1301.2*	Berücksichtigung des Strahlenschutzes der Arbeitskräfte bei Auslegung und Betrieb von Kernkraftwerken; Teil 2: Betrieb	6/89	158 a - 24.08.89 Correction 118 29.06.91	6/82	16.11.04	+
1301.2*	Berücksichtigung des Strahlenschutzes der Arbeitskräfte bei Auslegung und Betrieb von Kernkraftwerken; Teil 2: Betrieb	11/07	239 – 21.12.07	-	-	-
	<u>1400 Qualitätssicherung</u>					
1401*	Allgemeine Forderungen an die Qualitätssicherung	6/96	216 a - 19.11.96	2/80 12/87	19.06.01	+
1404*	Dokumentation beim Bau und Betrieb von Kernkraftwerken	6/01	235 a - 15.12.01	6/89	-	+
1408.1*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 1: Eignungsprüfung	6/85	203 a - 29.10.85	-	19.06.01	+
1408.1*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 1: Eignungsprüfung	11/07	239 – 21.12.07	-	-	-
1408.2*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 2: Herstellung	6/85	203 a - 29.10.85 Correction 229 - 10.12.86	-	19.06.01	+

Rule no. KTA	Title	Most recent edition	Published in <i>Bundesanzeiger</i> / Federal Gazette No. dated	Earlier versions	Confirmation of continued validity	Engl. translation
1408.2*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 2: Herstellung	11/07	239 – 21.12.07	-	-	-
1408.3*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 3: Verarbeitung	6/85	203 a - 29.10.85	-	19.06.01	+
1408.3*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 3: Verarbeitung	11/07	239 – 21.12.07	-	-	-
<u>1500 Strahlenschutz und Überwachung</u>						
1501	Ortsfestes System zur Überwachung von Ortsdosisleistungen innerhalb von Kernkraftwerken	11/04	35 a - 19.02.05	10/77 6/91	-	+
1502	Überwachung der Radioaktivität in der Raumluf von Kernkraftwerken	11/05	101 a - 31.05.06	6/86 (1502.1)	-	+
(1502.2)	Überwachung der Radioaktivität in der Raumluf von Kernkraftwerken; Teil 2: Kernkraftwerke mit Hochtemperaturreaktor	6/89	229 a - 07.12.89	-	-	+
1503.1	Überwachung der Ableitung gasförmiger und aerosolgebundener radioaktiver Stoffe; Teil 1: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei bestimmungsgemäßem Betrieb	6/02	172 a - 13.09.02	2/79 6/93	13.11.07	+
1503.2	Überwachung der Ableitung gasförmiger und aerosolgebundener radioaktiver Stoffe; Teil 1: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei Störfällen	6/99	243 b - 23.12.99	-	16.11.04	+
1503.3	Überwachung der Ableitung gasförmiger und aerosolgebundener radioaktiver Stoffe; Teil 1: Überwachung der nicht mit der Kaminluft abgeleiteten radioaktiven Stoffe	6/99	243 b - 23.12.99	-	16.11.04	+
1504	Überwachung der Ableitung radioaktiver Stoffe mit Wasser	11/07	9 a - 17.01.08	6/78 6/94	-	+
1505	Nachweis der Eignung von Strahlungsmesseinrichtungen	11/03	26 a - 07.02.04	-	-	-
(1506)	Messung der Ortsdosisleistung in Sperrbereichen von Kernkraftwerken (Rule has been withdrawn on 16/11/2004)	6/86	162 a - 03.09.86 Correction 229 - 10.12.86	-	16.11.04 with- drawn	+
1507	Überwachung der Ableitungen gasförmiger, aerosolgebundener und flüssiger radioaktiver Stoffe bei Forschungsreaktoren	6/98	172 a - 15.09.98	3/84	11.11.03	-
1508	Instrumentierung zur Ermittlung der Ausbreitung radioaktiver Stoffe in der Atmosphäre	11/06	245b - 30.12.06	9/88	-	+

Rule no. KTA	Title	Most recent edition	Published in <i>Bundesanzeiger</i> / Federal Gazette No. dated	Earlier versions	Confirmation of continued validity	Engl. translation
	<u>2100 Gesamtanlage</u>					
2101.1	Brandschutz in Kernkraftwerken; Teil 1: Grundsätze des Brandschutzes	12/00	106 a - 09.06.01	12/85	22.11.05	+
2101.2	Brandschutz in Kernkraftwerken; Teil 2: Brandschutz an baulichen Anlagen	12/00	106 a - 09.06.01	-	22.11.05	+
2101.3	Brandschutz in Kernkraftwerken; Teil 3: Brandschutz an maschinen- und elektrotechnischen Anlagen	12/00	106 a - 09.06.01	-	22.11.05	+
2103	Explosionsschutz in Kernkraftwerken mit Leichtwasserreaktoren (Allgemeine und fallbezogene Anforderungen)	6/00	231 a - 08.12.00	6/89	22.11.05	+
	<u>2200 Einwirkungen von außen</u>					
2201.1*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 1: Grundsätze	6/90	20 a - 30.01.91	6/75	20.06.00	+
2201.2*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 2: Baugrund	6/90	20 a - 30.01.91	11/82	20.06.00	+
2201.4*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 4: Anforderungen an Verfahren zum Nachweis der Erdbebensicherheit für maschinen- und elektrotechnische Anlagenteile	6/90	20 a - 30.01.91 Correction 115 - 25.06.96	-	20.06.00	+
2201.5	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 5: Seismische Instrumentierung	6/96	216 a - 19.11.96	6/77 6/90	07.11.06	+
2201.6*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 6: Maßnahmen nach Erdbeben	6/92	36 a - 23.02.93	-	18.06.02	+
2206*	Auslegung von Kernkraftwerken gegen Blitzeinwirkungen	6/00	159 a - 24.08.00	6/92	-	-
2207	Schutz von Kernkraftwerken gegen Hochwasser	11/04	133 a - 16.07.05	6/82 6/92	-	+
	<u>2500 Bautechnik</u>					
2501	Bauwerksabdichtungen von Kernkraftwerken	11/04	133 a - 16.07.05	9/88 6/02	-	+
2502*	Mechanische Auslegung von Brennelementlagerbecken in Kernkraftwerken mit Leichtwasserreaktoren	6/90	20 a - 30.01.91	-	20.06.00	+
	<u>3000 Systeme allgemein</u>					
	<u>3100 Reaktorkern und Reaktorregelung</u>					
3101.1*	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 1: Grundsätze der thermohydraulischen Auslegung	2/80	92 - 20.05.80	-	20.06.00	+

Rule no. KTA	Title	Most recent edition	Published in <i>Bundesanzeiger</i> / Federal Gazette No. dated	Earlier versions	Confirmation of continued validity	Engl. translation
3101.2*	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 2: Neutronenphysikalische Anforderungen an Auslegung und Betrieb des Reaktorkerns und der angrenzenden Systeme	12/87	44 a - 04.03.88	-	10.06.97	+
(3102.1)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 1: Berechnung der Helium-Stoffwerte	6/78	189 a - 06.10.78 Attachment 23/78	-	15.06.93	+
(3102.2)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 2: Wärmeübergang im Kugelhaufen	6/83	194 - 14.10.83 Attachment 47/83	-	15.06.93	+
(3102.3)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 3; Reibungsdruckverlust in Kugelhaufen	3/81	136 a - 28.07.81 Attachment 24/81	-	15.06.93	+
(3102.4)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 4: Thermohydraulisches Berechnungsmodell für stationäre und quasistationäre Zustände im Kugelhaufen	11/84	40 a - 27.02.85 Correction 124 - 07.07.89	-	15.06.93	+
(3102.5)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 5: Systematische und statistische Fehler bei der thermohydraulischen Kernauslegung des Kugelhaufenreaktors	6/86	162 a - 03.09.86	-	15.06.93	+
3103*	Abschaltssysteme von Leichtwasserreaktoren	3/84	145 a - 04.08.84 Attachment 39/84	-	15.06.99	+
3104	Ermittlung der Abschaltreaktivität	10/79	19 a - 29.01.80 Attachment 1/80	-	16.11.04	+
<u>3200 Primär- und Sekundärkreis</u>						
3201.1	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 1: Werkstoffe und Erzeugnisformen	6/98	170 a - 11.09.98	2/79 11/82 6/90	11.11.03	+
3201.2*	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 2: Auslegung, Konstruktion und Berechnung	6/96	216 a - 19.11.96 Correction 129 - 13.07.00	10/80 3/84	-	+
3201.3	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 3: Herstellung	11/07	9 a - 17.01.08	10/79 12/87 6/98	-	+
3201.4*	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung	6/99	200 a - 22.10.99	6/82; 6/90	-	+
3203	Überwachung der Strahlenversprödung von Werkstoffen des Reaktordruckbehälters von Leichtwasserreaktoren	6/01	235 a - 12.12.01	3/84	07.11.06	+
3204*	Reaktordruckbehälter-Einbauten	6/98	236 a - 15.12.98 Correction 129 - 13.07.00 136 - 22.07.00	3/84	-	-

Rule no. KTA	Title	Most recent edition	Published in <i>Bundesanzeiger</i> / Federal Gazette No. dated	Earlier versions	Confirmation of continued validity	Engl. translation
3204*	Reaktordruckbehälter-Einbauten	11/07	239 – 21.12.07	-	-	-
3205.1	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 1: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für Primärkreis-komponenten in Leichtwasserreaktoren	6/02	189 a - 10.10.02	6/82 6/91	13.11.07	-
3205.2*	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 2: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für druck- und aktivitätsführende Komponenten in Systemen außerhalb des Primärkreises	6/90	41 a - 28.02.91	-	20.06.00	+
3205.3	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 3: Serienmäßige Standardhalterungen	11/06	163 - 31.08.07	6/89	-	-
3211.1*	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 1: Werkstoffe	6/00	194 a - 14.10.00 Correction 132 - 19.07.01	6/91	-	+
3211.2*	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 2: Auslegung, Konstruktion und Berechnung	6/92	165 a - 03.09.93 Correction 111 - 17.06.94	-	-	+
3211.3	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 3: Herstellung	11/03	26 a - 07.02.04	6/90	-	-
3211.4*	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung	6/96	216 a - 19.11.96	-	19.06.01	+
<u>3300 Wärmeabfuhr</u>						
3301*	Nachwärmeabfuhrsysteme von Leichtwasserreaktoren 2)	11/84	40 a - 27.02.85	-	15.06.99 ¹⁾	+
3303*	Wärmeabfuhrsysteme für Brennelement-lagerbecken von Kernkraftwerken mit Leichtwasserreaktoren	6/90	41 a - 28.02.91	-	20.06.00	+
<u>3400 Sicherheitseinschluß</u>						
3401.1*	Reaktorsicherheitsbehälter aus Stahl; Teil 1: Werkstoffe und Erzeugnisformen	9/88	37 a - 22.02.89	6/80 11/82	16.06.98	+
3401.2	Reaktorsicherheitsbehälter aus Stahl; Teil 2: Auslegung, Konstruktion und Berechnung	6/85	203 a - 29.10.85	6/80	22.11.05	+
3401.3*	Reaktorsicherheitsbehälter aus Stahl; Teil 3: Herstellung	11/86	44 a - 05.03.87	10/79	10.06.97	+
3401.4	Reaktorsicherheitsbehälter aus Stahl; Teil 4: Wiederkehrende Prüfungen	6/91	7 a - 11.01.92	3/81	07.11.06	+
3402	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken - Personenschleusen	11/76	38 - 24.02.77	-	16.11.04	+

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3403*	Kabeldurchführungen im Reaktorsicherheitsbehälter von Kernkraftwerken	10/80	44 a - 05.03.81 Attachment 6/81	11/76	19.06.01	+
3404	Abschließung der den Reaktorsicherheitsbehälter durchdringenden Rohrleitungen von Betriebssystemen im Falle einer Freisetzung von radioaktiven Stoffen in den Reaktorsicherheitsbehälter	9/88	37 a 22.02.89 Correction 119 - 30.06.90	-	11.11.03	+
3405*	Integrale Leckratenprüfung des Sicherheitsbehälters mit der Absolutdruckmethode	2/79	133 a - 20.07.79 Attachment 27/79	-	15.06.99	+
3407	Rohrdurchführungen durch den Reaktorsicherheitsbehälter	6/91	113 a - 23.06.92	-	07.11.06	+
3409	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken - Materialschleusen	6/79	137 - 26.07.79	-	16.11.04	+
3413	Ermittlung der Belastungen für die Auslegung des Volldrucksicherheitsbehälters gegen Störfälle innerhalb der Anlage	6/89	229 a - 07.12.89	-	16.11.04	+
<u>3500 Instrumentierung und Reaktorschutz</u>						
3501*	Reaktorschutzsystem und Überwachungseinrichtungen des Sicherheitssystems	6/85	203 a - 29.10.85	3/77	20.06.00	+
3502	Störfallinstrumentierung	6/99	243 b - 23.12.99	11/82 11/84	16.11.04	+
3503	Typprüfung von elektrischen Baugruppen des Reaktorschutzsystems	11/05	101 a - 31.05.06	6/82 11/86	-	+
3504	Elektrische Antriebe des Sicherheitssystems in Kernkraftwerken	11/06	245 b - 30.12.06	9/88	-	-
3505	Typprüfung von Messwertgebern und Messumformern des Reaktorschutzsystems	11/05	101 a - 31.05.06	11/84	-	-
3506*	Systemprüfung der leittechnischen Einrichtungen des Sicherheitssystems in Kernkraftwerken	11/84	40 a - 27.02.85	-	18.06.02	+
3507*	Werksprüfungen, Prüfungen nach Instandsetzung und Nachweis der Betriebsbewährung für leittechnische Einrichtungen des Sicherheitssystems	6/02	27 a - 08.02.03	11/86	-	+
<u>3600 Aktivitätskontrolle und -führung</u>						
3601	Lüftungstechnische Anlagen in Kernkraftwerken	11/05	101 a - 31.05.06	6/90	-	+
3602	Lagerung und Handhabung von Brennelementen, Steuerelementen und Neutronenquellen in Kernkraftwerken mit Leichtwasserreaktoren	11/03	26 a - 07.02.04	6/82 6/84 6/90		+
3603*	Anlagen zur Behandlung von radioaktiv kontaminiertem Wasser in Kernkraftwerken	6/91	7 a - 11.01.92	2/80	19.06.01 ²⁾	+

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3604	Lagerung, Handhabung und innerbetrieblicher Transport radioaktiver Stoffe (mit Ausnahme von Brennelementen) in Kernkraftwerken	11/05	101 a - 31.05.06	6/83	-	+
3605	Behandlung radioaktiv kontaminierter Gase in Kernkraftwerken mit Leichtwasserreaktoren	6/89	229 a - 07.12.89	-	16.11.04	+
<u>3700 Energie- und Medienversorgung</u>						
3701	Übergeordnete Anforderungen an die elektrische Energieversorgung in Kernkraftwerken	6/99	243 b - 23.12.99	3701.1 (6/78) 3701.2 (6/82) 6/97	16.11.04	+
3702	Notstromerzeugungsanlagen mit Dieselaggregaten in Kernkraftwerken	6/00	159 a - 24.08.00	3702.1 (6/88) 3702.2 (6/91)	22.11.05	-
3703	Notstromanlagen mit Batterien und Gleichrichtergeräten in Kernkraftwerken	6/99	243 b - 23.12.99	6/86	16.11.04	+
3704	Notstromanlagen mit Gleichstrom-Wechselstrom-Umformern in Kernkraftwerken	6/99	243 b - 23.12.99	6/84	16.11.04	+
3705	Schaltanlagen, Transformatoren und Verteilungsnetze zur elektrischen Energieversorgung des Sicherheitssystems in Kernkraftwerken	11/06	245 b - 30.12.06	9/88 6/99	-	-
3706	Sicherstellung des Erhalts der Kühlmittelverlust-Störfallfestigkeit von Komponenten der Elektro- und Leittechnik in Betrieb befindlicher Kernkraftwerke	6/00	159 a - 24.08.00	-	22.11.05	-
<u>3900 Systeme, sonstige</u>						
3901	Kommunikationsmittel für Kernkraftwerke	11/04	35 a - 19.02.05	3/77 3/81	-	+
3902*	Auslegung von Hebezeugen in Kernkraftwerken	6/99	144 a - 05.08.99	11/75 6/78 11/83 6/92	16.11.04	+
3903*	Prüfung und Betrieb von Hebezeugen in Kernkraftwerken	6/99	144 a - 05.08.99	11/82 6/93	16.11.04	+
3904	Warte, Notsteuerstelle und örtliche Leitstände in Kernkraftwerken	11/07	9 a - 17.01.08	9/88	-	+
3905*	Lastanschlagpunkte an Lasten in Kernkraftwerken	6/99	200 a - 22.10.99 Correction 129 - 13.07.00 136 - 22.07.00	6/94	-	+

* Rule under revision

() HTR rule which is no longer included in monitoring to section 5.2 of the KTA procedural instruction and is no longer available for purchase via Carl Heymanns Verlag KG.

1) At its 43rd meeting on 17 June 1989, the KTA adopted the "Instructions for users of rule KTA 3301 (11/84)".

2) In this rule the stipulations on HTR have been removed.

(g) References to Official National and International Reports Related to Safety**Official National Reports**

1. Produktkontrolle radioaktiver Abfälle – Schachtanlage Konrad – Stand Dezember 1995; Hrsg.: Berndt-Rainer Martens; Salzgitter, Dezember 1995; BfS ET-IB-45-REV-3
2. Anforderungen an endzulagernde radioaktive Abfälle (Endlagerungsbedingungen, Stand: Dezember 1995) – Schachtanlage Konrad; Hrsg.: Peter Brennecke; Salzgitter, Dezember 1995; BfS ET-IB-79
3. Anforderungen an endzulagernde radioaktive Abfälle und Maßnahmen zur Produktkontrolle radioaktiver Abfälle Endlager für radioaktive Abfälle Morsleben (ERAM) Teil I: Endlagerungsbedingungen, Stand: August 1996; bearbeitet von Karin Kugel, Werner Noack, Heinz Giller, Berndt-Rainer Martens, Peter Brennecke; Salzgitter, August 1996; BfS ET-IB-85
4. Anforderungen an endzulagernde radioaktive Abfälle und Maßnahmen zur Produktkontrolle radioaktiver Abfälle Endlager für radioaktive Abfälle Morsleben (ERAM) Teil II: Produktkontrolle, Stand: Dezember 1996; bearbeitet von Berndt-Rainer Martens, Heinz Giller, Peter Brennecke; Salzgitter, Dezember 1996; BfS ET-IB-85/2
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Additional Report Concerning the Remediation of the Wismut GmbH

This section deals with contaminated uranium mining and milling sites and their remediation.

1 Scope of the Wismut Project

Starting Point of the Ecological Remediation of the Contaminated Former Uranium Ore Mining and Milling Sites in Germany

Starting in 1946, uranium ore mining in the former German Democratic Republic was executed by a purely Soviet company. Between 1954 and 1990, the mines were operated by the Soviet-German Wismut joint-stock company (SDAG Wismut). By 1990, these companies produced a total of approx. 231 000 Mg of uranium. This made the German Democratic Republic the third-largest uranium producer worldwide.

In the Transition Agreement of 9 October 1990, the governments of the Federal Republic of Germany and the USSR agreed to cease uranium mining on the territory of the former GDR on 1 January 1991. The Government Agreement of 16 May 1991 terminated the entire operations of the SDAG Wismut, and the Soviet share of 50 % was transferred to the Federal Republic of Germany.

Thus the conditions had been created for

- the conversion of the company into a corporation under German law,
- corporate restructuring,
- orderly decommissioning of the mining and processing operations
- the rapid remediation and recultivation of the contaminated uranium mining and milling sites.

The Wismut GmbH was founded in December 1991 as a federally-owned company. Sole shareholder is the Federal Republic of Germany, represented by the Federal Ministry of Economics and Technology.

The history of the Wismut company and the initial situation following the termination of uranium production in 1990 were presented in detail in the Wismut GmbH report on remediation activities for the second Review Meeting.

Task

It has been and still is the task of the Wismut GmbH to remediate the contaminated uranium mining and milling sites in the Free States of Saxony and Thuringia so that they will not pose any hazards or risks to man and the environment in the long run. Of particular importance in this context are the safe decommissioning and closeout of the pits and the stabilisation of tailings ponds as well as the treatment of all contaminated waters from remediation operations.

For the fulfilment of this task, the Federal Government earmarked a total of 6.2 billion euros in the federal budget, of which so far (end of 2007) approx. 5 billion euros have been spent.

Extent of the Contaminated Uranium Mining and Milling Sites

The areas of former uranium ore exploitation extended over a total area of approx. 37 km² when remediation began in 1991. About 15.2 km² accommodated 48 heaps with a volume of approx. 311.6 million m³. Approx. 160.4 million m³ of radioactive sludge from uranium ore exploitation and processing were deposited in 14 storage lagoons and tailings ponds covering a surface area of approx. 7.3 km². In 1991, the open underground drifts still had a total length of 1 400 km. Figure 1 gives a survey of the sites.

Figure 1: Map showing the remediation sites, ©Archive Wismut GmbH



In addition, there are abandoned former uranium mining and milling sites at locations that were already decommissioned prior to 31 December 1962 and the remediation of which is not the responsibility of Wismut GmbH (so-called abandoned Wismut sites).

Approach to Managing the Radioactive Legacies

Principles Under Radiation Protection Law

The radiation protection authorities of the *Länder* Saxony and Thuringia are responsible for granting any licenses under radiation protection law with respect to the remediation activities of Wismut GmbH. According to § 118 StrlSchV, the regulations of the former GDR continue to apply to the decommissioning and remediation of the former uranium ore mining sites; these are the GDR Ordinance on Nuclear Safety and Radiation Protection (*Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz - VOAS*) of 11 October 1984 and its Implementing Regulation of 1984 (*Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz - DB zur VOAS*) and the Order of 1980 on Radiation Protection in Relation to Heaps and Industrial Repositories (*Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei der Verwendung darin abgelagerter Materialien - HaldenAO*) of 17 November 1990.

The regulations of the StrlSchV have to be applied to the protection of occupationally exposed personnel as well as to emission and immission monitoring. Generally, the principles of justification, dose limitation and optimisation (according to the ALARA principle) have to be applied in the assessment and licensing of remediation measures. The justification of remediation measures as well as the assessment of the remaining radiation exposure still posed after conclusion of the remediation of the contaminated uranium mining and milling sites are based on the reference value for the effective individual dose to the population of 1 mSv/a.

Further details can be taken from the corresponding chapter in the National Report for the Second Review Meeting.

Brief Description of Remediation Techniques

- Partial backfilling of the shafts and underground mine workings.
- Flooding of the pits by termination of existing mine drainage measures, which may take several years up to several decades depending on the site and the geological conditions.
- Implementation of long-term measures for treating the emerging groundwater and leachate.
- Backfilling of the open-cast mine at the Ronneburg site using material from the surrounding dumps as well as radioactively contaminated material from demolition and from the remediation of surface areas. Termination of mine drainage measures will also entail partial flooding of the backfilled open-cast mine.
- Safe in-situ encapsulation of the tailings ponds of the processing plant with partial technical drainage. The remaining sludges are additionally stabilised with geotechnical materials so that a stable cover can be provided that reduces the infiltration of rainwater as well as the release of radon. Dams and basins are profiled to enhance their stability before being covered and landscaped.
- Mine dumps rehabilitated in-situ and the waste rock material materials relocated to the open-cast mine at the Ronneburg site are covered with a mineral layer to prevent direct radiation, radon exhalation and dusting as well as to reduce the infiltration of precipitation. The design planning considers whether the covers need to include a barrier against the entry of oxygen in order to avoid increased contaminant release due to oxidation processes in the heap material.
- Buildings of the various plant premises are for the most part demolished. The demolition waste is mostly deposited in the worked-out open-cast mine, in mine dumps and in tailings ponds. The largest part of the existing scrap metal is decontaminated if necessary and returned to the economic cycle.

2 Remediation Progress Made by the End of 2007

Status of Remediation

Remedial operations at the sites of former uranium ore mining and processing have progressed considerably in recent years. A large number of remediation projects have already been completed, and rehabilitated areas have been prepared for future re-use.

A noteworthy example of alternative use of former mining areas at the Ronneburg site is their re-use to host part of the German Federal Garden Show BUGA 2007 from April until October 2007. Almost 1.5 million visitors took the opportunity to visit not only the gardening exhibition but particularly also the remediation performance in the former uranium ore mining area.

Underground remediation is 99 % complete. It involved

- cleanup and abandonment of 1 450 km of mine workings,
- plugging and sealing 1 364 000 m³ of shafts and adits,
- backfilling 218 756 m³ of mine workings near the surface.

The remediation of mine dumps continues to schedule at all sites. Backfilling of the Lichtenberg open-cast mine has reached almost 100 % and is about to be finished (so far, approx. 130 million m³ of waste rock material and material from demolition and the remediation of surface

areas have been deposited). Work relating to the excavation or relocation of mine dumps is 90 % complete, which corresponds to approx. 151 million m³ of material moved. The covering mine dumps including the open-cast mines is 84 % complete.

Interim covers on industrial tailings ponds have been applied almost 100 %. In contouring the Trünzig, Culmitzsch and Helmsdorf/Dänkritz I tailings ponds, approx. 7.9 million m³ of material have been moved so far, which corresponds to 36 % of the planned amounts. Final covering is 16 % complete at approx. 1.8 million m³.

Demolition of buildings and facilities is 89 % complete. So far, the work has generated approx. 800 000 m³ of demolition waste. Of the former plant areas, approx. 920 ha have been rehabilitated, which corresponds to 68 %.

Operation of water treatment plants at the different sites takes site-specific conditions into account. As and when required, treatment plants are adapted to the changing conditions at the sites (elimination of supernatant water in the tailings ponds, changes in the water quality). The operation of the passive-biological water treatment facility at the Pöhla site was further stabilised. Altogether, approx. 291 million m³ of contaminated waters have been treated so far in the water treatment plans.

Of the € 6.2 billion provided by the Federal Government for the fulfilment of the remediation tasks, almost € 5.0 billion had been spent by the end of 2007, which is approx. 80 %.

On 5 September 2003, the Federation and the Free State of Saxony signed an administration agreement on the remediation of abandoned Wismut sites of Saxony (cf. also section 1). The Federation and the Free State of Saxony each will provide € 39 million until the end of 2012 for the remediation of abandoned Wismut sites in Saxony. Wismut GmbH was commissioned as project management agency. The Remediation Advisory Committee, established on the basis of the administration agreement, has approved of approx. 250 preparation and implementation projects since 2003. By the end of 2007, a total of € 29 million has been spent on the remediation of abandoned Wismut sites in Saxony.

Presentation of Selected Remediation Projects

Figure 2 to Figure 6 depict of a few selected remediation projects.

Figure 2: Mine dump 366 Aue Operations Office, in 1991 (left) and the remediated dump 366 with feeder road in 2007 (right), ©Wismut GmbH Archives



Figure 3: Lichtenberg open-cast mine in 1992 (left) and with fill body, New Ronneburg Landscape part of 2007 German Federal Garden Show landscape (right), ©Wismut GmbH Archives



Figure 4: Trünzig tailings pond (TMA) at the Seelingstädt site, Ronneburg Operations Office, in 1991 (left) and in 2007 (right), ©Wismut GmbH Archives



Figure 5: Former ore-loading point at the Oberschlema railway station at the time of the removal of radioactively contaminated materials (left) and after completion of the remediation (right), ©Wismut GmbH Archives

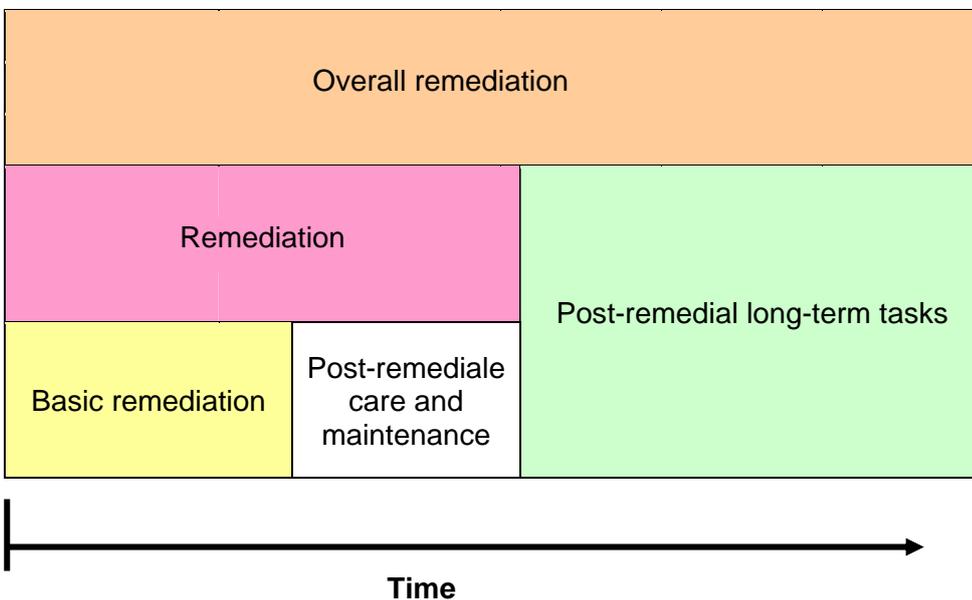


Figure 6: Surface subsidence mitigation near Shaft 348, Schmiedeberg, ©Wismut GmbH Archives



3 Long-Term Tasks

The so-called long-term tasks comprise all activities that are necessary for the long-term preservation and safeguarding of the conditions achieved by the remediation. The long-term tasks commence with the completion of the remediation work. Scheduling and hierarchical classification of the long-term tasks are shown in the diagram below:



Post-remedial care and maintenance forms a part of remediation and represents a special case that only is of relevance for the covers of mine dumps and tailings ponds and for which usually a period of approx. 5 years following the completion of basic remediation of the object in question is assumed.

The long-term tasks are divided in to the following categories:

- I. Control, repair and maintenance of covers of mine dump and tailings pond covers and of the covers placed on the backfilled Lichtenberg open pit mine and the Lichtenberg dump.
- II. Treatment of flooding waters and leachates
- III. Stability of mine workings
- IV. Environmental monitoring
- V. Mitigation of mining damage

From today's perspective, it is assumed that the remediation tasks will largely be complete by the year 2015. The long-term tasks will be necessary for a period that cannot be defined exactly today; some of these tasks will be of an eternal character.